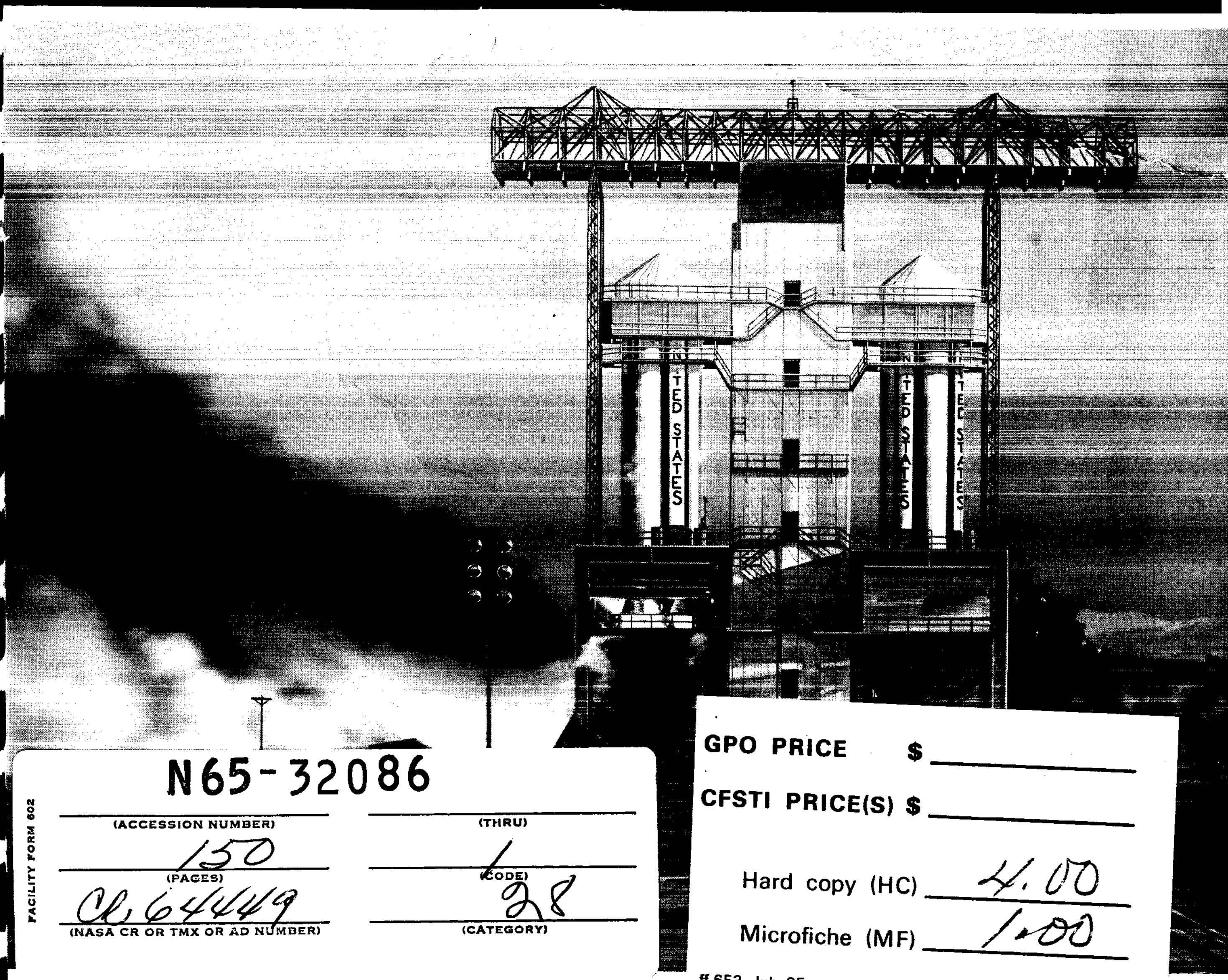
SATURN S-IB STAGE FINAL STATIC TEST REPORT



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STAGE S-IB-1

SPACE DIVISION CHRYSLER CORPORATION

SATURN S-IB STAGE

FINAL STATIC TEST REPORT

STAGE S-IB-1

JUNE 4, 1965

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ABSTRACT

This report describes the acceptance test firing of the Saturn flight stage S-IB-1 conducted at the Static Test Tower East, Marshall Space Flight Center (MSFC), 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-1. 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.

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SUMMARY

This report describes the acceptance test firings of the Saturn flight stage S-IB-1 which were conducted at the Static Test Tower East (STTE), Marshall Space Flight Center (MSFC), Huntsville, Alabama, during the period March 14 to April 20, 1965.

The short duration static firing, SA-25, and the long duration acceptance firing, SA-26, were both successful. They were conducted on April 1 and April 13, respectively.

Test duration of SA-25 was 35.174 seconds from ignition command to inboard engine cutoff. Cutoff was initiated by the firing panel operator. On test SA-26, inboard engine cutoff signal was initiated 138.21 seconds after ignition command by the flight sequencer, 2 seconds after the LOX low level sensor in tank O-2 uncovered. Outboard engine cutoff signal was initiated 6.80 seconds later when LOX depletion caused dropout of engine 1 Thrust OK pressure switches. No adverse hardware effects were noted on engine 1 as a result of LOX depletion cutoff.

Engine operation and performance were satisfactory during tests SA-25 and SA-26, and all engines produced thrust within the specified limits of 200,000 pounds $\pm$ 3 percent.

Engine 3 solid propellant gas generator ignition characteristics for test SA-26 were abnormal in that combustion was established slower than usual. Gas generator injection pressures and conisphere temperature rise rate were slower than at other engines (approximately 65 milliseconds slower to peak). The effect of the slight delay in SPGG combustion was negligible and was not discernible in the engine starting transients. The probable cause for the SPGG ignition delay was either incomplete pellet ignition or premature diaphragm burst.

Oscillograph data on test SA-26 indicated that engine 2 experienced a P_c Pop after the hypergol diaphragm had burst. Igniter fuel system had been purged prior to the test.

After test SA-26, an inspection of engine 7 (S/N 4046) indicated an internal thrust chamber tube leak 13 inches below the injector. A thrust chamber tube was found to have a longitudinal crack 15/32 inch long by 1/16 inch wide. Engine 7 will be replaced with a spare engine upon return of the stage to Michoud for post static checkout.

Visual inspection of engine 8 after test SA-26 revealed a distorted bellows section in the turbine exhaust duct adjacent to the heat exchanger. The bellows section will be replaced during post static checkout of the stage at Michoud.

The LOX ullage at ignition for test SA-25 was 2.2 percent. This was a greater ullage than the 1.7 percent flight ullage desired for the test due to LOX boiloff during a hold in the countdown. LOX tank pressure reached a maximum of 57.5 psia at cutoff as a result of excessive GOX flow. The GOX flow control valve (GFCV) position measurement indicated that it reached the closed position at approximately X+4 seconds and remained there for the duration of the test. Prior to test SA-26, the heat exchangers were reorificed from 0.108-inch diameter to 0.104-inch diameter, and the GFCV closed stop setting was changed from 0.290 inch to 0.255 inch. These changes reduced LOX tank pressure to a maximum of 55 psia during test SA-26.

The fuel tank pressurization system functioned properly during test SA-25. On test SA-26, the fuel discrete probe data indicated the differential levels in fuel tanks F-1 and F-3 varied considerably. The difference in fuel levels is attributed to unequal fuel tank ullage pressures caused by unbalanced pressure distribution in the fuel tank pressurizing manifold.

The GN_2 control pressure system functioned normally during test SA-25. It also functioned normally during test SA-26 except for maintaining 3,000 psig preignition control sphere pressure with the gearcase purge on. Post test checkout showed that a change of the supply line orifice from 0.050-inch diameter to 0.055-inch diameter will provide the specified 3,000 psig control sphere pressure.

During stage removal from the static test tower, five ripples in fuel tank F-3 were observed. The ripples were approximately 12 inches long and 1/4 inch deep.

The performance of all other stage systems was satisfactory.

Necessary repairs and modifications to the stage will be accomplished at the Chrysler Corporation manufacturing facility at Michoud, Louisiana.

SECTION 1

INTRODUCTION

The short and full duration firings, tests SA-25 and SA-26 of Saturn stage S-IB-1, were performed by Chrysler Corporation Systems Static Test Branch, on April 1 and 13, 1965, respectively, at the Static Test Tower East (STTE), Marshall Space Flight Center (MSFC), Huntsville, Alabama.

Stage S-IB-1 is the first of the Saturn 200 series booster stages to be manufactured by Chrysler Corporation Space Division (CCSD). The stage was shipped by barge from the CCSD manufacturing facility at Michoud, Louisiana, on March 6 and arrived at the MSFC dock on March 14. Installation of stage S-IB-1 in the STTE was performed on March 15. After completion of the long duration firing, preparations were made to remove the stage from the test tower. The stage was removed from the STTE on April 19 and departed the MSFC dock by barge April 20.

The primary objective of the static firing tests of the Saturn S-IB stage is to demonstrate the correct functional performance and operation of the airborne systems under simulated launch conditions. To meet this requirement, two static firings were conducted on stage S-IB-1. The short duration firing, test SA-25, constituted a confidence test to verify airborne/ground control system compatibility, to check out instrumentation, and to obtain engine thrust level data. The long duration firing constituted an acceptance test and confirmed the correct operation of all airborne systems. The test objectives are further outlined as follows:

<u>SHORT DURATION FIRING</u>

1. Performance check of the gimbal system.

2. Performance check of the telemetry system.

3. Performance check of the engines.

4. Evaluation of the modified fuel pressurizing system.

5. Determination of LOX boiloff rate.

6. Evaluation of tank pressurization system transients with flight ullages.

7. Verification of stage/ground electrical control system compatibility.

LONG DURATION FIRING

1. Determine propellant tank draining rates and terminal LOX draining characteristics.

2. Verify engine performance.

3. Verify performance of the gimbal control system.

4. Verify reliability and performance of telemetry equipment.

5. Obtain LOX boiloff evaluation data, and verify bulk LOX density obtained during initial tanking.

The static test configuration of stage S-IB-1 is defined by drawing 60C10016. Deletions from the flight configuration include the following: stabilizer fins, instrumentation canister doors, and LOX replenish valve. Hardware additions include the following: static test holddown brackets, upper stage deluge firex ring, inboard engine turbine exhaust duct extensions, auxiliary LOX dome purge manifold, and three LOX and three fuel fill and drain valves. Block II type static test heat shield panels and engine flame curtains similar to flight hardware are used in place of the actual flight hardware (stainless steel honeycomb heat shield panels will not be incorporated until stage S-IB-3). A peripheral tail skirt radiation shield is also included as a part of the static test configuration.

The performance of each stage system is presented in sections 2 through 8 of this report.

The various sections of the APPENDIX contain the following information: reference reports, redline and blueline values, stage and ground support test data sheets, meteorological data, operating time/cycle history of components and Unsatisfactory Condition Reports.

SECTION 2

ENGINE SYSTEMS

Engine operation and performance during tests SA-25 and SA-26 was satisfactory. All engines produced thrust values within the specified limits of 200K±3 percent. No reorificing is recommended prior to launch.

Test duration of test SA-25 was 35.174 seconds from ignition command to inboard engine cutoff signal, with cutoff being initiated as scheduled by the firing panel operator. Outboard engine cutoff signal was given 120 milliseconds later by the switch selector.

Inboard engine cutoff signal for test SA-26 was initiated by the switch selector 138.21 seconds after ignition command and 2 seconds after the LOX low level sensor in tank 0-2 was uncovered. Outboard engine cutoff signal, triggered by dropout of the Thrust OK pressure switch (TOPS) on engine 1, occurred 6.80 seconds later. Thrust decay of engine 1, resulting from LOX depletion, began 117 milliseconds before dropout of the TOPS. Thrust decay was also indicated on engine 3, 67 milliseconds prior to dropout of the TOPS.

H-1 engine schematics can be found in FIGURES 2-1 and 2-2. Engine static test data for tests SA-25 and SA-26 can be found in TABLES 2-1 and 2-2, respectively. Ignition and cutoff sequences times for each engine are listed in TABLE 2-3 and 2-4 for tests SA-25 and SA-26, respectively. GRAPHS 2-1 through 2-16 show the oscillograph traces during the ignition and cutoff transition of each engine during test SA-26. Engine orifice sizes may be found in Item 13, APPENDIX C, Stage and Ground Support Test Data Sheets, Stage S-IB-1.

The "Confidential Supplement, Stage S-IB-1" contains the following information for tests SA-25 and SA-26: sea level engine thrust and turbopump speed values, combustion chamber pressures, run-to-run turbopump speeds versus chamber pressures, and a comparison of telemetry and hardwire values of combustion chamber pressures.

Prior to test SA-25, the pressure transducers for measurement PP116 were installed at the A-B gear jet pressure tap on engines 1, 2, 5, and 7. This was done as a part of a continuing investigation of possible lube jet restrictions on three of these engines (engines 1, 2, and 5). Engine 7 was instrumented as a control reference. Data were obtained from both the fuel lube blowdown and test SA-25. The values recorded during test SA-25 were 680, 670, 660, and 650 psig for engines 1, 2, 5, and 7, respectively. All values are within the maximum allowable limits.

Main LOX valves (MLV) position indicators were installed by Rocketdyne personnel on all engines prior to test SA-25. During test SA-25, the MLV position indication, measurement *P0100-4, was lost 230 milliseconds after the MLV began to close. Also, the MLV position indication on engine 1 did not indicate valve opening. Upon disassembly of the MLV from engine 4, the potentiometer retaining screws were found to be loose allowing the body of the potentiometer to rotate. This potentiometer was replaced prior to test SA-26. An investigation of engine 1 revealed a wiring error in the measuring system. This error was corrected.

Oscillograph data from test SA-26 indicated that the MLV position indication from engine 5 was erratic during the test. However, the opening and closing traces were normal. Further investigation revealed that two of the position indicator housing screws were loose allowing the potentiometer to vibrate during the test.

The Conax valve firing signal, as recorded on oscillograph during test SA-25, appeared to have occurred from 40 to 80 milliseconds late (see TABLE 2-3). This results from the routing of this signal through the vehicle Digital Data Acquisition System (DDAS) which has an interrogating rate of 83.3 milliseconds. On future stages, data appearing on oscillograph will be hardwired around the DDAS so that all oscillograph data will appear in the actual time sequence.

The engine 8 conisphere temperature thermocouple measurement *PT103-8, malfunctioned at ignition of test SA-25. Post test inspection indicated that the fast-response lead was bent against the heavy wire lead; however, the junction was covered with carbon and the exact cause of the malfunction could not be proven. All thermocouples were replaced prior to test SA-26.

Prior to test SA-26, the igniter fuel system was purged and hypergol orifices visually inspected. No restrictions or abnormal flow conditions were noted. On test SA-26, the oscillograph data indicated that engine 2 experienced a P_c Pop after the hypergol diaphragm had burst (see GRAPH 2-3). The igniter fuel system purge is known to reduce conditions conducive to P_c Pops but does not completely eliminate them, as indicated by engine 2.

Engine 3 solid propellant gas generator (SPGG) ignition characteristics were abnormal during test SA-26, in that combustion was established slower than usual at engine 3 (see GRAPH 2-5). This was evidenced by a slower conisphere temperature rise rate (65 milliseconds longer to peak temperature) and slower buildup of gas generator injection pressures. The effect of this slight delay in SPGG combustion was negligible to the engine starting transients. The possible causes for a delayed SPGG ignition are low initiator current, delayed ignition of the main grain, incomplete pellet ignition, or premature diaphragm rupture. However, the latter two are the most probable cause. All SPGG's used for test SA-26 were approximately 20 months old. The ignition delay occurred only at engine 3 and therefore the cause can not be directly attributed to age.

An immediate post test inspection of engine 7 following test SA-26 revealed an internal thrust chamber tube leak 13 inches below the injector. A closer inspection indicated a longitudinal crack 15/32 inch long by 1/16 inch wide. Engine 7 (S/N 4046) will be replaced with an allocated spare engine (S/N 4052) during post static checkout at Michoud.

PRETEST SA-25 HARDWARE INSPECTION AND LEAK CHECKS

1. All static test instrumentation was installed and checked. This previously has been done at Michoud, but beginning with stage S-IB-1 this work will be performed at Static Test.

2. The MLV position indicators were installed by Rocketdyne personnel after the stage arrived at Static Test. The position indicators were then functionally checked by cycling the MLVs and recording potentiometer resistance. All readings were satisfactory.

3. While performing an engine purge checkout on engine 3 (S/N H-7048), it was discovered that the hose assemblies (P/N 60C00520) from the stage purge panel to the engine customer connect panel were improperly connected such that the fuel injector purge was connected to the gas generator LOX injector purge, the gas generator LOX injector purge to the LOX dome purge, and the LOX dome purge to the fuel injector purge. The hose assemblies were changed to the proper configuration and a gas sample was taken through the fuel injector purge flex hose to check the nonvolatile residue count. Results showed no contamination which indicated that the gas generator LOX injector manifold was not contaminated by this incident (reference UCR 01114).

4. During the turbine exhaust system leak check, two leaks were discovered at engine 6 (S/N 4045). One leak was at the calibration valve inlet to measurement *PP704-6 (pressure, turbine exhaust). The calibration valve had the wrong type seal installed and it was replaced. The valve still leaked, and this was corrected by plumbing the turbine exhaust pressure sensing line directly to the transducer (reference UCR 01141). The second leak was at an instrumentation boss on the turbine inlet and was corrected by torquing the fitting to the maximum value.

5. Following the initial propellant loading test, the screens at the LOX and fuel pump inlets were removed. A piece of O-ring approximately $4\frac{1}{4}$ inches long was found in the fuel pump inlet screen on engine 5 (S/N H-4044). It was later determined that the section of O-ring was from a damaged facility fill and drain line flange seal. The remainder of the O-ring was found external of the stage.

6. Upon removal of the LOX suction line at engine 1 (S/N H-7046), excessive LOX lube was found on the pump inlet seal and in the LOX pump inlet adapter. The adapter housing was cleaned, and the LOX suction line was installed using an unlubricated new seal (reference UCR 01142).

7. While performing a heat exchanger dropoff test at engine 6 (S/N H-4046), excessive leakage was noted at the LOX inlet flange. An inspection revealed that a neoprene O-ring had been coated with an excessive amount of lubricant (specific type unknown) and installed at the heat exchanger LOX inlet flange. The flanges were cleaned and the correct Flexitallic gasket installed (reference UCR 01113).

8. Inspection of the outboard Thrust OK pressure switch on engine 2 (S/N H-7047) revealed a bent electrical connector. This switch was replaced (reference UCR 01131).

9. Pretest inspection of the injectors revealed no baffle distortion.

10. A LOX seal swab check and turbopump torque check were performed. No contamination was noted and the torque results were satisfactory.

11. In preparation for a gaseous thrust chamber leak check, considerable trouble was encountered in installing the throat plugs P/N 903404. The plugs would not seal the throat area. The furnace brazed thrust chambers have larger valleys between the tubes providing a reduced contact surface. This problem will be remedied in the future by increasing the sealing surface of the throat plug by wrapping the plug with JM 88 weather stripping.

12. When installing the explosive Conax valves (P/N 1804001), interference was experienced between the explosive squib (trigger) and the MLV closing control line on engines 1, 2, 4, and 7 (S/N H-7046, H-7047, H-7049, and H-4046, respectively). Since the valve will function correctly when inverted, this was attempted. Insufficient clearance then existed between the lower squib and the gas generator control valve for attachment of the engine harness connector, Bendix P/N 10-281302-4F. The problem was temporarily resolved by installing a jumper cable that had a smaller connector (Cannon P/N MS 3106-E-1056-45) to attach to the connector on the lower squib of these engines

(reference UCR 01140). The Bendix connectors on the engine harnesses were replaced with Cannon connectors prior to test SA-26. This fix will necessitate installing the Conax valves with the squib nearest the main fuel valve pointing downward at the launch facility.

POST TEST SA-25 HARDWARE INSPECTION AND LEAK CHECKS

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

ENGINE	LOCATION OF LEAKAGE	CORRECTIVE ACTION
1	Instrumentation boss on turbine inlet	Replaced copper crush seal
2	Turbine to turbine exhaust duct flange	Replaced gasket
3	Instrumentation boss on turbine inlet	Replaced copper crush seal
4	Turbine inlet flange	Replaced gasket
5	Turbine inlet flange	Retorqued
6	Turbine inlet flange	Replaced gasket
7	Turbine inlet flange	Retorqued
8	Instrumentation boss on turbine inlet	Replaced copper crush seal

2. Evidence of a leak at transducer for flight measurements D1-5 (thrust chamber pressure, engine 5) was noted during test SA-25. The seal was replaced and the flight transducer reinstalled (reference UCR 01144). This transducer had been installed at Static Test.

3. Turbopump preservation was performed at all engines. The turbopumps were torqued prior to preservation with the following results:

ENGINE	BREAKAWAY TORQUE (INCH-POUNDS)	RUNNING TORQUE (INCH-POUNDS)
1	95	80
2	90	75
3	75	70
4	85	75
5	65	60
6	55	50
7	70	65
8	50	50

PRETEST SA-26 HARDWARE INSPECTION AND LEAK CHECKS

1. The 840 psia rated TOPS were replaced with 800 psia rated TOPS. This action was necessary due to a flight design requirement for the S-IB vehicle.

2. The 0.108-inch diameter orifices in the heat exchanger LOX inlet were replaced with 0.104-inch diameter orifices. This orifice change in conjunction with a change in the GOX flow control valve closed stop setting was made to reduce the excessive LOX tank pressure experienced during test SA-25.

3. Thrust chamber leak checks with fuel were performed on all engines prior to test SA-26. In this leak check procedure, fuel was filled to a level of 72 inches and allowed to stand for approximately 4 hours. No leaks were noted.

POST TEST SA-26 HARDWARE INSPECTION AND LEAK CHECKS

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

ENGINE	PRIOR TO PRESERVATION BREAKAWAY TORQUE (INCH-POUNDS)	PRIOR TO PRESERVATION RUNNING TORQUE (INCH-POUNDS)	AFTER PRESERVATION BREAKAWAY TORQUE (INCH-POUNDS)	AFTER PRESERVATION RUNNING TORQUE (INCH-POUNDS)
1	90	80	100	90
2	100	90	80	75
3	90	80	90	80
4	100	90	90	80
5	75 ⚠1	70	80	70
6	60	50	60	50
7	60	50	60	50
8	80	70	60	50

⚠1 Initial breakaway torque was 300 inch-pounds. After breaking at 300 inch-pounds, the breakaway torque was rechecked and found to be 75 inch-pounds.

2. Visual inspection of engine 8 after test SA-26 revealed a distorted bellows section in the turbine exhaust duct adjacent to the heat exchanger inlet (see FIGURE 2-3). The extent of damage will be investigated further during post static checkout at Michoud.

3. Turbine exhaust system leak checks were performed and the results are shown below. The turbine exhaust system leaks will be repaired at Michoud.

ENGINE	LOCATION OF LEAKAGE
2 ⚠1	Instrumentation boss on turbine inlet
3	Turbine outlet flange
4	Turbine inlet flange
4	Turbine outlet flange
5	Turbine inlet flange
5	Instrumentation boss on turbine inlet
6	Turbine inlet flange
6	Turbine outlet flange
8 ⚠1	Turbine inlet flange

⚠1 Leaks at engines 2 and 8 were corrected by retorquing.

4. Thrust chamber leak checks with fuel revealed the following internal leakage:

ENGINE	LEAKAGE RATE	LEAKAGE ELEVATION ⚠1	LEAKAGE LOCATION ⚠2
3	4 drops per minute	6 inches	120 degrees
4	Slight seep	6 inches	5 degrees
5	Slight seep	6 inches	240 degrees
7	$3\frac{1}{2}$ to 4 milliliters per minute	9 inches	85 degrees
7	130 milliliters per minute	13 inches	80 degrees

⚠1 Down from the face of the injector.

⚠2 Degrees counterclockwise from the fuel inlet, looking forward.

Normally, the thrust chamber fuel jackets are prefilled to the 72-inch level with fuel for the leak check. Because of the accelerated schedule at Static Test, the chambers were flushed with trichloroethylene and the post test leak checks made. This is the first time the chambers were checked for leaks above the fuel prefill level. The leaks noted in the above table were more pronounced with trichloroethylene, prompting a leak check with fuel during which the above leakage was measured.

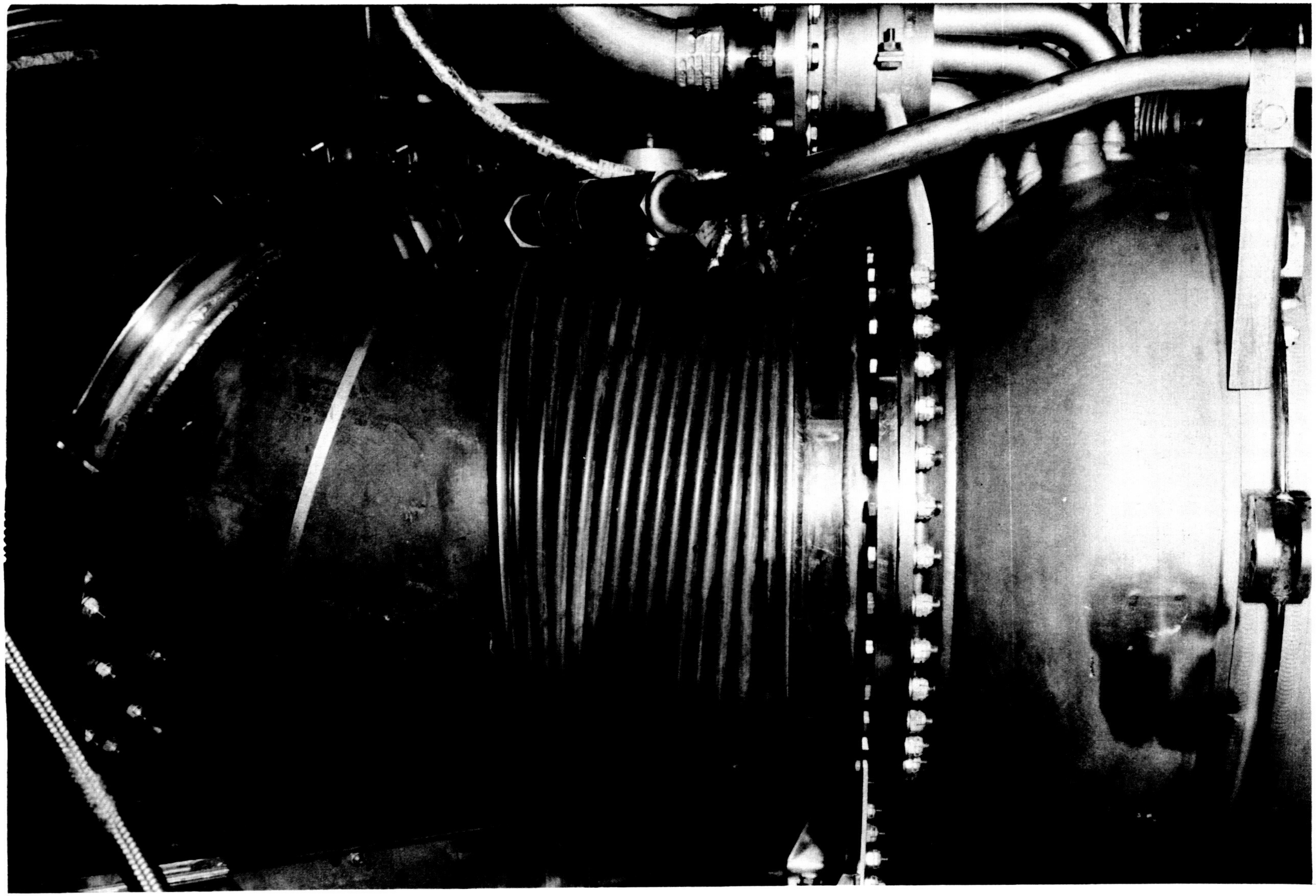
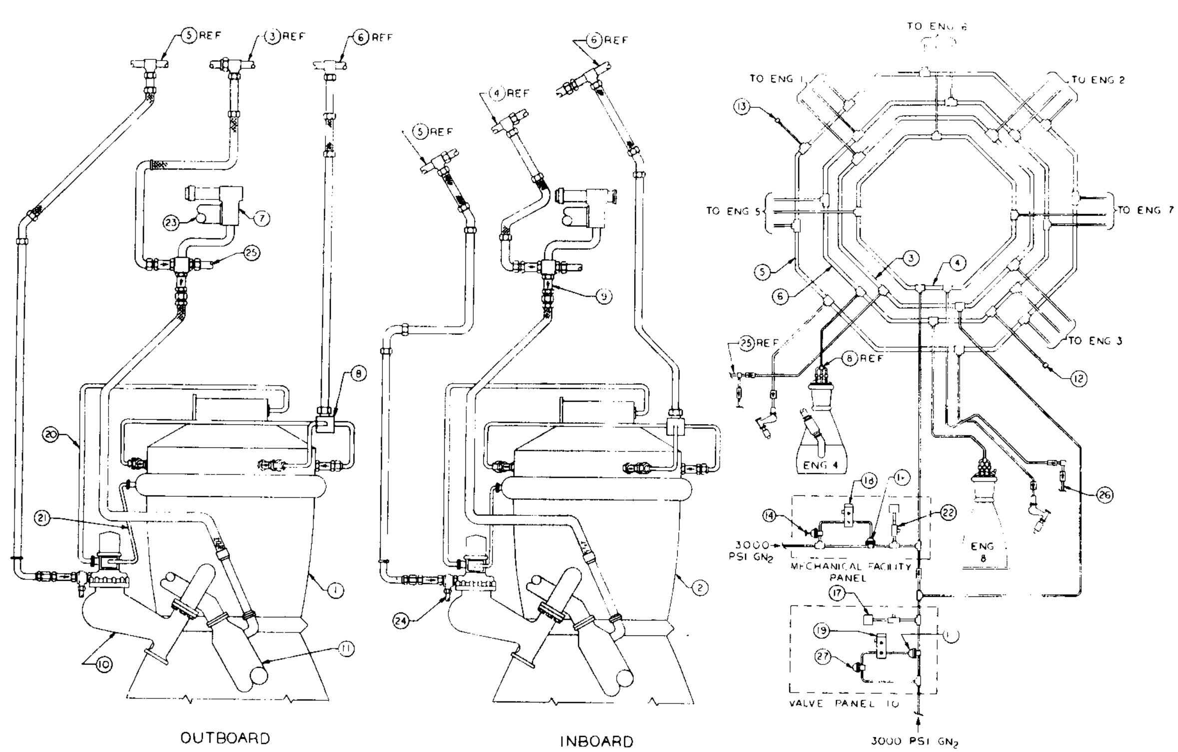
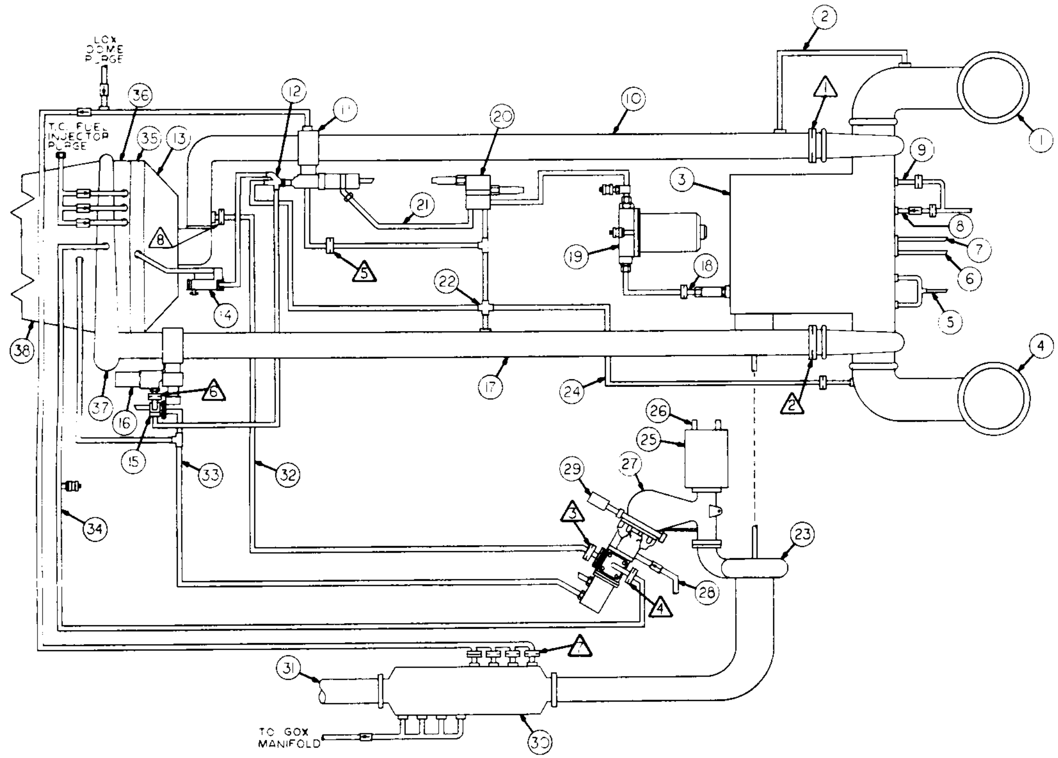


FIGURE 2-3. DISTORTED BELLOWS IN TURBINE EXHAUST DUCT, HEAT EXCHANGER INLET ENGINE 8



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	CHECK VALVE (TYPICAL 6 PLACES) (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 PP101, PRESSURE GAS GENERATOR LOX INJECTOR MANIFOLD (TYPICAL ALL ENGINES)
25	TO MEASUREMENT D111 (TYPICAL ENGINES 3 & 4)
26	TO HEAT EXCHANGER (TYPICAL ALL ENGINES)
27	FIXED REGULATOR

FIGURE 2-2 H-I ENGINE PURGE SYSTEM



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	HYPEGOL CONTAINER
15	IGNITION MONITOR VALVE
16	MAIN FUEL VALVE
17	FUEL HIGH PRESS DUCT
18	T/P LUBE LINE
19	FABU
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-I ENGINE SCHEMATIC

TABLE 2-1

ENGINE STATIC TEST DATA

Ambient Pressure (psia)	14.477 ⚠1
Ambient Temperature (°F)	57.0 ⚠1

TEST SA-25

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	VALUES AT X+29-32 SEC.
*PT100	Temperature, Fuel Pump Inlet (°F)	8	41.0	47.2 ⚠1
	Density, Fuel Pump Inlet (lb/ft3)	8	50.844 ⚠1	50.695 ⚠1
*PP113	Pressure, Fuel Pump Inlet (psig)	1	40.0	27.3
		2	41.0	27.6
		3	40.0	26.5
		4	41.1	27.2
		5	40.6	27.8
		6	40.4	27.2
		7	41.5	28.7
		8	39.8	26.3
*PP104	Pressure, Fuel Pump Outlet (psig)	1		955.6
		2		0 ⚠2
		3		983.4
		4		972.4
		5		924.6
		6		918.7
		7		965.8
		8		968.8
*PT107	Temperature, LOX Pump Inlet (°F)	1	-278.5	-292.55
		2	-278.2	-292.7
		3	-278.8	-292.5
		4	-277.4	-292.7
		5	-278.15	-292.7
		6	-277.7	-292.8
		7	-278.25	-292.8
		8	-277.9	-292.8
*PP114	Pressure, LOX Pump Inlet (psig)	1	79.5	59.0
		2	78.5	58.0
		3	78.0	58.6
		4	77.5	57.0
		5	78.0	59.5
		6	77.0	58.2
		7	77.0	58.2
		8	76.0	58.0

⚠1 Values corrected from those published in the "Preliminary Static Test Report, Test SA-25."

⚠2 Millisadic value not valid.

TABLE 2-1 (CONTINUED)

TEST SA-25

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	VALUES AT X+29-32 SEC.
*PP105	Pressure, LOX Pump Outlet (psig)	1		827.4
		2		818.9
		3		827.8
		4		830.2
		5		809.3
		6		814.2
		7		813.1
		8		806.0
*PT101	Temperature, SPGG Surface (°F)	3	40.5	
		7	43.9	
*PT102	Temperature, Conisphere (°F)	1		1216
		2		1210.8
		3		1225
		4		1228.5
		5		1185
		6		102 ⚠1
		7		1224
		8		1252.5
*PP100	Pressure, GG Fuel Injector Manifold (psig)	1		720
		2		660
		3		720
		4		700
		5		680
		6		700
		7		710
		8		680
*PP101	Pressure, GG LOX Injector Manifold (psig)	1		760
		2		740
		3		756
		4		770
		5		735
		6		750
		7		777
		8		767
*PP102	Pressure, Turbine Inlet (psig)	1		533.9
		2		517.0
		3		0 ⚠1
		4		523.2
		5		516.9
		6		514.7
		7		512.4
		8		0 ⚠1
*PP704	Pressure, Turbine Exhaust (psig)	2		13.7
		6		8.3

⚠1 Millisadic value not valid.

TABLE 2-1 (CONTINUED)

TEST SA-25

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	VALUES AT X+29-32 SEC.
	Turbopump Speed (rpm), derived from *PR700, Turbine rpm	1		6847
		2		6757
		3		6852
		4		6798
		5		6676
		6		6708
		7		6766
		8		6825
*PT701	Temperature, Oronite (°F)	1	128.5	
		2	123.0	
		3	129.5	
		4	125.1	
		5	131.0	
		6	127.2	
		7	130.05	
		8	127.2	
*PP112	Pressure, Gearcase (psig)	1		4.0
		2		4.15
		3		4.2
		4		3.55
		5		3.75
		6		4.1
		7		4.25
		8		4.25
*PT700	Temperature, LOX Pump Bearing 1 (°F)	1	102.2	125.2
		2	108.0	115.1
		3	91.5	112.8
		4	98.4	115.0
		5	112.6	119.6
		6	107.4	118.4
		7	49.7	130.0
		8	112.2	127.0
*PT104	Temperature, Turbopump Bearing 2 (°F)	1	66.3	109.6
		2	52.6	396.1 ⚠1
		3	52.6	95.1
		4	54.7	105.7
		5	62.0	105.1
		6	56.4	106.6
		7	58.8	103.6
		8	52.6	82.8

⚠1 Millisadic value not valid.

TABLE 2-1 (CONTINUED)

TEST SA-25

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	VALUES AT X+29-32 SEC.
*PT105	Temperature, Turbopump Bearing 4 (°F)	1	52.6	126.1
		2	0 ⚠	0 ⚠
		3	55.5	128.3
		4	62.5	131.6
		5	63.1	126.5
		6	61.4	132.7
		7	52.6	118.6
		8	53.0	118.5
*PT108	Temperature, Turbopump Bearing 8 (°F)	1	59.6	149.1
		2	0 ⚠	0 ⚠
		3	52.4	147.7
		4	53.4	137.9
		5	62.2	160.3
		6	58.2	136.0
		7	55.2	164.6
		8	60.3	156.3
*PP115	Pressure, Lube Oil, Bearing 1 (psig)	1		93.0
		2		137.0
		3		131.0
		4		140.05
		5		112.5
		6		129.0
		7		130.0
		8		144.5
PP116	Pressure, A and B Gear Jet Nozzle (psig)	1		680.0
		2		674.0
		5		656.0
		7		646.0

⚠ Millisadic value not valid.

TABLE 2-2

ENGINE STATIC TEST DATA

Ambient Pressure (psia)	14.482 ⚠1
Ambient Temperature (°F)	69.0 ⚠1

TEST SA-26

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT		
			IGNITION	X+29-32 SEC	CUTOFF
*PT100	Temperature, Fuel Pump Inlet (°F)	8	59.7	57.2	57.4
	Density, Fuel Pump Inlet (lb/ft³)	8	50.396	50.456	50.450
*PP113	Pressure, Fuel Pump Inlet (psig)	1	40.6	27.1	16.3
		2	41.2	27.8	16.9
		3	42.2	28.1	16.6
		4	41.4	28.4	17.6
		5	40.9	27.9	17.7
		6	40.9	27.4	17.2
		7	40.7	28.1	18.1
		8	41.1	28.1	18.0
*PP104	Pressure, Fuel Pump Outlet (psig)	1	30.0	970.0	950.0
		2	25.0	939.0	900.0
		3	23.0	1010.0	985.0
		4	39.0	965.0	950.0
		5	39.0	930.0	900.0
		6	38.0	923.0	900.0
		7	39.0	942.0	910.0
		8	36.0	980.0	950.0
*PT107	Temperature, LOX Pump Inlet (°F)	1	-279.8	-292.9	-291.2
		2	-279.4	-293.1	-291.4
		3	-280.15	-293.0	-291.0
		4	-280.3	-293.0	-291.2
		5	-278.6	-293.05	-291.9
		6	-278.6	-293.1	-292.2
		7	-279.2	-293.35	-292.5
		8	-278.8	-293.4	-291.9
*PP114	Pressure, LOX Pump Inlet (psig)	1	75.0	53.2	30.6
		2	75.5	53.5	30.0
		3	77.0	54.5	30.0
		4	75.2	53.2	29.5
		5	77.5	56.0	33.1
		6	75.0	53.6	31.0
		7	75.5	54.5	32.0
		8	75.0	54.5	31.0

⚠1 Value corrected from that published in the "Preliminary Static Test Report, Test SA-26".

TABLE 2-2 (CONTINUED)

TEST SA-26

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	X+29-32 SEC	CUTOFF
*PP105	Pressure, LOX Pump Outlet (psig)	1	66.3	827.9	780.0
		2	73.1	810.0	776.2
		3	72.8	835.0	780.0
		4	76.7	839.6	800.9
		5	79.4	817.5	778.5
		6	76.8	818.8	790.8
		7	76.0	810.0	774.9
		8	72.6	820.5	789.7
*PT101	Temperature, SPGG Surface (^{o}F)	3	66.3		
		7	68.7		
*PT102	Temperature, Conis-phere (^{o}F)	1		1225	1197
		2		1215	1181
		3		1236	1216
		4		1240	1206
		5		1215	1182
		6		1200	1186
		7		1185	1169
		8		1266	1232
*PP100	Pressure, GG Fuel Injector Manifold (psig)	1		742	730
		2		780	750
		3		743	700
		4		735	700
		5		750	710
		6		738	705
		7		690	668
		8		720	695
*PP101	Pressure, GG LOX Injector Manifold (psig)	1		763	
		2		738	
		3		754	
		4		771	
		5		743	
		6		749	
		7		748	
		8		757	
*PP102	Pressure, Turbine Inlet (psig)	1		532.6	513.0
		2		512.5	492.0
		3		521.5	500.0
		4		520.0	500.0
		5		519.3	500.1
		6		513.8	498.0
		7		499.9	483.1
		8		521.1	507.8
*PP704	Pressure, Turbine Exhaust (psig)	2		14.05	
		6		9.6	

TABLE 2-2 (CONTINUED)

TEST SA-26

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	X+29-32 SEC	CUTOFF
	Turbopump Speed (rpm), derived from Turbine rpm *PR700	1		6856	6787
		2		6745	6653
		3		6876	6796
		4		6829	6740
		5		6725	6628
		6		6733	6666
		7		6729	6641
		8		6851	6769
*PT701	Temperature, Oronite (°F)	1	130.05		
		2	135.0		
		3	124.0		
		4	121.0		
		5	131.0		
		6	126.0		
		7	127.5		
		8	132.0		
*PP112	Pressure, Gearcase (psig)	1		3.65	
		2		3.77	
		3		4.31	
		4		3.88	
		5		4.02	
		6		4.22	
		7		3.94	
		8		3.80	
*PT700	Temperature, LOX Pump Bearing 1 (°F)	1	110.8	141.5	237.8
		2	132.0	134.7	208.3
		3	109.8	130.3	209.9
		4	99.8	127.2	203.3
		5	119.7	131.6	204.0
		6	125.2	137.1	201.3
		7	116.3	131.3	205.6
		8	123.7	140.5	215.6
*PT104	Temperature, Turbopump Bearing 2 (°F)	1	73.1	115.4	209.2
		2	78.2	120.0	193.2
		3	69.6	117.1	191.9
		4	64.0	114.5	191.0
		5	73.7	113.2	181.0
		6	75.9	120.9	186.4
		7	77.0	116.8	185.2
		8	78.0	113.1	183.5

TABLE 2-2 (CONTINUED)

TEST SA-26

MEAS. NO.	MEASUREMENT DESCRIPTION	ENGINE	VALUES AT IGNITION	X+29-32 SEC	CUTOFF
*PT105	Temperature, Turbopump Bearing 4 (°F)	1	61.2	138.1	207.9
		2	78.0	139.0	197.2
		3	71.6	144.4	216.0
		4	66.0	136.7	200.8
		5	77.0	142.2	210.6
		6	80.0	145.0	204.0
		7	78.0	136.5	201.0
		8	85.0	149.5	207.0
*PT108	Temperature, Turbopump Bearing 8 (°F)	1	66.0	156.0	361.0
		2	74.0	148.0	332.0
		3	69.0	155.0	367.0
		4	67.0	148.0	331.0
		5	73.0	155.0	326.0
		6	82.0	159.0	322.0
		7	74.0	165.0	350.0
		8	74.0	157.0	330.0
*PP115	Pressure, Lube Oil, Bearing 1 (psig)	1		145.3	144.5
		2		138.0	134.5
		3		132.2	129.1
		4		150.7	146.0
		5		109.5	106.5
		6		131.8	129.0
		7		129.1	127.0
		8		151.1	149.5
PP116	Pressure, A and B Gear Jet Nozzle (psig)	1		680.0	
		2		672.0	
		5		670.0	
		7		645.0	

TABLE 2-3

IGNITION AND CUTOFF SEQUENCE TIMES FROM OSCILLOGRAPH RECORDS

TEST SA-25

ENGINE POSITION	1	2	3	4	5	6	7	8
IGNITION SIGNAL FROM IGNITION COMMAND (MILLISECONDS)	327	226	326	226	28	126	26	127
TIMES FROM THE IGNITION SIGNAL OF EACH ENGINE IN MILLISECONDS								
MLV Starts Opening	(2)	245	235	225	215	220	220	240
MLV Full Open	(2)	545	515	515	525	520	525	235
MLV Opening Time	(2)	300	280	290	310	300	305	295
Thrust Chamber Ignition	565	585	545	525	575	570	570	575
Pc Prime	925	930	900	885	910	880	905	910
Pc Reaches 90% (1)	1175	1165	1125	1065	1135	1085	1095	1100

(1) 90% of Slice Time Value (X+29 to 32 seconds)
(2) Measurement Lost

TABLE 2-3 (CONTINUED)

TEST SA-25

ENGINE POSITION	1	2	3	4	5	6	7	8
Turbopump Prime Speed (rpm)	5288	5345	5353	5396	5353	5288	5263	5263
Conax Firing Signal (Seconds from Commit)	32.402	32.403	32.403	32.402	32.238	32.244	32.243	32.244
TIMES FROM CONAX FIRING SIGNAL OF EACH ENGINE IN MILLISECONDS								
MLV Starts Closing (1)	(2)	0	0	0	50	45	40	40
MLV Full Closed	(2)	240	240	230	290	280	270	275
MLV Closing Time	(2)	240	240	230 (3)	240	235	230	235
P_C Leaves Mainstage	20	25	30	20	70	60	65	55
P_C Decays to 90% (4)	70	75	70	70	125	115	115	110
P_C Decays to 10%	265	300	260	270	370	285	280	275
ENGINE RUN TIME FROM P_C REACHES 90% to P_C DECAYS TO 90% (SECONDS)								
Engine Run Time (this test)	33.907	34.087	34.022	34.181	34.200	34.148	34.237	34.127
Cumulative Engine Run Time	480.6	441.2	574.9	440.3	563.1	524.3	480.9	440.7

(1) Signal delayed by hardwire DDAS.
(2) Measurement lost.
(3) Measurement lost after 230 milliseconds.
(4) 90% of final mainstage value.

TABLE 2-4

IGNITION AND CUTOFF SEQUENCE TIMES
FROM OSCILLOGRAPH RECORDS

TEST SA-26

ENGINE POSITION	1	2	3	4	5	6	7	8
IGNITION SIGNAL FROM IGNITION COMMAND (MILLISECONDS)	326	226	327	225	27	127	27	126
TIMES FROM THE IGNITION SIGNAL OF EACH ENGINE IN MILLISECONDS								
MLV Starts Opening	225	225	250	210	225	195	235	240
MLV Full Open	525	515	550	505	520	500	530	545
MLV Opening Time	300	290	300	295	295	305	295	305
Thrust Chamber Ignition	565	555	600	555	575	545	585	590
P_c Prime	925	890	940	875	920	860	915	930
P_c Reaches 90% △	1125	1080	1110	1040	1155	1055	1115	1180

△ 90% of Slice Time Value (X+29 to 32 seconds)

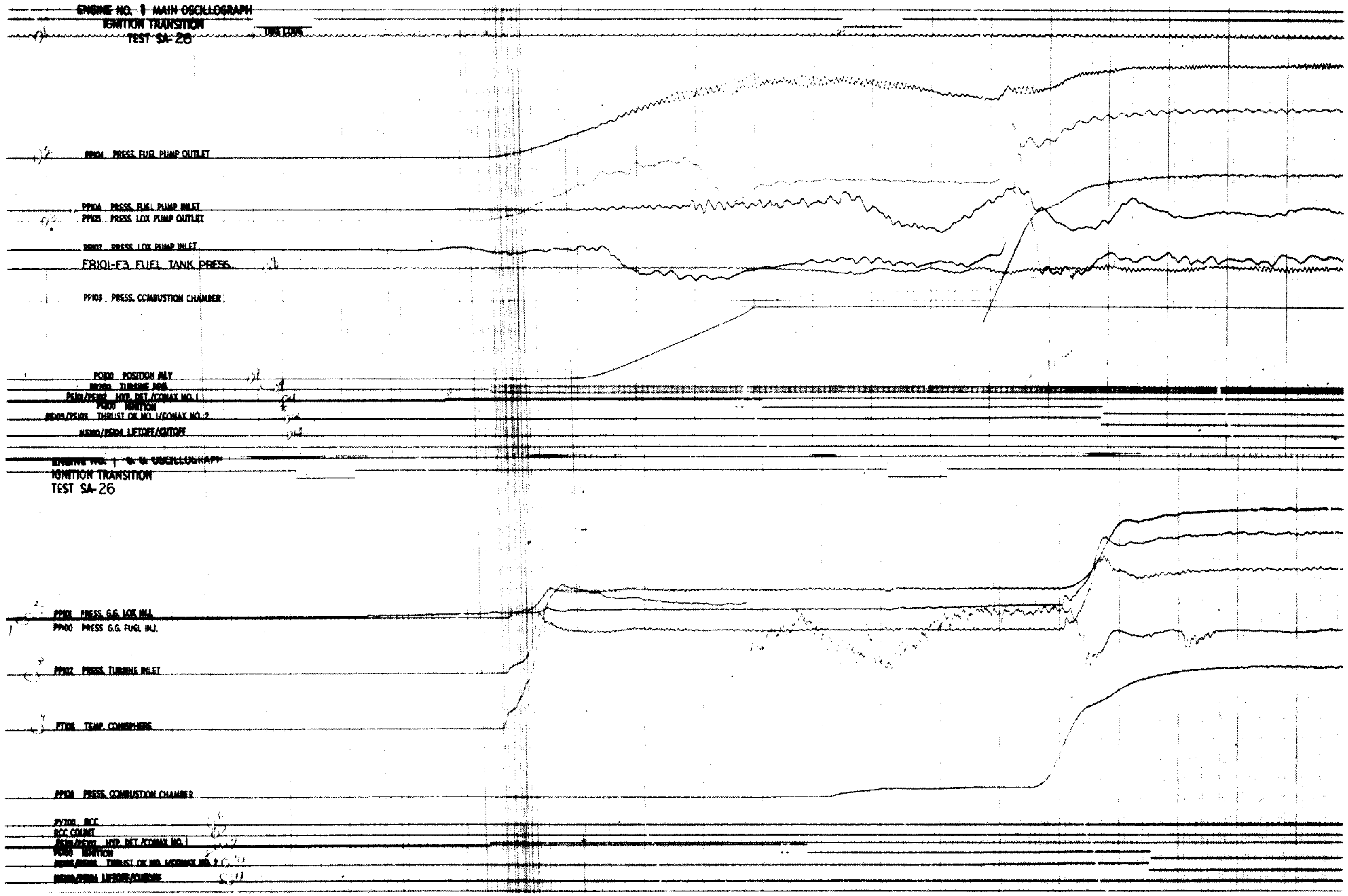
TABLE 2-4 (CONTINUED)

TEST SA-26

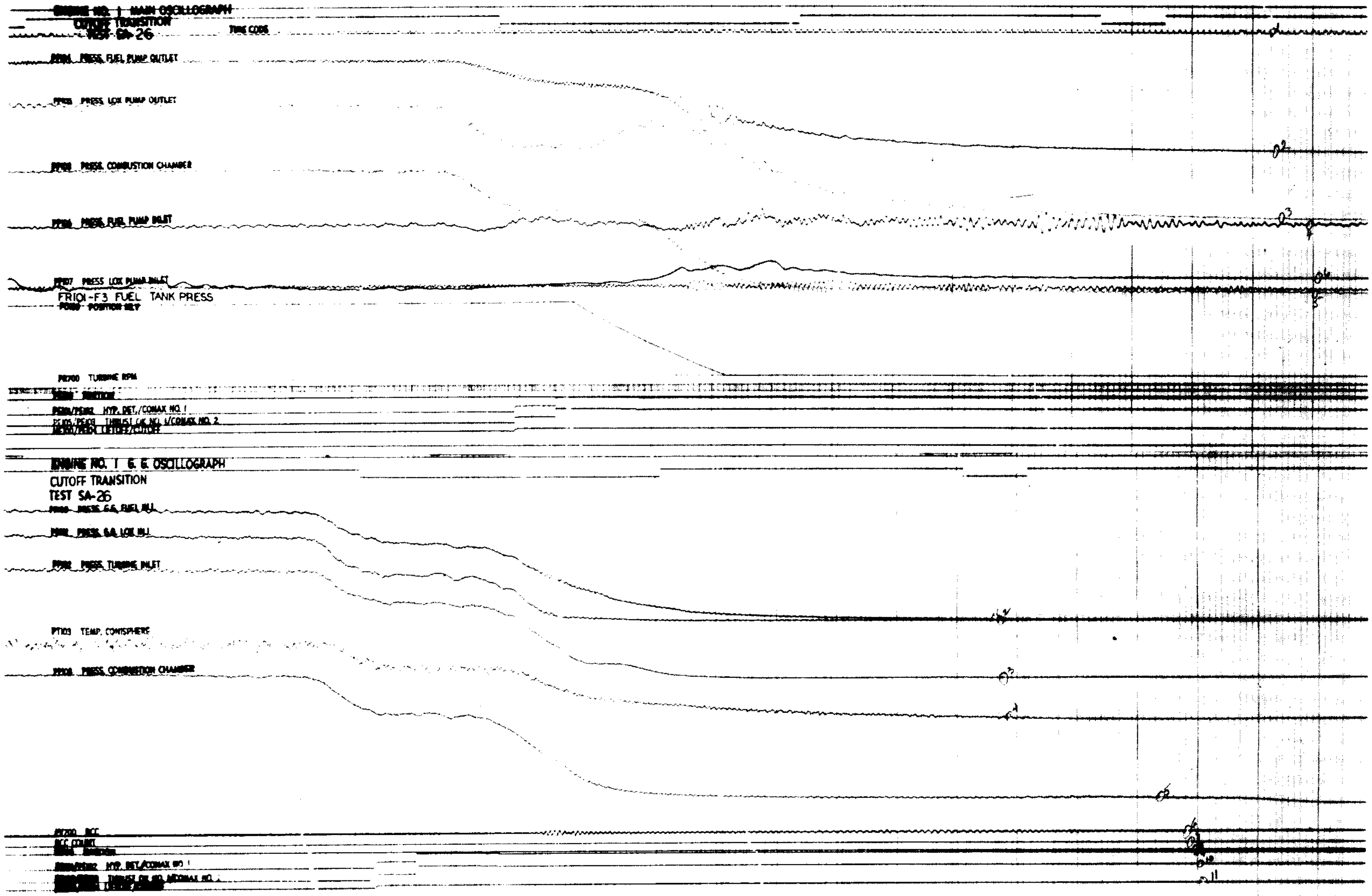
ENGINE POSITION	1	2	3	4	5	6	7	8
Turbopump Prime Speed (rpm)	6856	6745	6876	6829	6725	6733	6729	6851
Conax Firing Signal (Seconds from Commit)	142.092	142.092	142.091	142.091	135.258	135.267	135.266	135.264
TIMES FROM CONAX FIRING SIGNAL OF EACH ENGINE IN MILLISECONDS								
MLV Starts Closing	30	30	30	25	65	55	65	55
MLV Full Closed	280	275	275	265	310	295	295	290
MLV Closing Time	250	245	245	240	245	240	230	235
P_c Leaves Mainstage	-185 (2)	50	-26 (2)	45	85	80	90	75
P_c Decays to 90% (1)	-140 (2)	110	+60	95	145	135	140	130
P_c Decays to 10%	+340 (2)	350	+315	290	385	305	305	295
ENGINE RUN TIME FROM P_c REACHES 90% to P_c DECAYS TO 90% (SECONDS)								
Engine Run Time (this test)	143.501	143.896	143.714	143.921	137.221	137.220	137.264	137.088
Cumulative Engine Run Time	624.1	585.1	718.6	584.2	700.3	661.6	618.2	577.8

(1) 90% of final mainstage value.

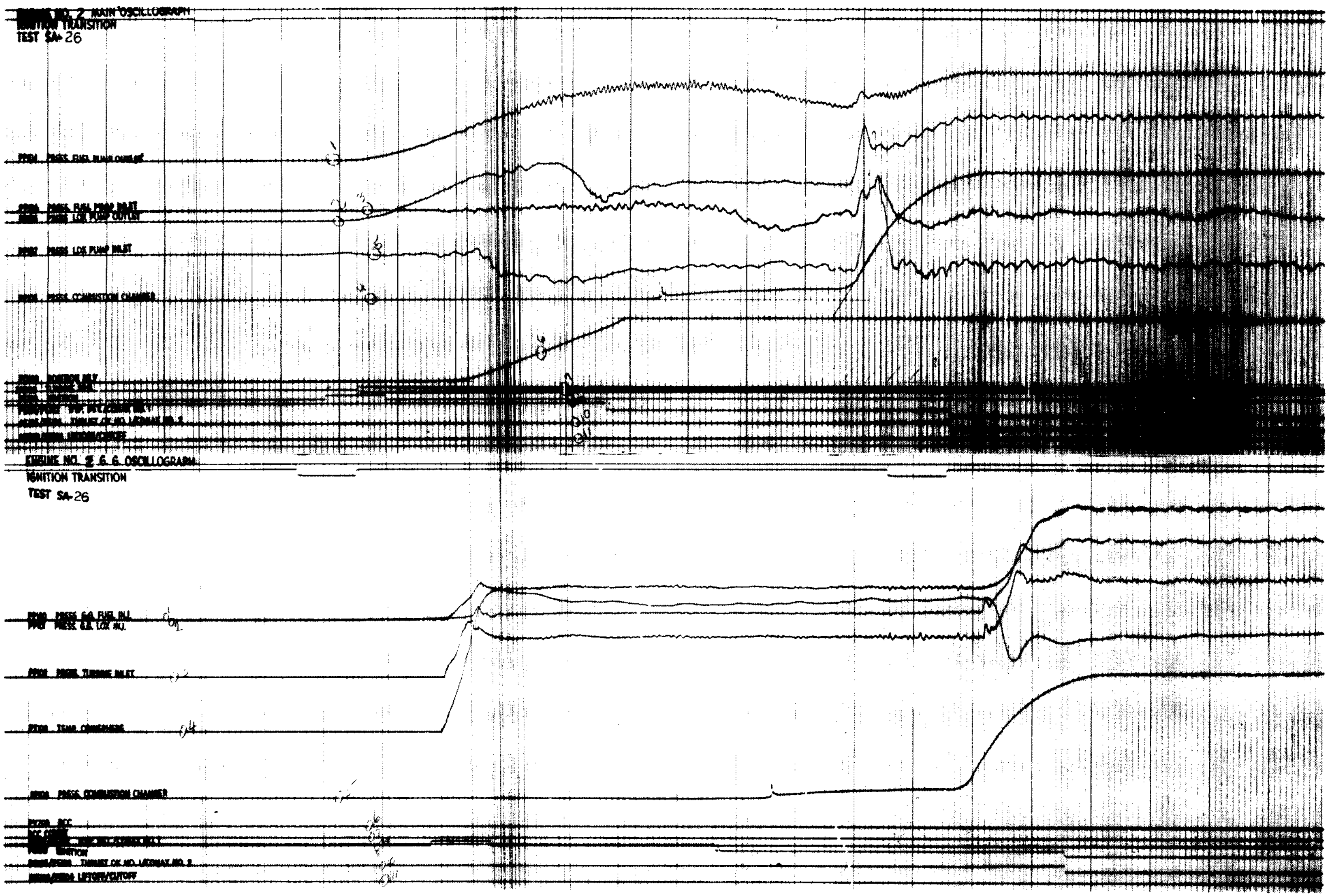
(2) LOX depletion.



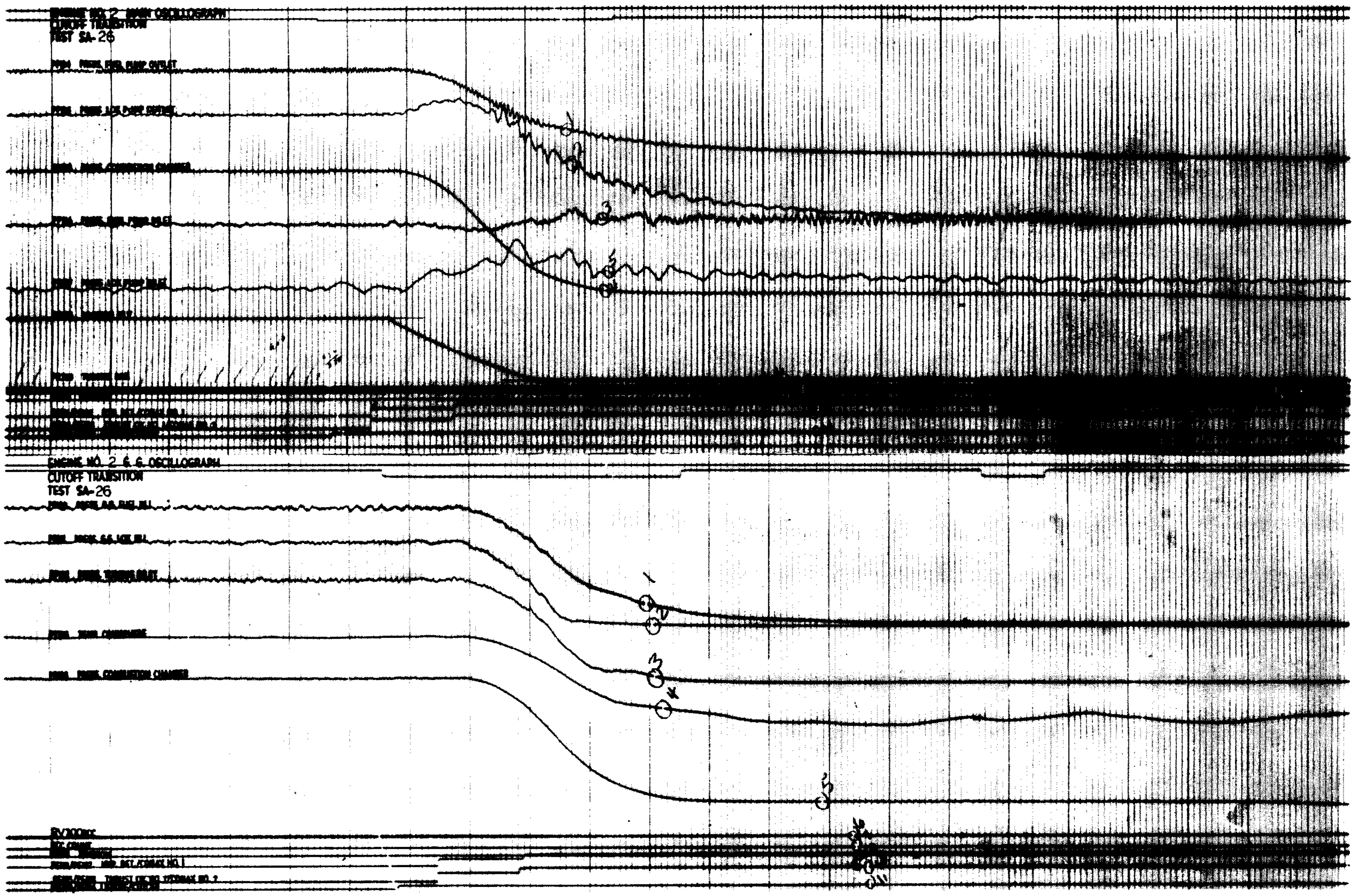
GRAPH 2-1
ENGINE 1, IGNITION TRANSITION, TEST SA-26



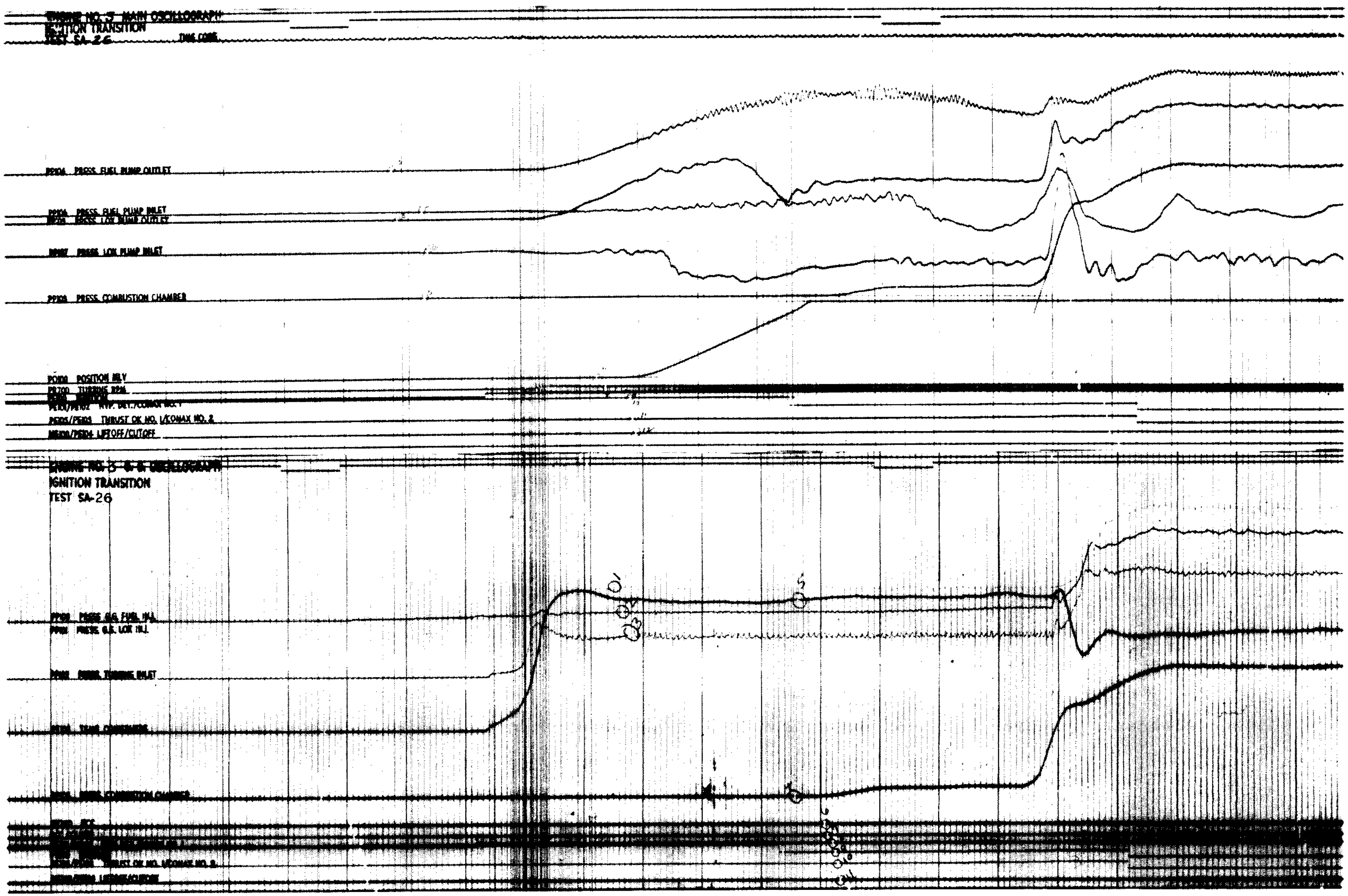
GRAPH 2-2
ENGINE 1, CUTOFF TRANSITION, TEST SA-26



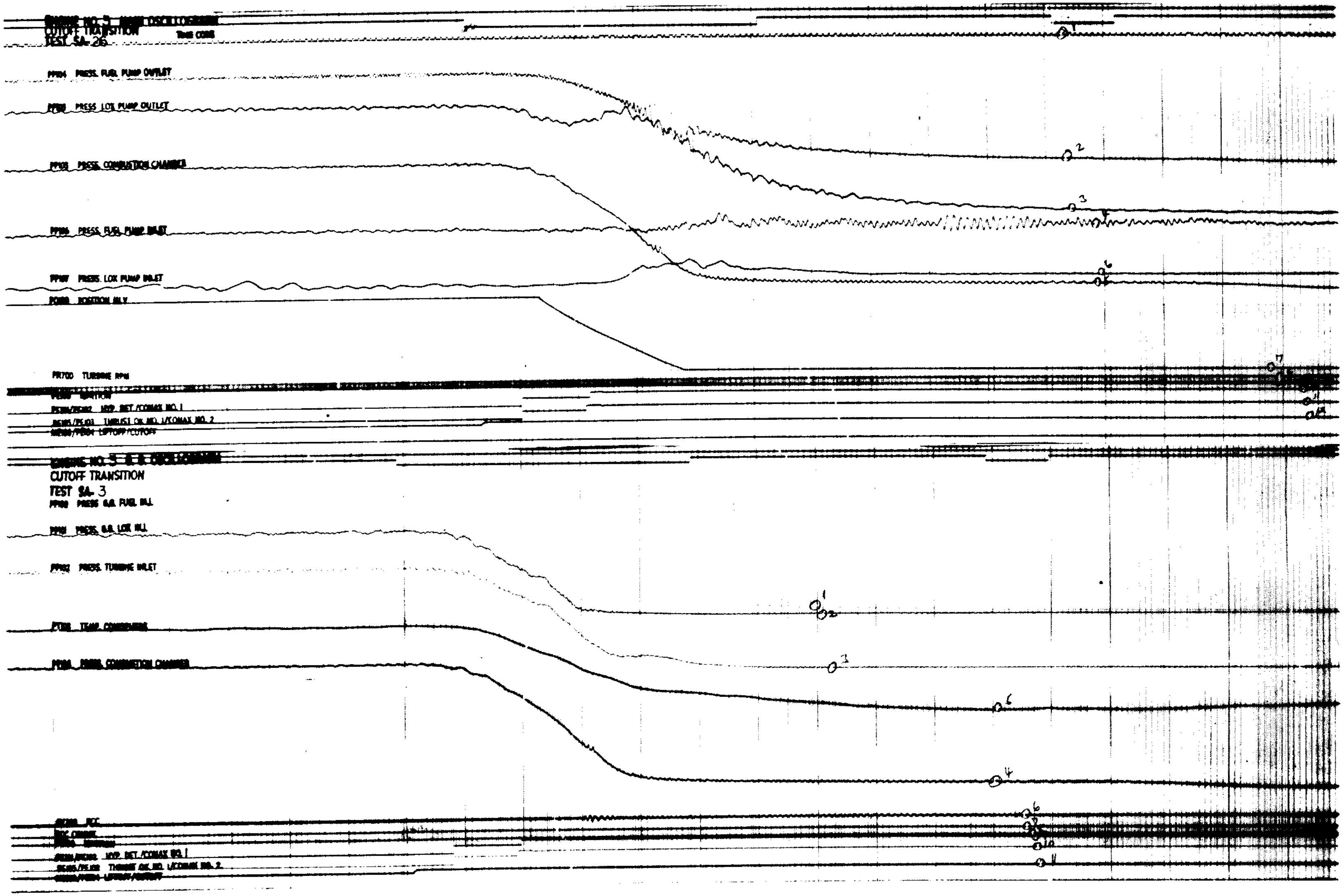
GRAPH 2-3
ENGINE 2, IGNITION TRANSITION, TEST SA-26



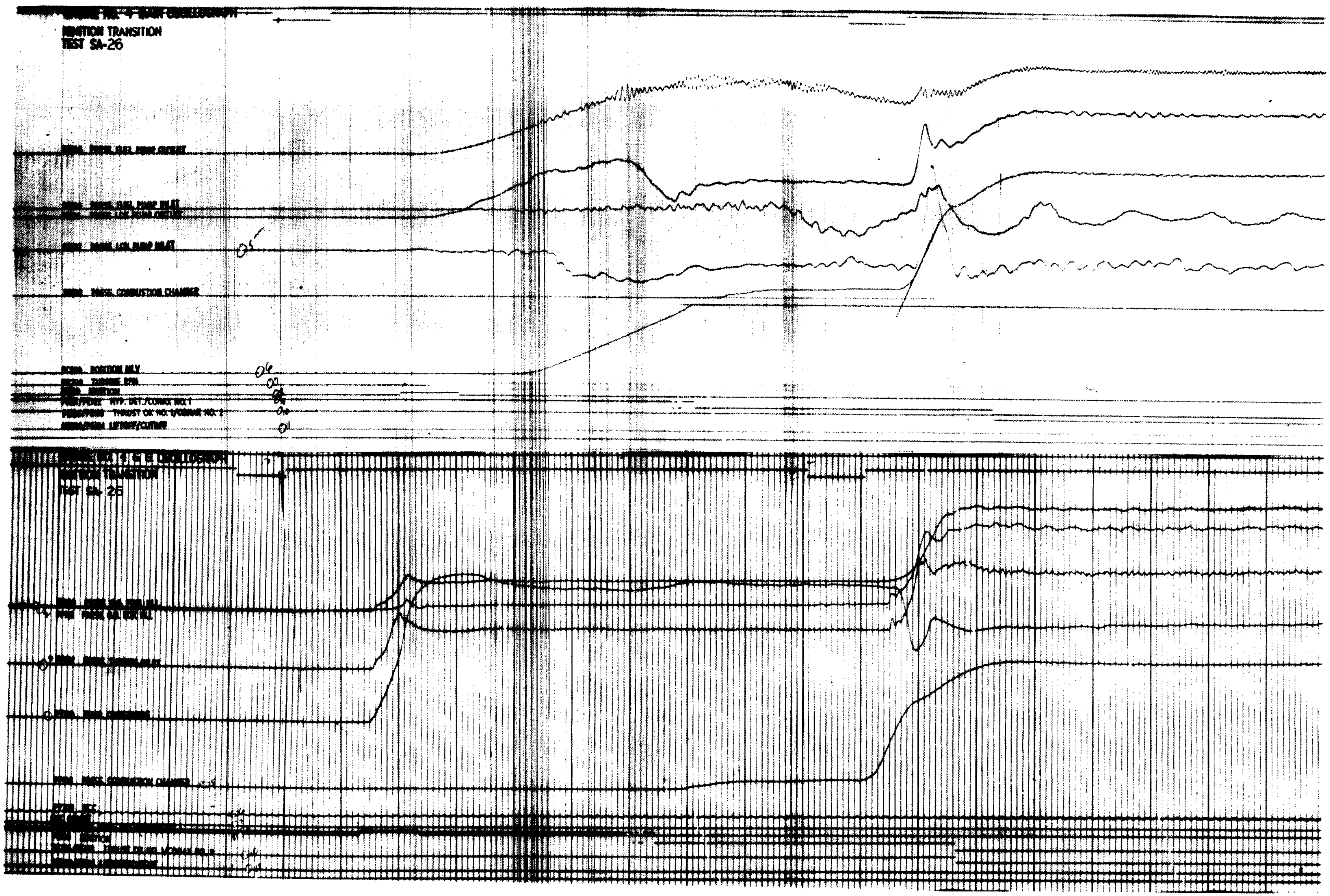
GRAPH 2-4
ENGINE 2, CUTOFF TRANSITION, TEST SA-26



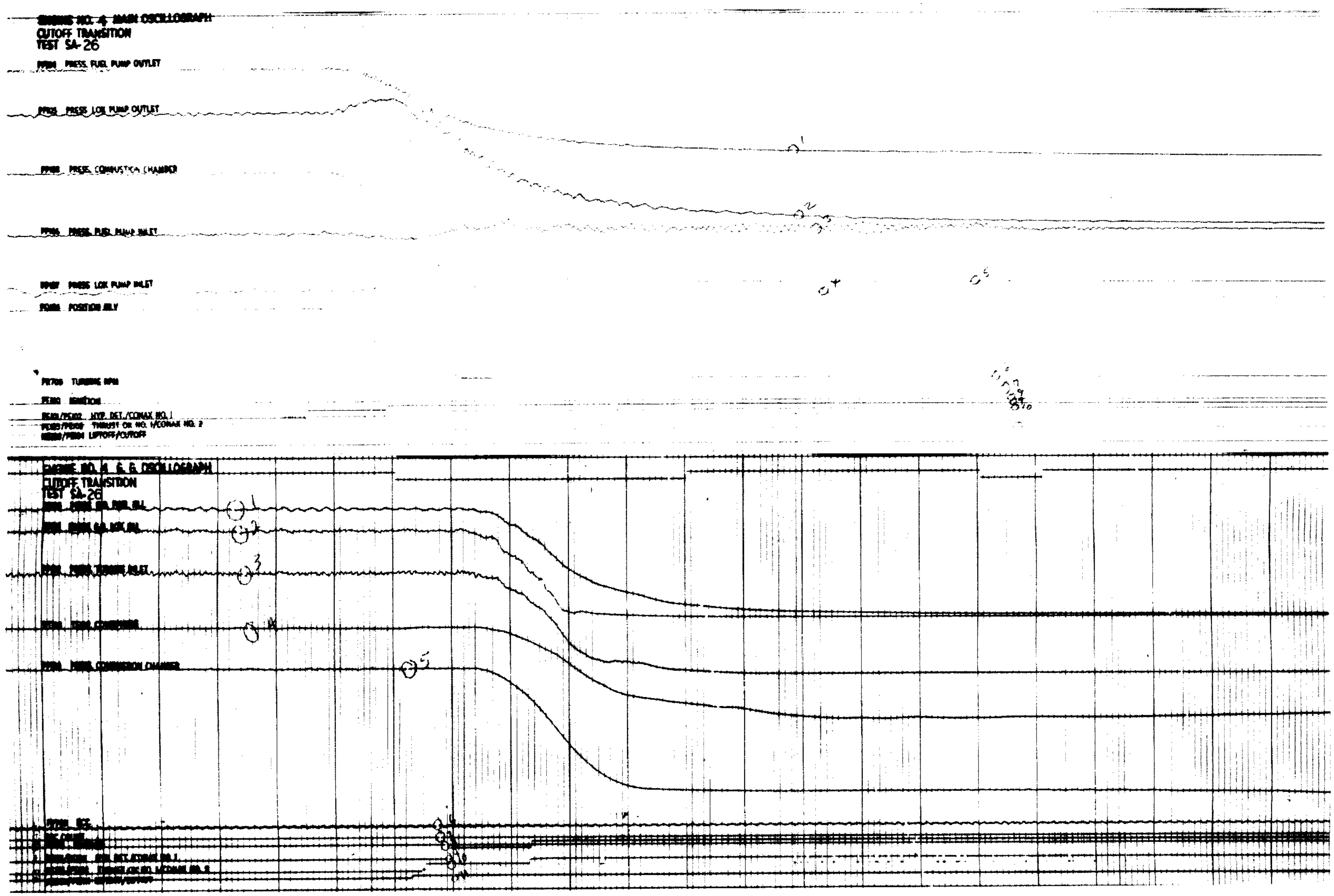
GRAPH 2-5
ENGINE 3, IGNITION TRANSITION, TEST SA-26



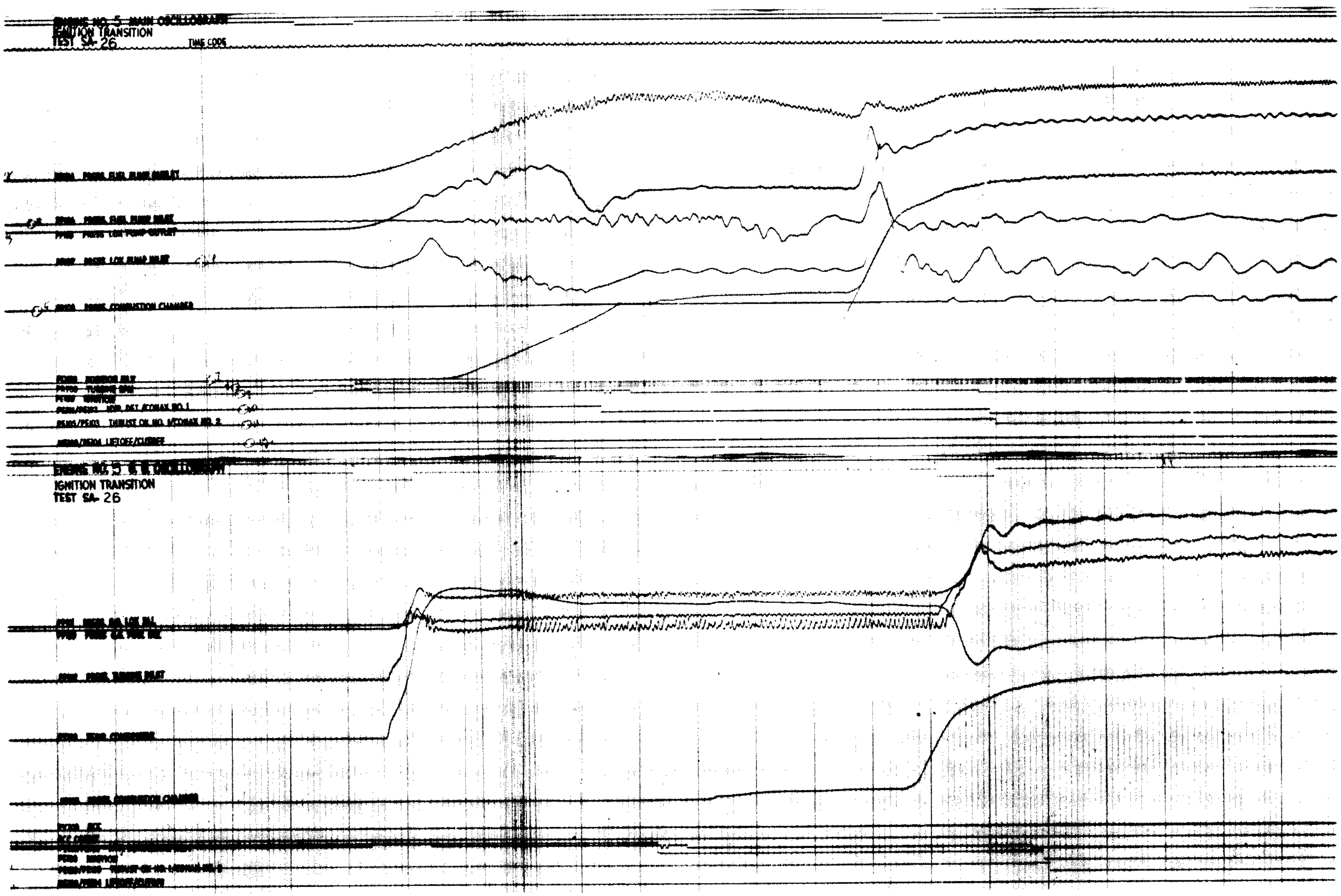
GRAPH 2-6
ENGINE 3, CUTOFF TRANSITION, TEST SA-26



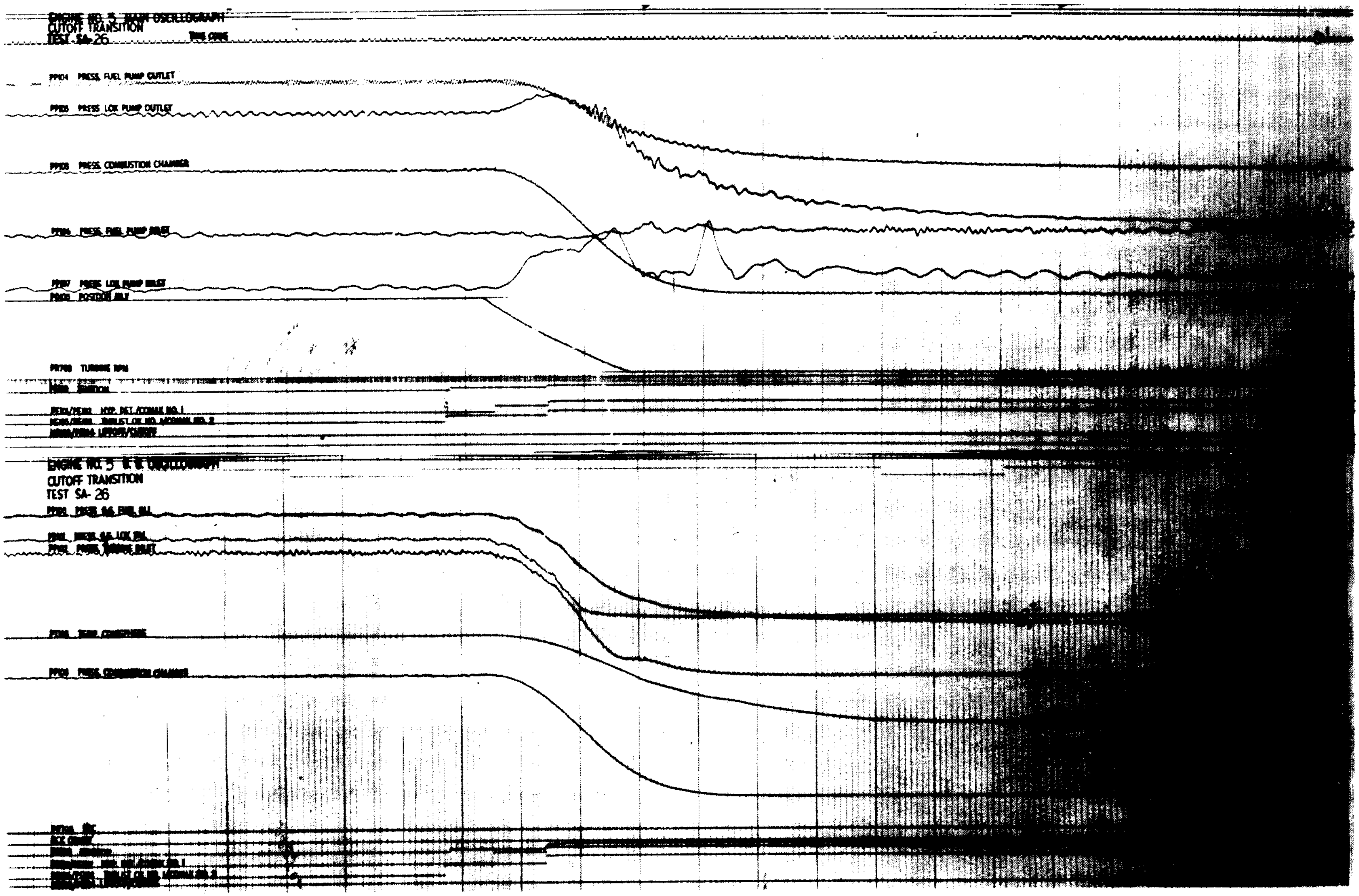
GRAPH 2-7
ENGINE 4, IGNITION TRANSITION, TEST SA-26



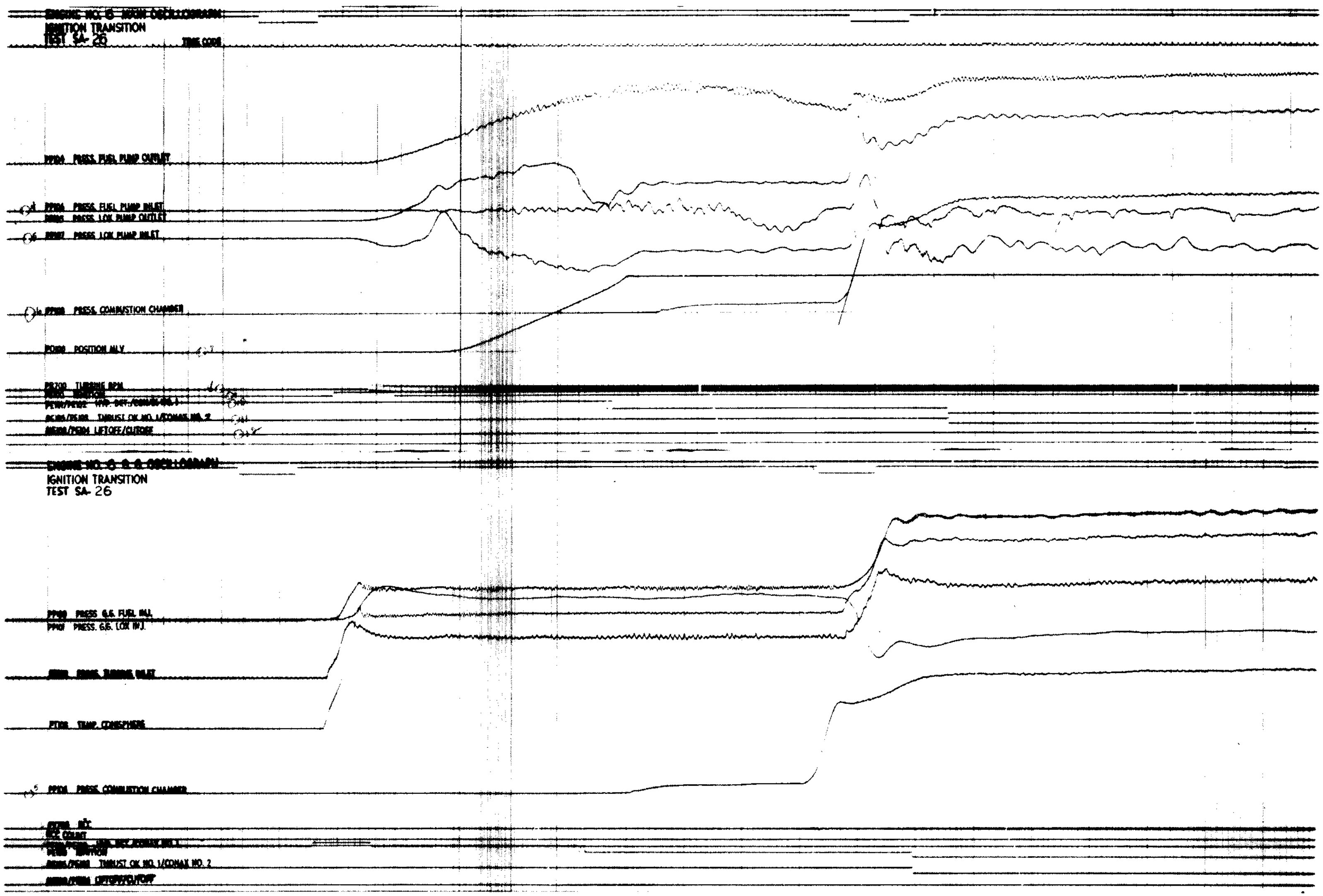
GRAPH 2-8
ENGINE 4, CUTOFF TRANSITION, TEST SA-26



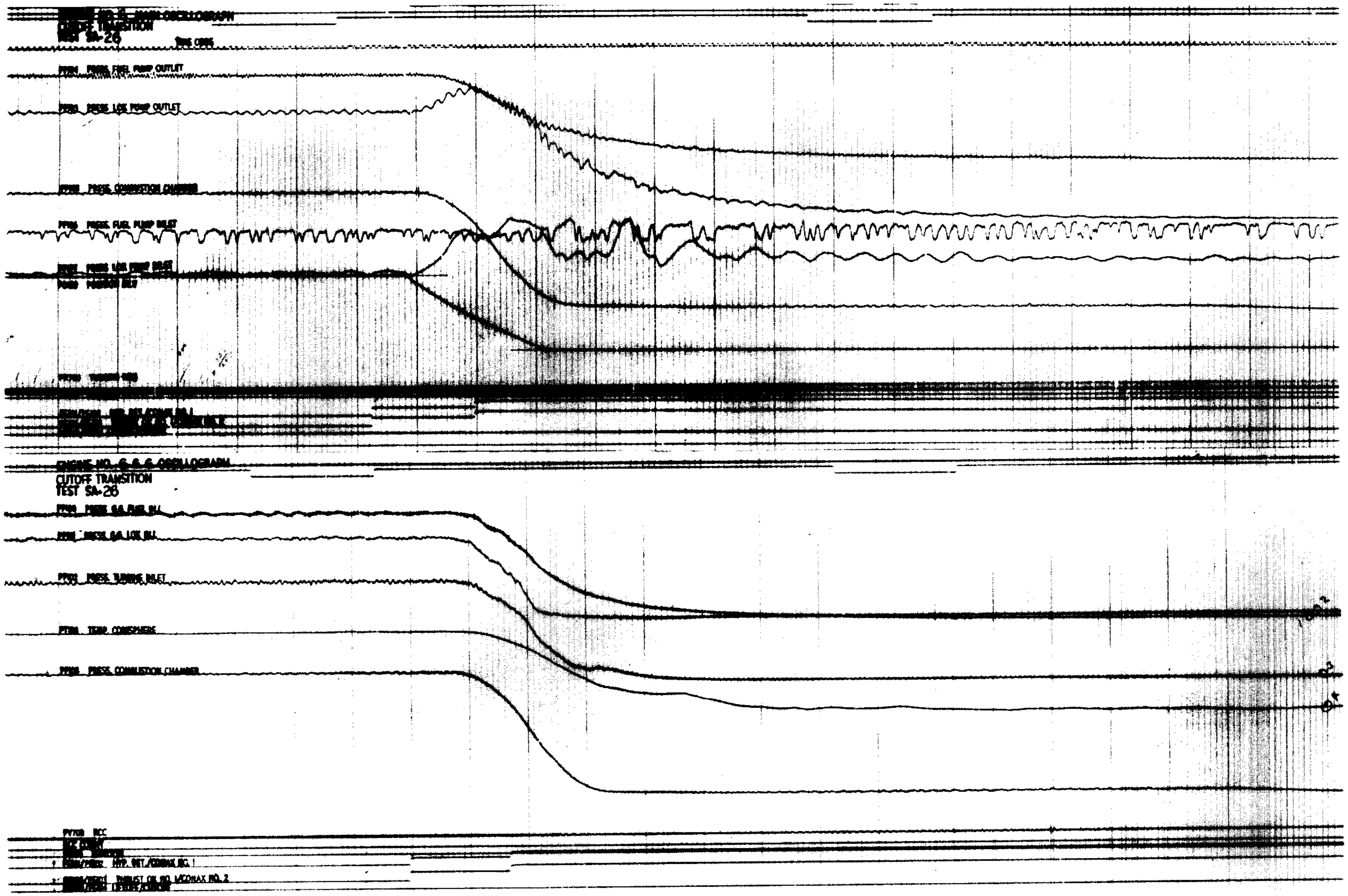
GRAPH 2-9
ENGINE 5, IGNITION TRANSITION, TEST SA-26



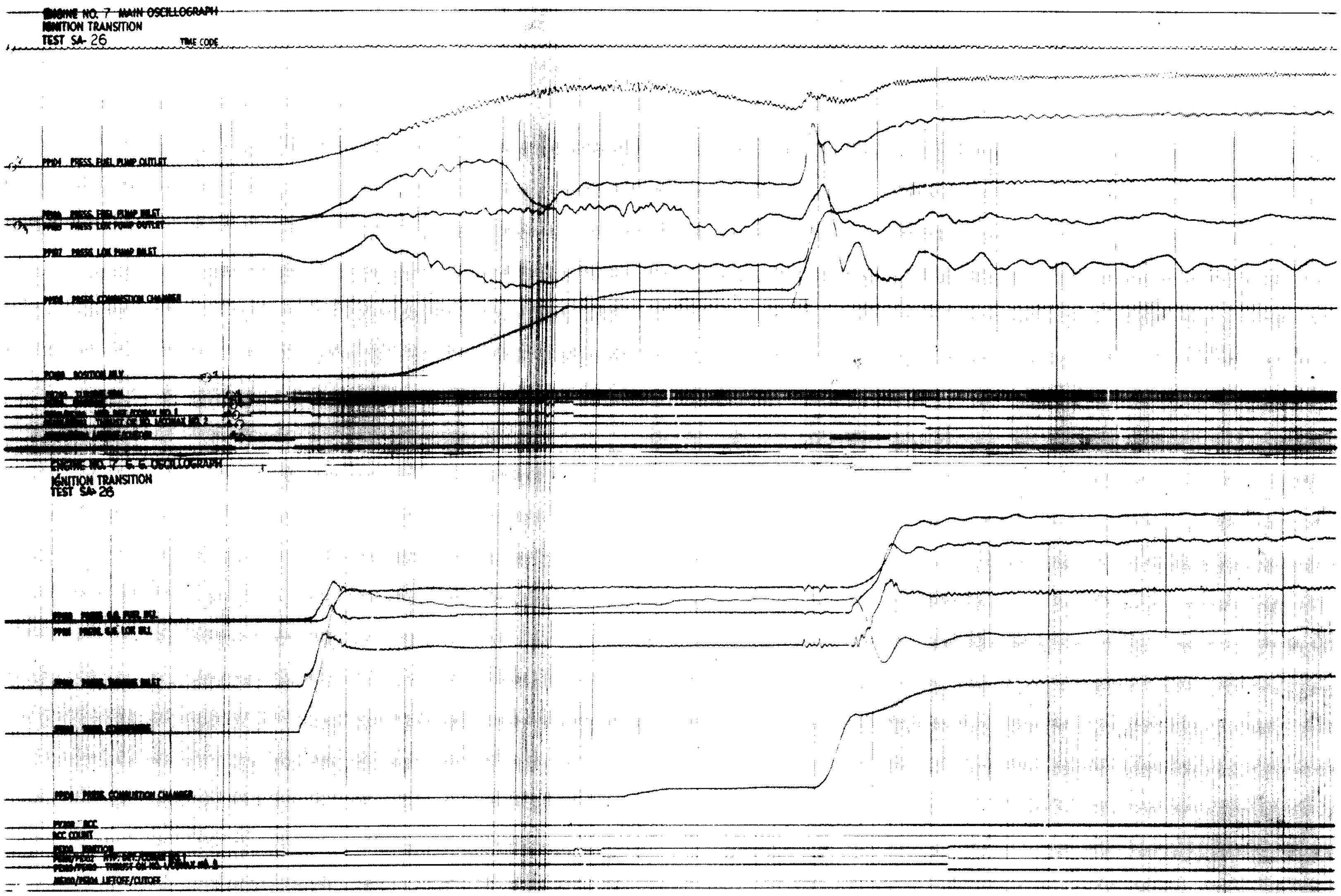
GRAPH 2-10
ENGINE 5, CUTOFF TRANSITION, TEST SA-26



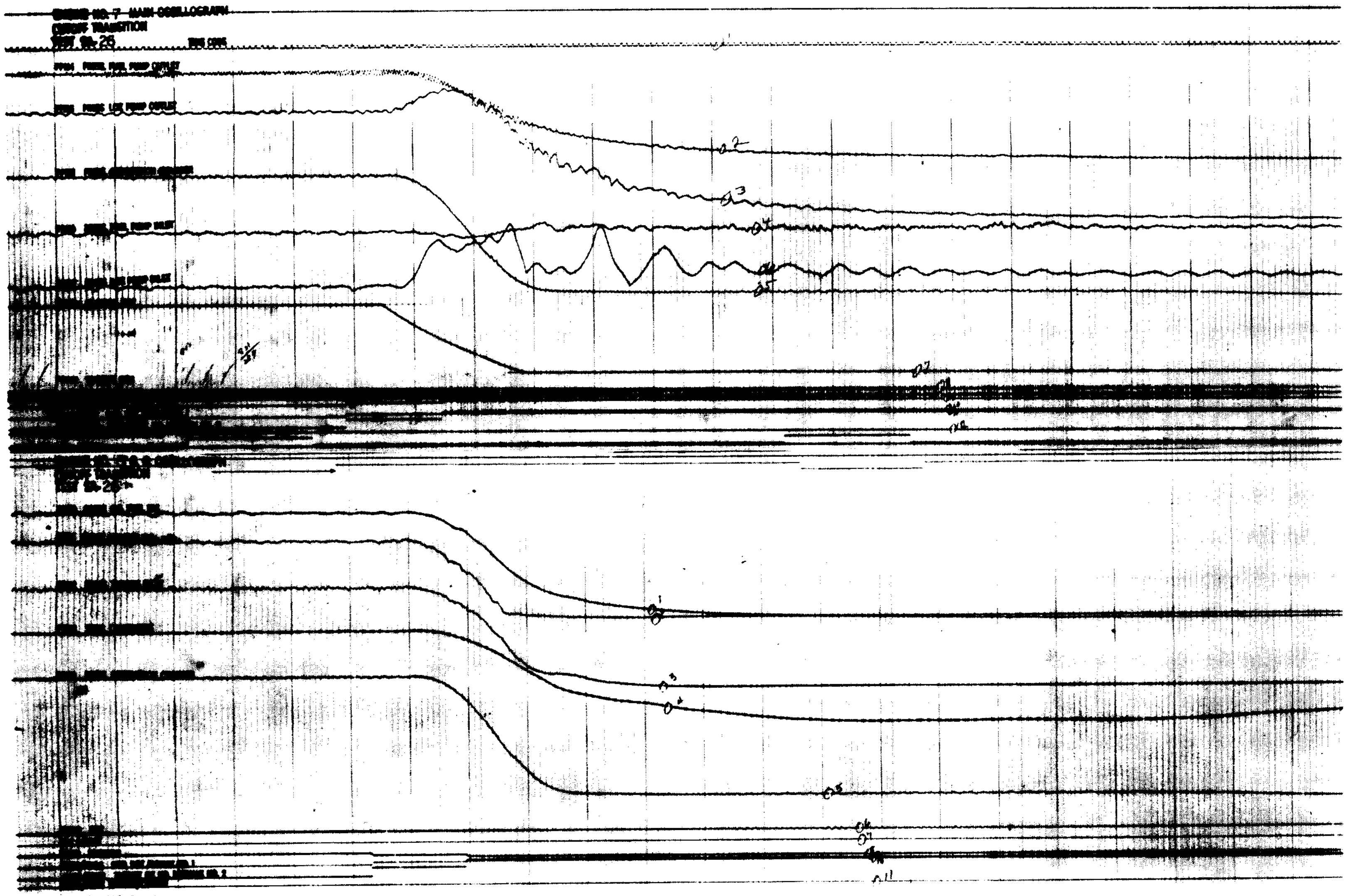
GRAPH 2-11
ENGINE 6, IGNITION TRANSITION, TEST SA-26



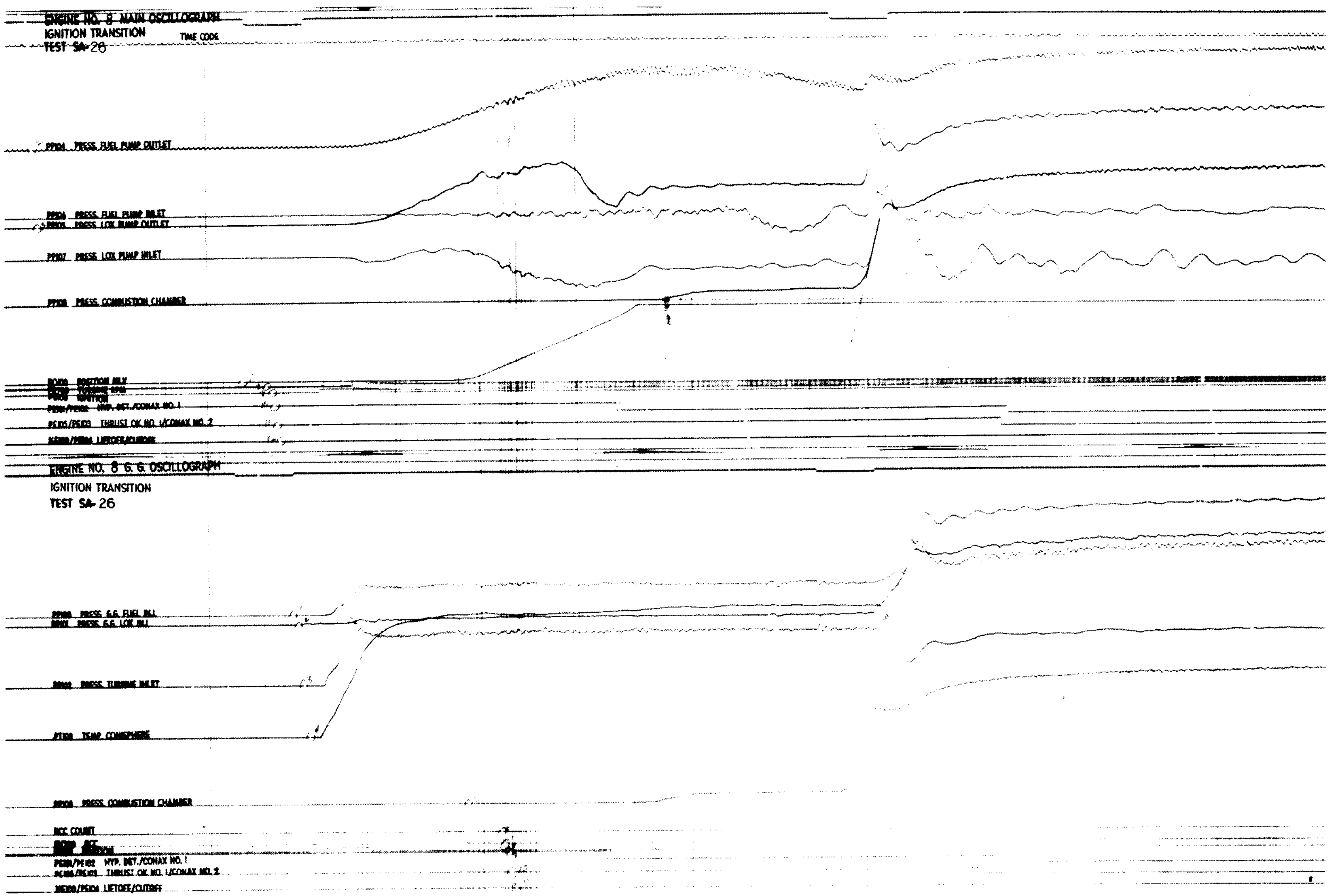
GRAPH 2-12
ENGINE 6, CUTOFF TRANSITION, TEST SA-26



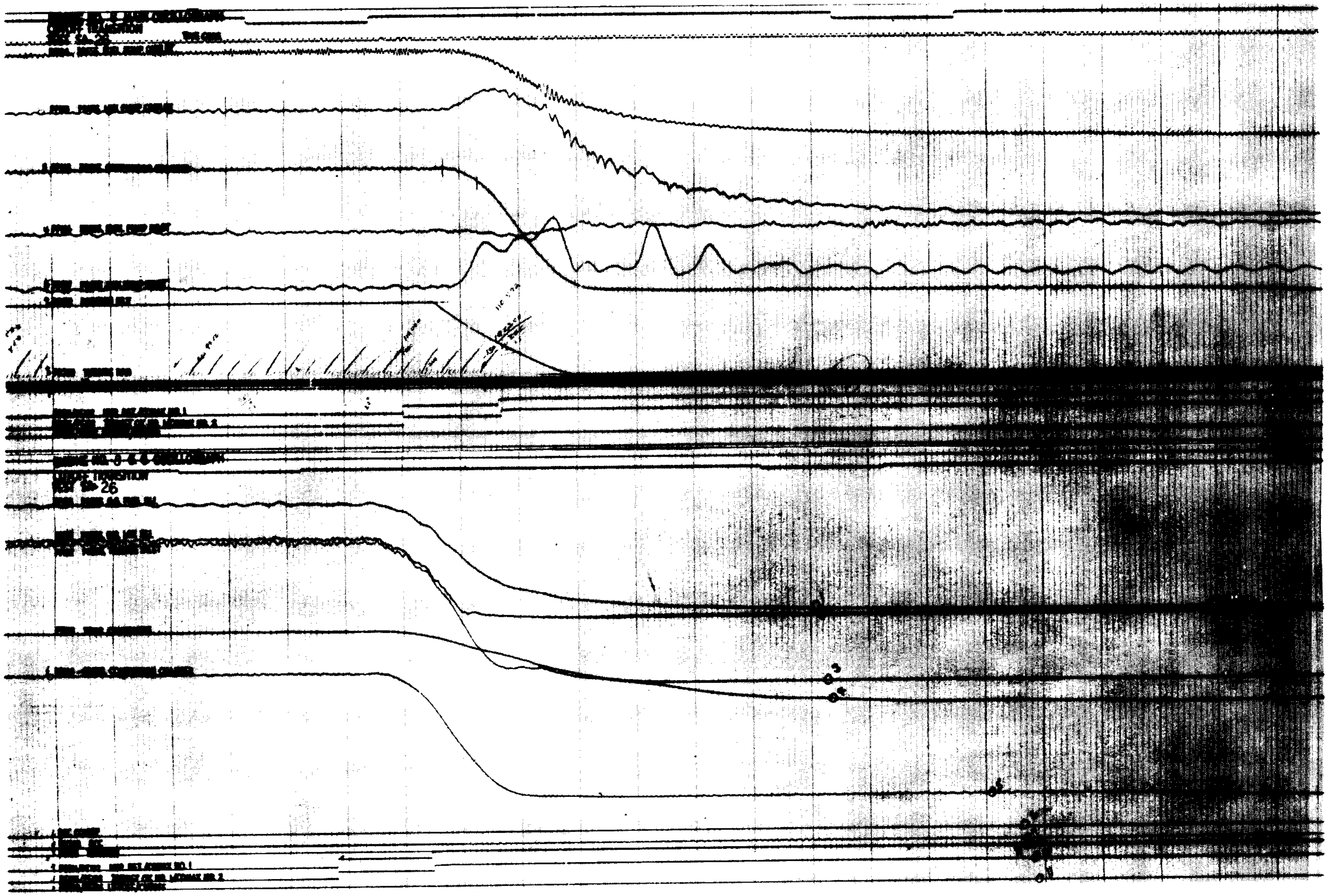
GRAPH 2-13
ENGINE 7, IGNITION TRANSITION, TEST SA-26



GRAPH 2-14
ENGINE 7, CUTOFF TRANSITION, TEST SA-26



GRAPH 2-15
ENGINE 8, IGNITION TRANSITION, TEST SA-26



GRAPH 2-16
ENGINE 8, CUTOFF TRANSITION, TEST SA-26

SECTION 3

ENGINE HYDRAULIC SYSTEMS

The engine hydraulic systems performed satisfactorily during tests SA-25 and SA-26, and all functional requirements were accomplished as outlined by the gimbal programs in TABLES 3-1 and 3-2. Post test inspections performed following each test showed no evidence of hydraulic leakage or damage to system components. A schematic of the engine 1 hydraulic system is shown in FIGURE 3-1.

On previous stages, several hydraulic supply pressure transducers (P/N 20C85079, previous measurement 56.01, present measurement *HP702) have been replaced due to erratic operation. However, investigation of the defective transducers has failed to reveal any discrepancies in most cases. Four static measurements were installed on each engine hydraulic system prior to test SA-25 to assist in locating the cause of these discrepancies. These four measurements consist of a static supply pressure transducer and three accelerometers. The static supply pressure transducers were installed in conjunction with the installation of Modification Bulletins FH-651-A through FH-654-A.

Pretest functional checks were performed on all engine hydraulic systems upon completion of the cleaning and filling operations prior to test SA-25. All systems performed satisfactorily with one exception. The flight supply pressure trace, measurement *HP702-2, indicated erratic fluctuations during the period when no gimbaling was occurring. Since the static supply pressure trace, measurement HP100-2, indicated normal operation, no action was taken.

A review of the records following test SA-25 revealed that the flight supply pressure traces, measurement *HP702, at engines 1, 2, and 3 were erratic during the test. This condition was the most pronounced at engine 2, with fluctuations of 1,940 psi occurring prior to ignition and less extreme fluctuations occurring throughout the test. The fluctuations at engine 3 also appeared throughout the test with a maximum amplitude of 800 psi occurring immediately following engine cutoff. The fluctuations at engine 1 were the least pronounced with a maximum amplitude of 270 psi occurring following ignition. These fluctuations at engines 1, 2, and 3 were not in evidence on the static supply pressure traces, measurements HP100-1, -2, and -3, which indicated that the flight transducers are defective. Also, the static vibration records, measurements HV100, HV101, and HV102, for each of these engines revealed no unusual vibrations during the time these fluctuations occurred. These defective flight supply pressure transducers were replaced prior to test SA-26.

During cleaning operations following replacement of the supply pressure transducer at engine 1, the auxiliary pump discharge pressure was observed to be only 87 psig (specification 3,000±50 psig). Due to the nature of this problem, an auxiliary pump compensator malfunction was suspected. The defective auxiliary pump and corresponding motor were removed and sent to Michoud for further investigation. A new auxiliary pump and motor were installed at engine 1 prior to test SA-26.

Upon removal of the defective auxiliary pump from engine 1, the snap ring which holds the spline shaft in place between the pump and motor was found to be broken. Since the spline shaft cannot become disengaged from the pump or motor, this defect could not have caused the low auxiliary pump discharge pressure. The broken snap ring was removed and replaced prior to shipment of the defective auxiliary pump to Michoud.

When precharging engine 1 accumulator to 1,600 psig, a GN_2 leak was observed at the high-pressure charging valve. Investigation revealed that the charging valve poppet was scored. This defective charging valve was removed and replaced prior to test SA-26.

When cleaning the engine 2 hydraulic system following the installation of low-pressure flex hoses per Modification Bulletin FH-652-A, an unusual noise was heard in the auxiliary pump. As the temperature of the hydraulic oil approached the normal operating range, this noise increased noticeably. Due to the nature of this problem, a defective bearing in the auxiliary pump was suspected. The auxiliary pump and motor assembly were removed and replaced prior to test SA-25 (pump P/N 20C85064, S/N MS100724A replaced by S/N MS100728A; motor P/N 20C85065, S/N 1335456 replaced by S/N 1335457). The defective auxiliary pump and motor were sent to Michoud for further investigation. The spare hydraulic package assembly (P/N 20C85053, S/N 130), from which the new auxiliary pump and motor were removed, was returned to Michoud.

A hydraulic leak was also observed at engine 2 main hydraulic pump low-pressure bleed valve during cleaning and filling operations. Investigation revealed that the P/N 60C27718-4 O-ring on this bleed valve was damaged. Since a new O-ring was not available, one of the bleed valves (P/N 60C27699, S/N 135-1) and its corresponding O-ring were removed from the defective auxiliary pump and installed at engine 2. The defective O-ring and bleed valve (P/N 60C27699, S/N 0009) were installed on the defective auxiliary pump prior to shipment of the pump to Michoud.

Pretest functional checks were performed on all engine hydraulic systems upon completion of the cleaning and purging operations prior to test SA-26. All systems performed satisfactorily with two exceptions. The yaw actuator differential pressure trace, measurement *HP700, for engine 4 was highly erratic, and slight blips were observed simultaneously in engine 2 yaw actuator control valve trace, measurement GM104; position trace, measurement HD101; differential pressure trace, measurement *HP700; and supply pressure trace, measurement *HP702. The condition at engine 4 was found to be an instrumentation problem and was corrected prior to test SA-26. Investigation at engine 2 revealed no discrepancies, and the operation was satisfactory during test SA-26. Since the condition at engine 2 could have been caused by a contaminated or defective servo control valve, it is recommended that further investigation be conducted upon return of the stage to Michoud.

Following test SA-26, all static instrumentation was removed from the engine hydraulic systems. Since the hydraulic systems were opened during removal of the static supply pressure transducers, measurement HP100, it is requested that each hydraulic system be cleaned and filled per MSFC-PROC-166 upon return of the stage to Michoud.

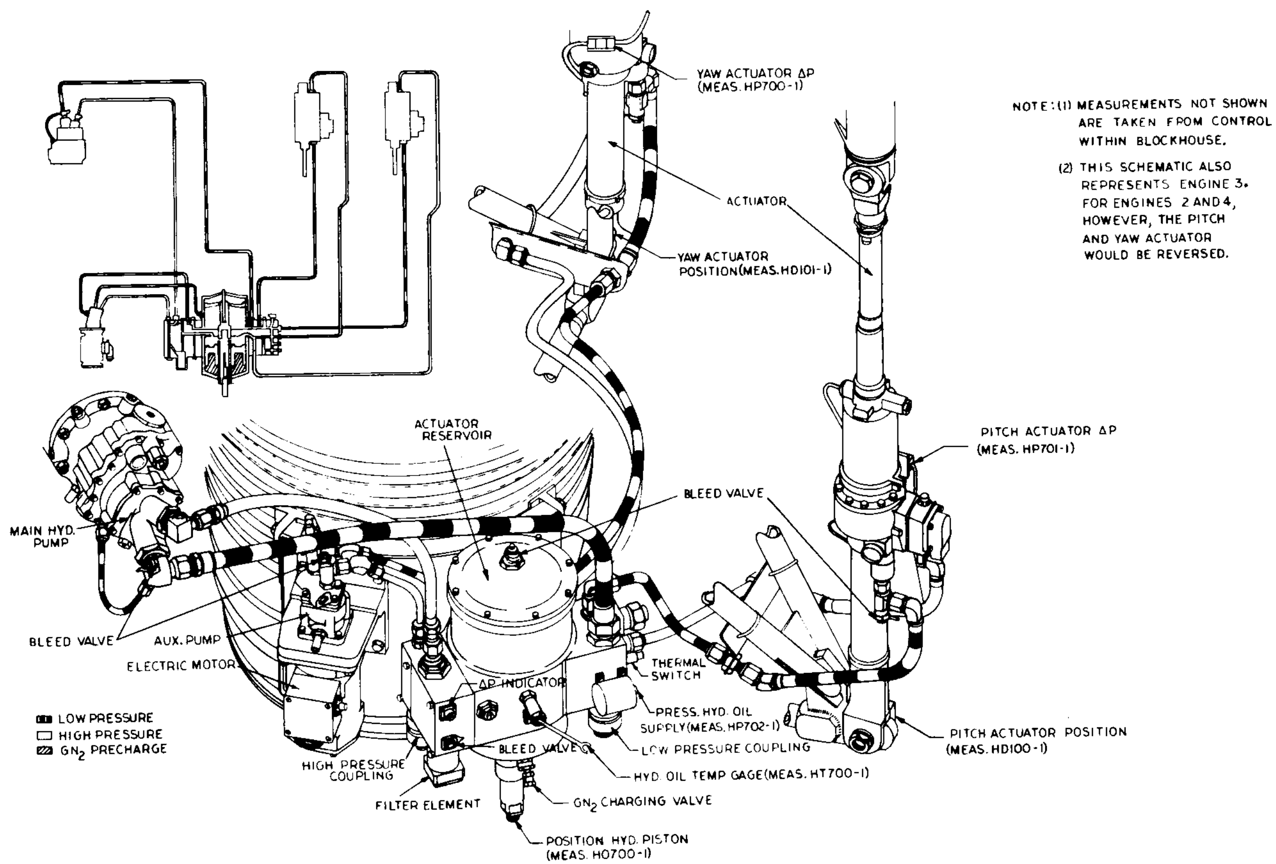


FIGURE 3-1 HYDRAULIC SYSTEM SCHEMATIC

TABLE 3-1

GIMBAL PROGRAM

TEST SA-25

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

[1] All times are referenced to simulated liftoff, X+0.29 seconds.

TABLE 3-2

GIMBAL PROGRAM

TEST SA-26

ENGINES	TIME (SECONDS) ⚠1	FREQUENCY (CPS)	INPUT (DEGREES)
1,2,3, & 4	0 - 5	0	0
1,2,3, & 4	5 - 35	1 Thru 20	±0.5 Pitch
1,2,3, & 4	35 - 40	0	0
1,2,3, & 4	40 - 71	1 Thru 20	±0.5 Yaw
1,2,3, & 4	71 - 76	0	0
1,2,3, & 4	76 - 77	Step	+2 Pitch
1,2,3, & 4	77 - 81	0	0
1,2,3, & 4	81 - 82	Step	-2 Pitch
1,2,3, & 4	82 - 86	0	0
1,2,3, & 4	86 - 87	Step	+2 Yaw
1,2,3, & 4	87 - 91	0	0
1,2,3, & 4	91 - 92	Step	-2 Yaw
1,2,3, & 4	92 - 100	0	0
1,2,3, & 4	100 - 130	0.5	±2 Roll
1,2,3, & 4	130 - Cutoff	0	0

⚠1 All times are referenced to simulated liftoff, X+0.27 seconds.

SECTION 4

PROPELLANT AND PNEUMATIC SYSTEM

The propellant and pneumatic systems functioned satisfactorily during tests SA-25 and SA-26 except for excessive LOX tank pressure during test SA-25 and uneven fuel levels during test SA-26. 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. Propellant loading and pressurization data for tests SA-25 and SA-26 are shown in TABLE 4-1.

LOX SYSTEM

The LOX system parameters indicate that the system functioned properly during tests SA-25 and SA-26 except for the excessive LOX tank pressure experienced during test SA-25.

The height of LOX on board at ignition of test SA-25 was 650.5 inches in tank O-C, which corresponds to an ullage of 2.2 percent. This was a greater ullage than the 1.7 percent flight ullage desired for this test due to LOX boiloff during a preignition hold of the countdown. LOX ullage at ignition of test SA-26 was 6.0 percent with a liquid height of 624.0 inches.

Test SA-25 preignition pressurization of the LOX tanks was accomplished in 82.7 seconds. Following the ignition transients, LOX tank pressure increased from 53.5 psia at X+5 seconds to 57.5 psia at cutoff. The excessive LOX tank pressure was caused by incorrect heat exchanger orificing and GOX flow control valve (GFCV) closed stop setting.

Test SA-26 preignition pressurization was accomplished in 71.5 seconds, utilizing a 0.149-inch diameter ground LOX pressurizing orifice. LOX tank pressure during the test was maintained between 50 and 55 psia. A plot of the LOX tank pressure versus time during each static test firing is shown in GRAPH 4-1. GRAPH 4-2 shows the position of the GFCV in terms of percent closed versus time for test SA-26. The excessive LOX tank pressure experienced on test SA-25 was corrected by changing the mass GOX flow past the closed GFCV from 21 pounds per second to 19 pounds per second. This was accomplished by reducing the LOX heat exchanger orifices from 0.108-inch diameter to 0.104-inch diameter and reducing the GFCV closed stop setting from 0.290-inch to 0.255-inch clearance.

A comparison of LOX depletion characteristics during test SA-26 using discrete probe data from tank O-C and the continuous probe data from the outer LOX tanks shows a variation in levels of approximately 4 to 9 inches between tank O-C and the outer tanks (reference GRAPH 4-3). The discrete probe data were used from tank O-C due to the loss of the continuous level probe in that tank. The differential height between tanks during the cutoff sequence was also verified by comparing actuations of LOX discrete probes 14 and 15 in all LOX tanks (reference GRAPH 4-4). The LOX and fuel discrete probe actuation times are shown in TABLE 4-2, and the corresponding LOX and fuel volumes below the discrete probes are presented in TABLE 4-3.

LOX density tests were conducted in conjunction with LOX loading for tests SA-25 and SA-26. The objectives of these tests were to determine LOX bulk densities and the LOX liquid levels. The LOX suppressed range differential pressure measurements LP111 established the actual weight of LOX above the 51.6-inch reference boss in the LOX tanks. The LOX tank differential pressure measurements SP206 established the true LOX height in the LOX tanks. The LOX bulk densities prior to test SA-25 were calculated as:

Density in LOX tank O-C = 71.09 pounds/cubic foot
Density in LOX tank O-3 = 70.61 pounds/cubic foot

The bulk density of the LOX in the center tank prior to test SA-26 was calculated to be 71.09 pounds per cubic foot which was comparable to the results of test SA-25.

During prefiring LOX loading tests, it was determined that LOX could be bubbled at 1.7 percent ullage with the tank vents open. There was no evidence of LOX entering the GOX standpipe, but LOX was emitted from the vents.

The outboard tank boiloff rate, as calculated from the pitot probes (measurements SP201, SP202, SP203, and SP204) was 6.32 pounds per second during standby for test SA-25. The boiloff rate for the center LOX tank was calculated at 3.08 pounds per second from measurement LP111-OC. The total boiloff rate was 9.40 pounds per second (see TABLE 4-1). The total boiloff rate during standby of test SA-26 was 11.986 pounds per second (see TABLE 4-1).

Test SA-26 was terminated as planned, with inboard engine cutoff being initiated by the switch selector 2 seconds after closure of the LOX low level sensor in LOX tank O-2. This sensor is located 28.2 inches below theoretical tank bottom in tanks O-2 and O-4 (see FIGURE 4-1). Outboard engine cutoff was initiated 6.8 seconds later when LOX depletion caused dropout of the Thrust OK pressure switches at engine 1.

FUEL SYSTEM

The fuel system functioned satisfactorily during tests SA-25 and SA-26 except for the uneven fuel levels experienced during test SA-26. The fuel level at ignition for both tests was 634.5 inches which provided the required 2 percent ullage.

Fuel sphere pressurization for tests SA-25 and SA-26 was comparable. GRAPH 4-5 shows the pressurization and temperature characteristics versus time from approximately 1,500 psig to 3,100 psig for the high pressure spheres, test SA-26.

The performance of the fuel system pressurization for test SA-26 is shown in GRAPH 4-6. The fuel tank pressure was maintained by the stage system until X+62 seconds. At X+62 seconds, the fuel tank pressure had decreased to 6.8 psig, which initiated facility fuel tank pressurizing. At X+71 seconds, the launch sequencer activated the facility fuel tank pressurizing system, and it maintained pressure for the remainder of the test.

The fuel consumption characteristics plotted in GRAPH 4-7 show the difference in fuel levels during test SA-26. A comparison of fuel levels in tank F-1 and F-3 from X+17 seconds shows that the fuel level in tank F-3 was 9 inches above the level in tank F-1, and that it remained relatively constant until X+62 seconds. At X+62 seconds, the fuel levels began changing again until tank F-1 assumed a higher level than F-3, and reached a maximum difference of 35 inches at X+95 seconds. The 35-inch difference was constant through the remainder of the test.

The difference in fuel levels was apparently the result of unequal ullage pressures caused by unbalanced pressure distribution in the fuel pressurizing manifold.

There are two successive conditions which contribute to this unbalanced pressure distribution. During the time from ignition to X+62 seconds, tank F-3 was lowest in ullage pressure. This was apparently the result of the pressurizing gas entering the fuel tank pressurizing manifold at only one port (reference FIGURE 4-3).

The second condition, when tanks F-2 and F-3 receive the highest ullage pressures, is caused by activation of the facility fuel pressurizing system in conjunction with stage pressurization. This causes an unequal pressure distribution in the fuel pressurizing manifold. This condition is peculiar to static test because of the need for supplemental pressurization.

It is recommended that both conditions be corrected by routing the pressure from the high-pressure spheres to two positions 180 degrees apart on the fuel tank pressurizing manifold. Neither problem was encountered on S-I Block II stages because stage pressurization entered the pressurizing manifold through three ports 90 degrees apart. Also, stage pressurization was terminated at X+70 seconds, after which time the facility pressurization maintained fuel tank pressure.

GN_2 CONTROL SYSTEM

The GN_2 control system functioned normally during test SA-26 except for obtaining 3,000 psig preignition control sphere pressure. With the gearcase purge on, only 2,965 psig control sphere pressure could be obtained using a supply pressure of 3,100 psig and a 0.050-inch orifice in the supply line (reference GRAPH 4-8). Post test checkout showed that a change of the supply orifice to 0.055-inch diameter will provide the specified 3,000 psig preignition control sphere pressure with both the gearcase and calorimeter purges on.

PREVALVES

The LOX prevalves on engines 2 and 4 were replaced prior to test SA-25 due to the failure of the valves to give closed indications. The LOX prevalve on engine 2 did not give a closed indication after test SA-25 cutoff. This prevalve was replaced prior to test SA-26.

All prevalves functioned satisfactorily for test SA-26.

The prevalve closing times for tests SA-25 and SA-26 are shown in TABLE 4-4.

MISCELLANEOUS

The sliding pins on fuel tanks F-1, F-3, and F-4 were slightly galled after test SA-26 (reference UCR 01169).

During stage removal from the static test tower, five ripples were noted in fuel tank F-3. The ripples were approximately 12 inches long and 1/4 inch deep (see FIGURE 4-5). The cause of the ripples is under investigation (reference UCR 01186). Further investigation will be conducted on stage S-IB-2 during installation and removal of this stage from the static test tower. An instrumentation program is being formulated for this investigation.

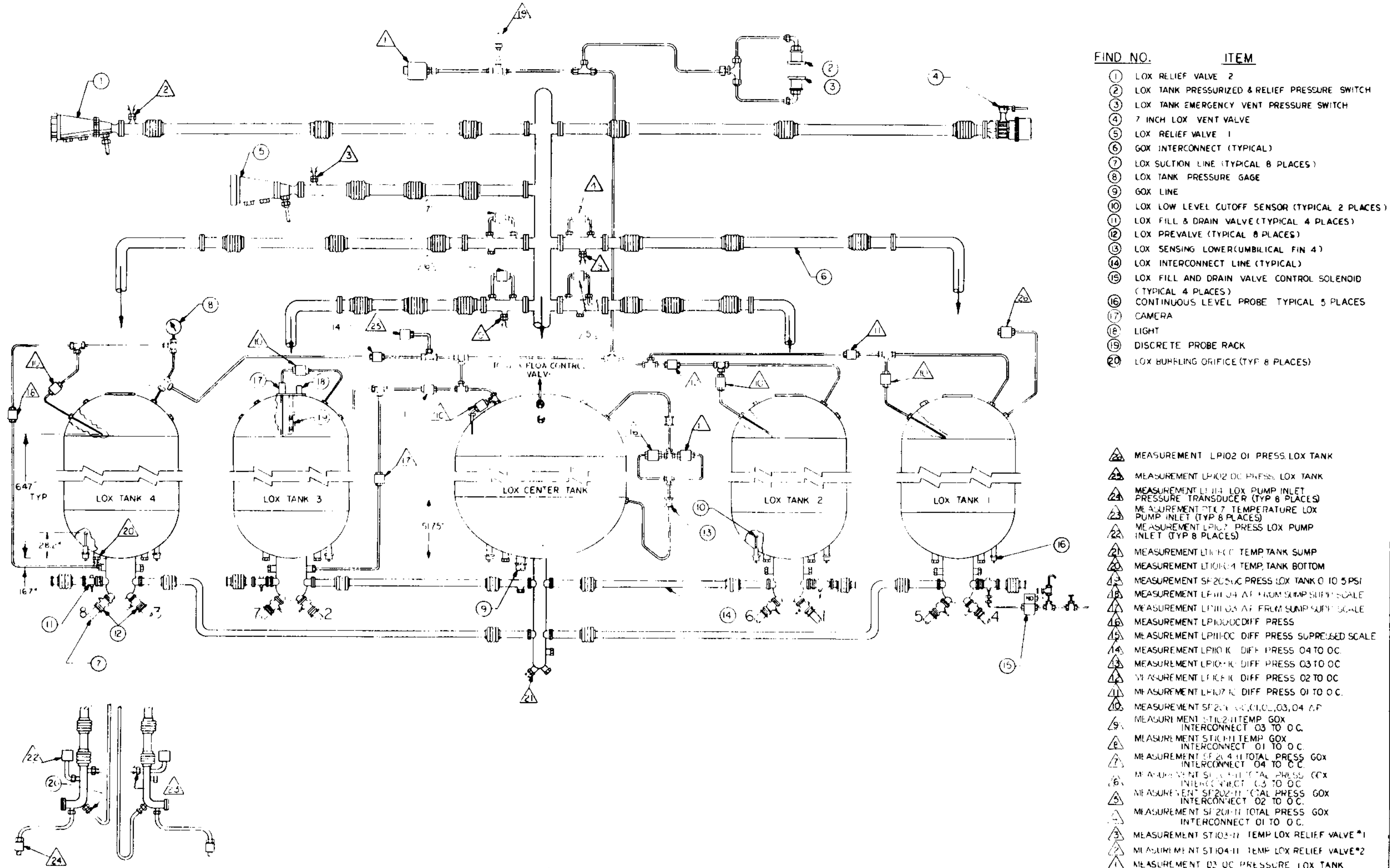


FIGURE 4-1 LOX SYSTEM

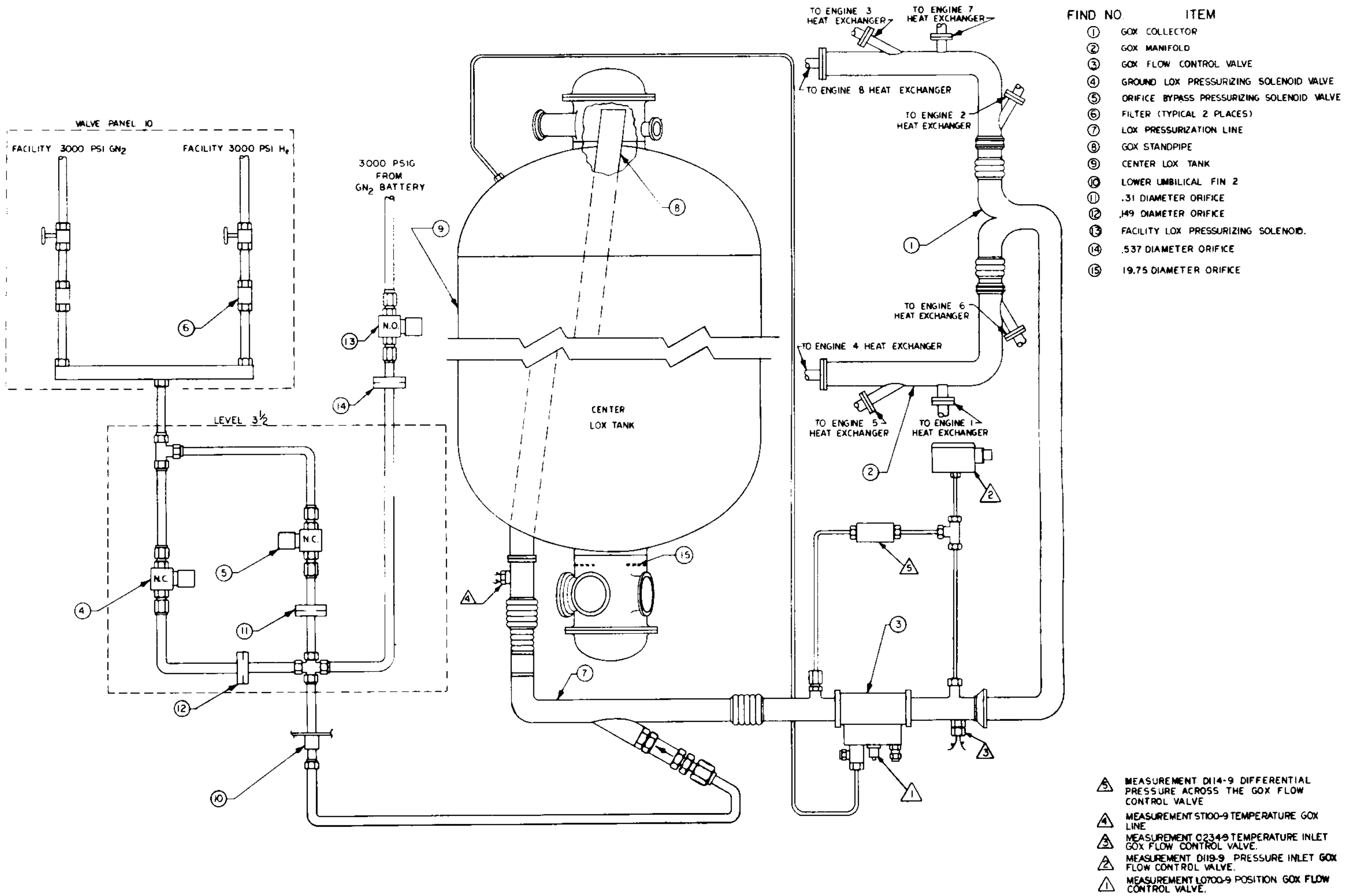


FIGURE 4-2 LOX PRESSURIZATION SYSTEM

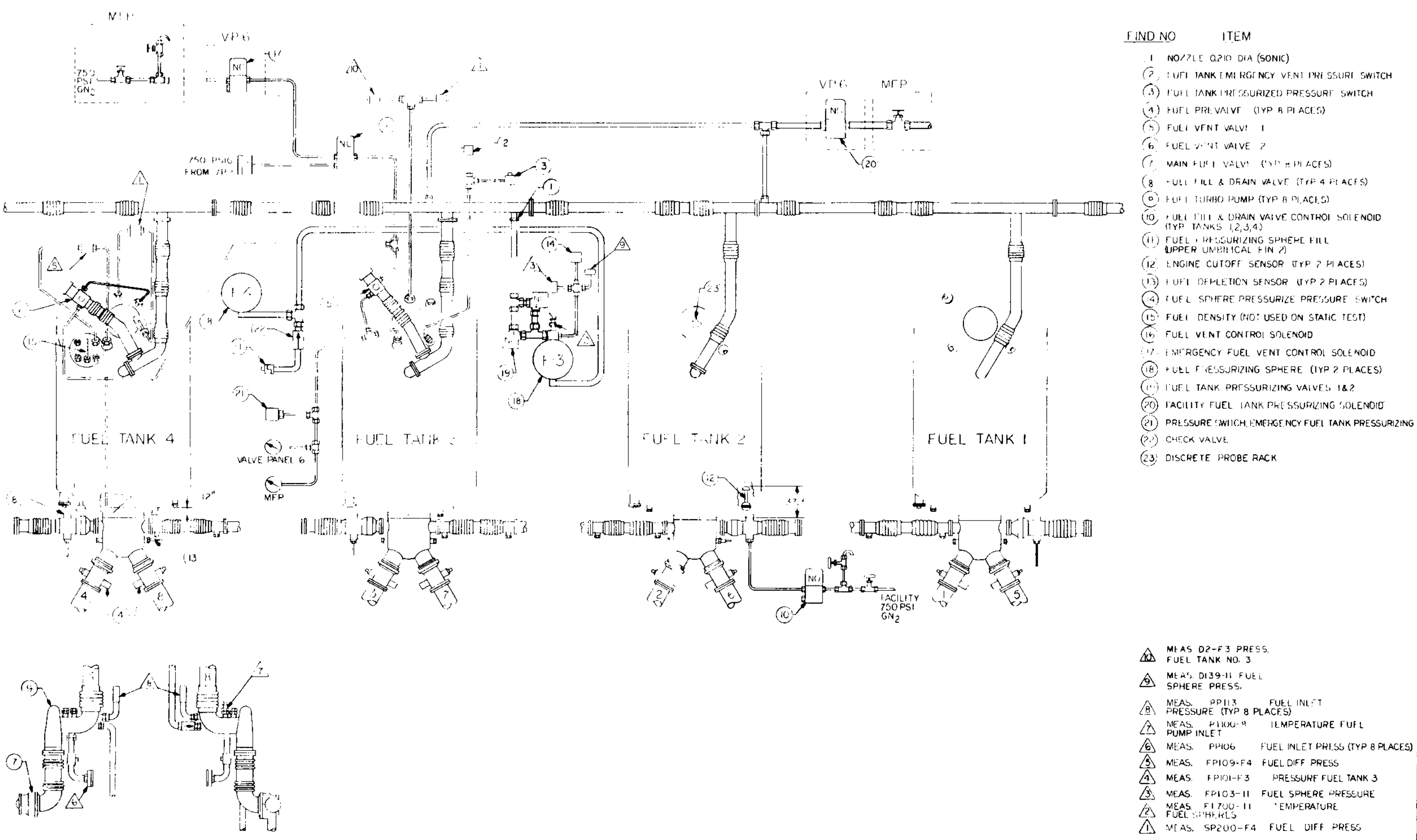


FIGURE 4-3 FUEL PROPELLANT AND PRESSURIZATION SYSTEM

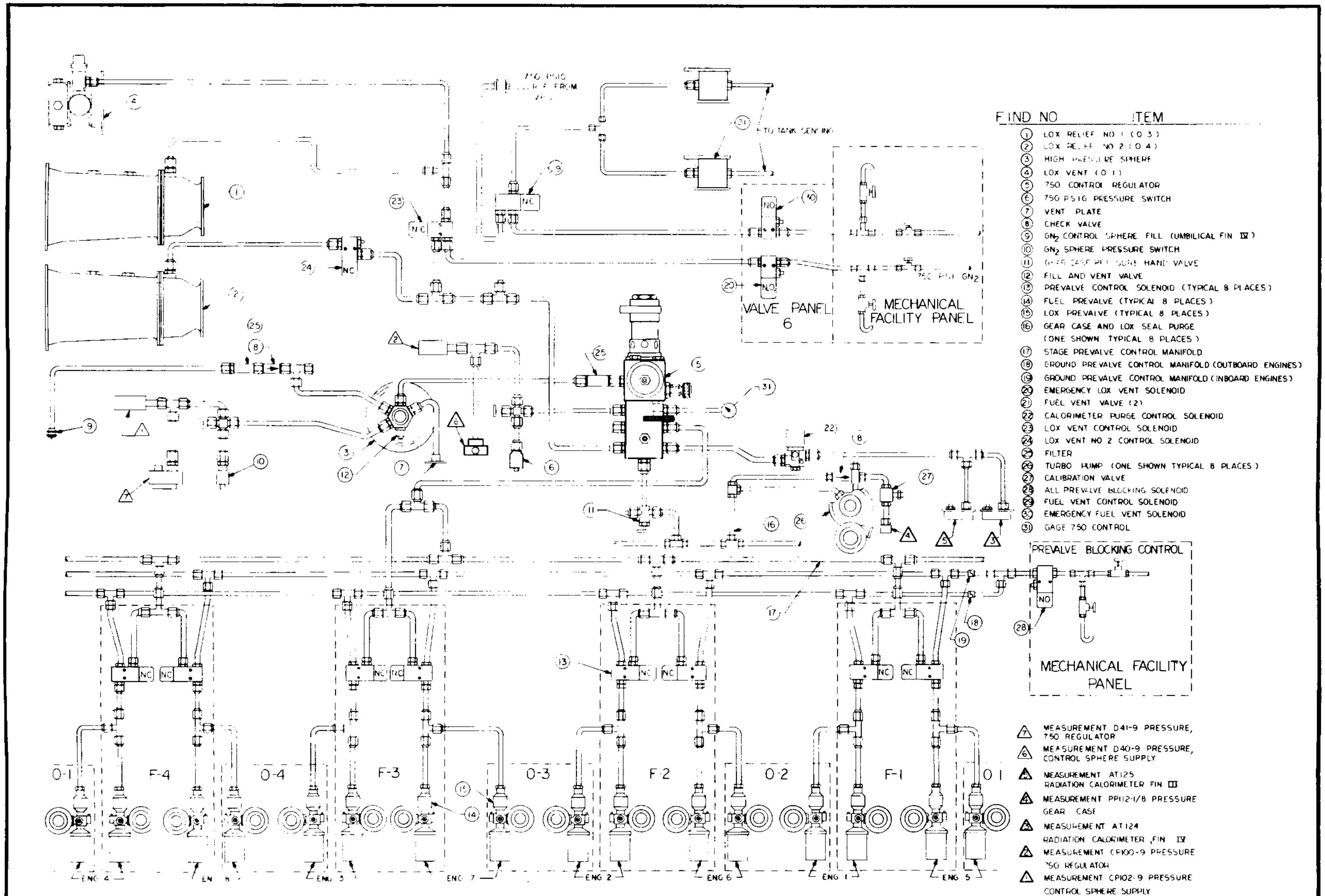


FIGURE 4-4 GN$_2$ CONTROL PRESSURE SYSTEM

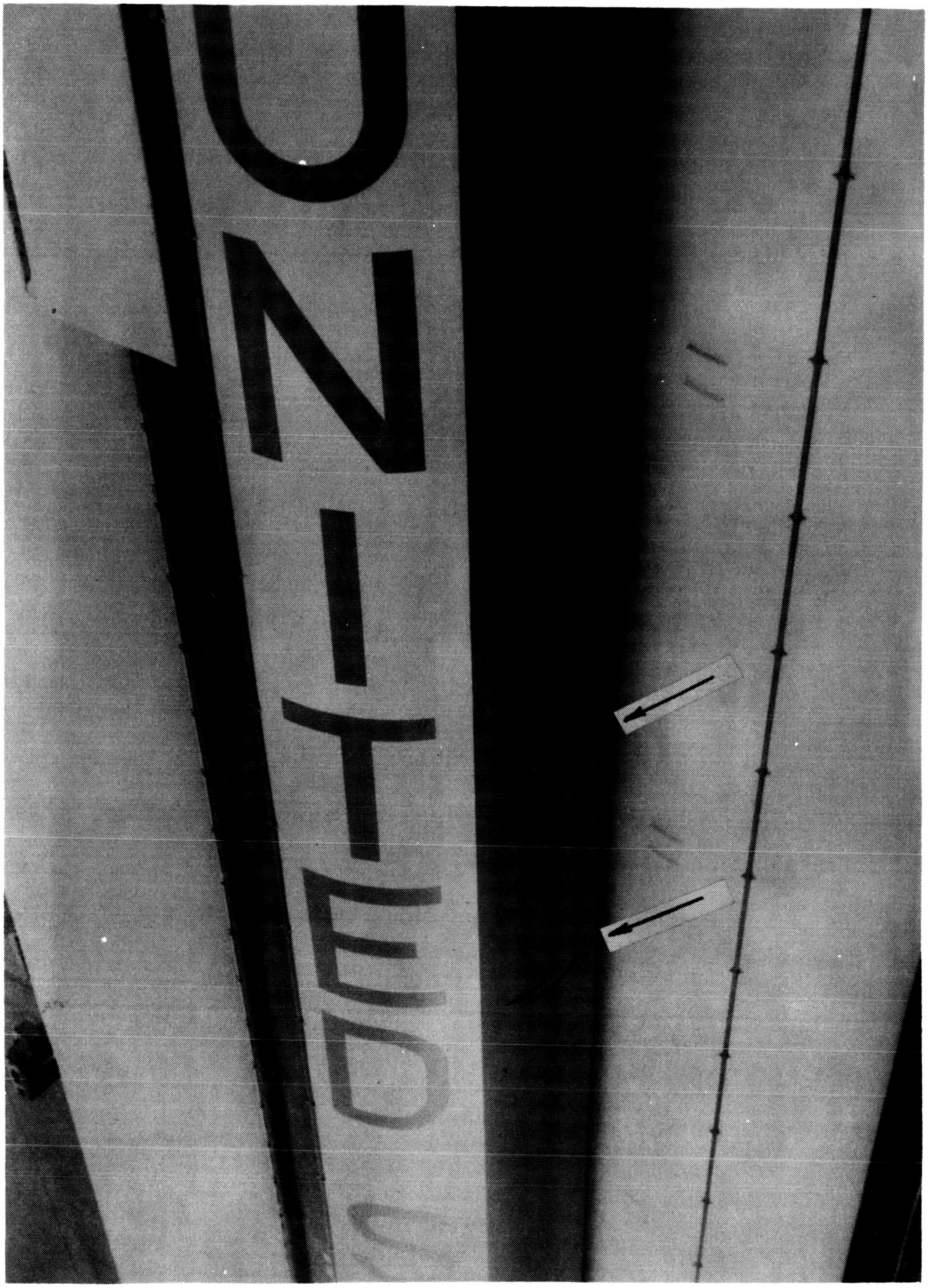


FIGURE 4-5. RIPPLES IN TANK F-3
(Photograph Touched Up)

TABLE 4-1

PROPELLANT LOADING AND PRESSURIZATION DATA

LOX

		TEST SA-25	TEST SA-26
1.	Tank Pressurant	Helium	Helium
2.	Pressurizing time (seconds)	82.72	71.504
3.	Height from tank bottom at ignition command (inches)	650.5	624.0
4.	Ullage volume at ignition (gallons)	1,432	4,120
5.	Ullage volume at ignition (percent)	2.2	6.0
6.	Volume at ignition (gallons)	66,544	63,856
7.	Volume at outboard cutoff signal (gallons)	46,944	0
8.	Average boiloff rate during standby (pounds/second)	9.40	11.986

FUEL

		TEST SA-25	TEST SA-26
1.	Tank pressurant	Helium	Helium
2.	Pressurizing time (seconds)	1.5	1.524
3.	Height from tank bottom at ignition (inches)	634.5	634.5
4.	Ullage at ignition (gallons)	845.4	845.4
5.	Ullage at ignition (percent)	2.0	2.0
6.	Volume at ignition (gallons)	42,100	42,100
7.	Volume at outboard cutoff	32,230	3,400

TABLE 4-2

DISCRETE PROBE ACTUATION TIMES

LOX PROBES

TEST SA-26

TIME FROM ⚠1 (SECONDS)	TANK 0-C	TANK 0-1	TANK 0-2	TANK 0-3	TANK 0-4
Ignition to P1	6.29	4.60	4.56	4.59	4.67
P1 to P2	9.75	9.31	8.77	9.25	9.28
P2 to P3	9.39	9.45	9.49 ⚠2	9.48	9.22 ⚠2
P3 to P4	9.45	9.45	⚠3	9.44	9.53
P4 to P5	9.34	9.40	18.38 ⚠2	9.50	9.54
P5 to P6	9.33	9.51	9.61	9.52	9.21
P6 to P7	9.39	9.45	9.46	9.50	9.52
P7 to P8	9.46	9.53	9.40	9.55	9.65
P8 to P9	9.37	9.59	9.55	9.52	9.37
P9 to P10	9.59	9.42	9.41	9.50	9.78
P10 to P11	9.44	9.56	9.65	9.43	9.32
P11 to P12	9.54	9.55	9.78	9.86	9.73
P12 to P13	9.54	9.67	9.52	9.58	9.55
P13 to P14	9.63	9.62	9.51 ⚠2	9.70	9.70
P14 to P15	9.20	9.55	9.71	9.65	9.57

⚠1 Times shown are periods in seconds between probe actuations.

⚠2 Value corrected from that published in the "Preliminary Static Test Report, Test SA-26".

⚠3 Pulse lost. Next reading shows accumulative time from P3 to P5.

TABLE 4-2 (CONTINUED)

FUEL PROBES

TEST SA-26

TIME FROM 1 (SECONDS)	TANK F-1	TANK F-2	TANK F-3	TANK F-4
Ignition to P1	14.27	14.55	16.14	2
P1 to P2	9.46	9.44	9.39	23.84 3
P2 to P3	9.47	9.43	9.15	9.40
P3 to P4	9.50	9.44	9.34	9.48
P4 to P5	9.46	9.47	9.22	9.48
P5 to P6	9.50	9.45	9.31	9.44
P6 to P7	10.00	9.33	8.64	9.89
P7 to P8	10.81	9.18	8.11	10.88
P8 to P9	10.76	9.00	7.77	10.52
P9 to P10	10.08	9.05	8.35	9.93
P10 to P11	9.83	9.30	9.09	9.75
P11 to P12	9.61	9.33	9.21	9.42
P12 to P13	9.55	9.58	9.52	9.42
P13 to P14	10.46	9.60	9.56	10.24

1 Times shown are periods in seconds between probe actuations.

2 Pulse Lost

3 Accumulative time from ignition.

TABLE 4-3

PROPELLANT VOLUMES BELOW DISCRETE PROBES

LOX
(UNSHRUNK GALLONS)

TEST SA-26

PROBE	TANK 0-C	TANK 0-1	TANK 0-2	TANK 0-3	TANK 0-4
P1	22,190	9,965	9,954	9,966	9,959
P2	20,635	9,276	9,265	9,275	9,270
P3	19,081	8,581	8,573	8,583	8,576
P4	17,526	7,890	7,882	7,891	7,886
P5	15,972	7,199	7,191	7,201	7,197
P6	14,416	6,506	6,500	6,508	6,504
P7	12,857	5,816	5,812	5,819	5,814
P8	11,304	5,127	5,121	5,128	5,124
P9	9,752	4,435	4,431	4,436	4,432
P10	8,193	3,740	3,738	3,745	3,740
P11	6,639	3,055	3,049	3,055	3,051
P12	5,085	2,359	2,358	2,362	2,360
P13	3,531	1,668	1,668	1,672	1,670
P14	1,979	978	978	983	980
P15	483	299	299	301	302

TABLE 4-3 (CONTINUED)

FUEL
(GALLONS)

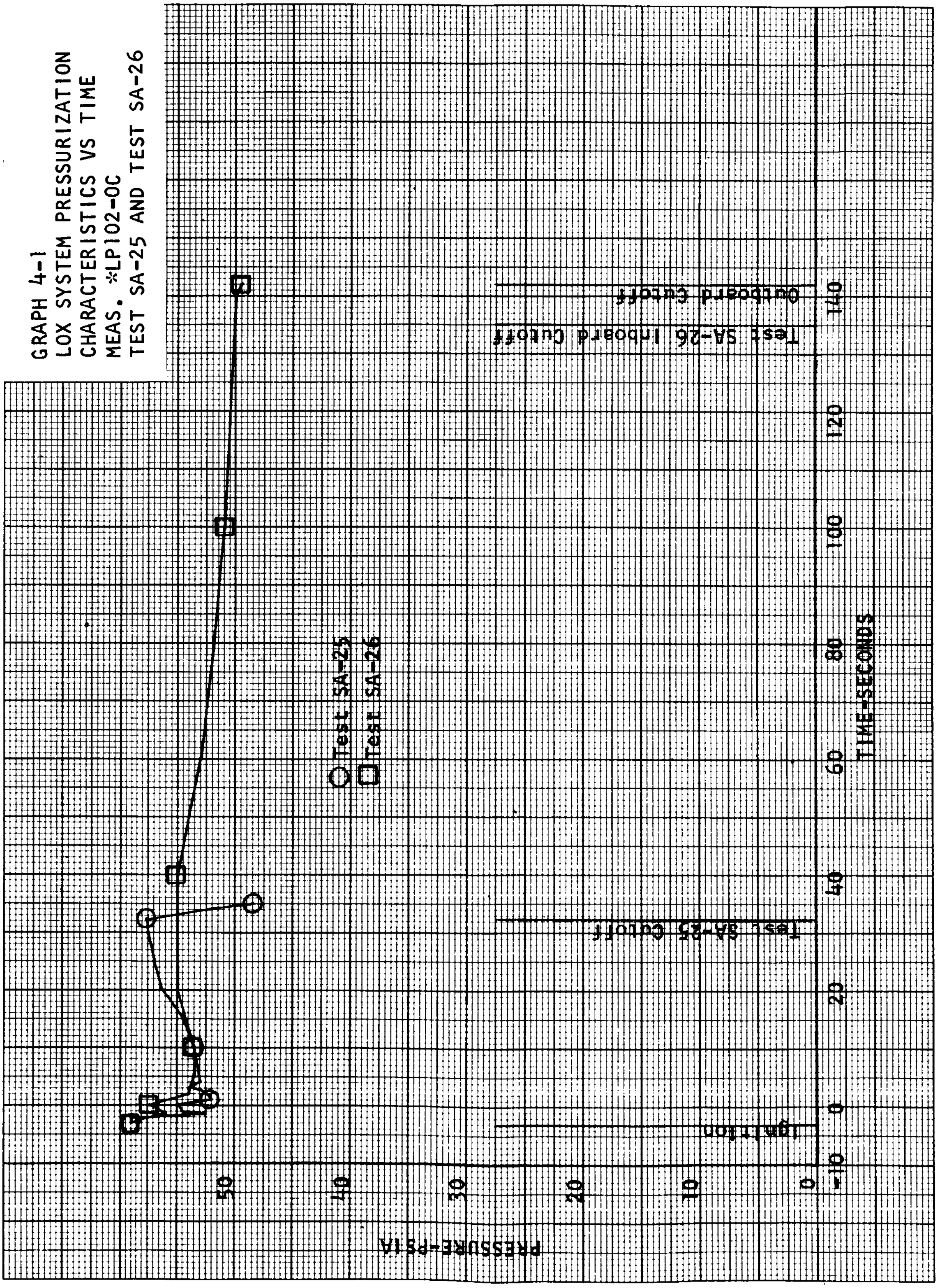
PROBE	TANK F-1	TANK F-2	TANK F-3	TANK F-4
P1	9,484	9,476	9,481	9,471
P2	8,822	8,816	8,820	8,811
P3	8,164	8,158	8,162	8,154
P4	7,511	7,499	7,506	7,497
P5	6,849	6,841	6,847	6,835
P6	6,190	6,181	6,188	6,180
P7	5,531	5,523	5,530	5,523
P8	4,871	4,865	4,870	4,864
P9	4,214	4,206	4,211	4,206
P10	3,555	3,547	3,555	3,548
P11	2,897	2,890	2,896	2,891
P12	2,238	2,232	2,237	2,233
P13	1,577	1,572	1,579	1,573
P14	919	915	920	918
P15	274	270	274	272

TABLE 4-4

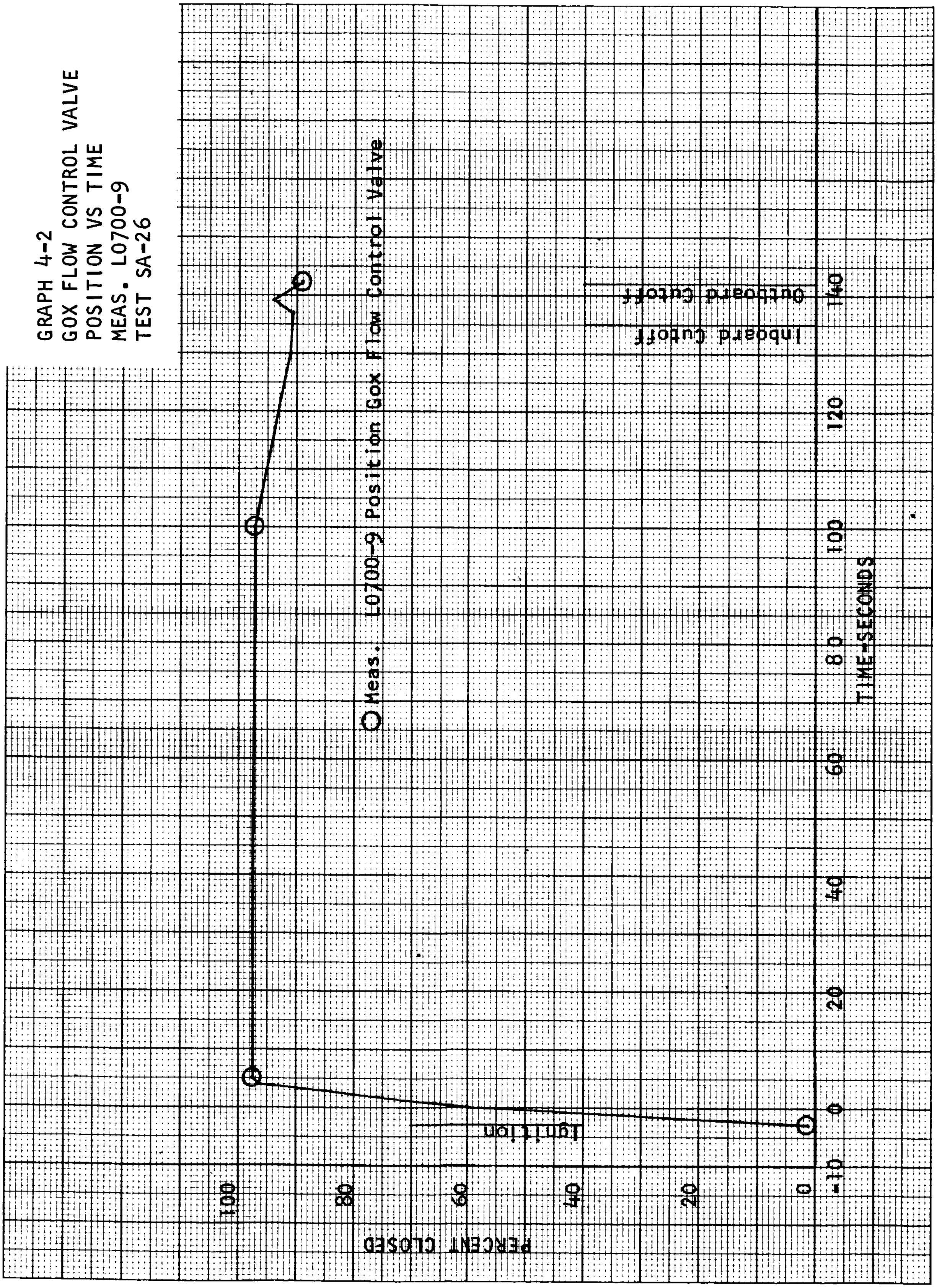
PREVALVE CLOSING TIMES
($4\frac{1}{2}$ HOUR EXPOSURE TO LOX)

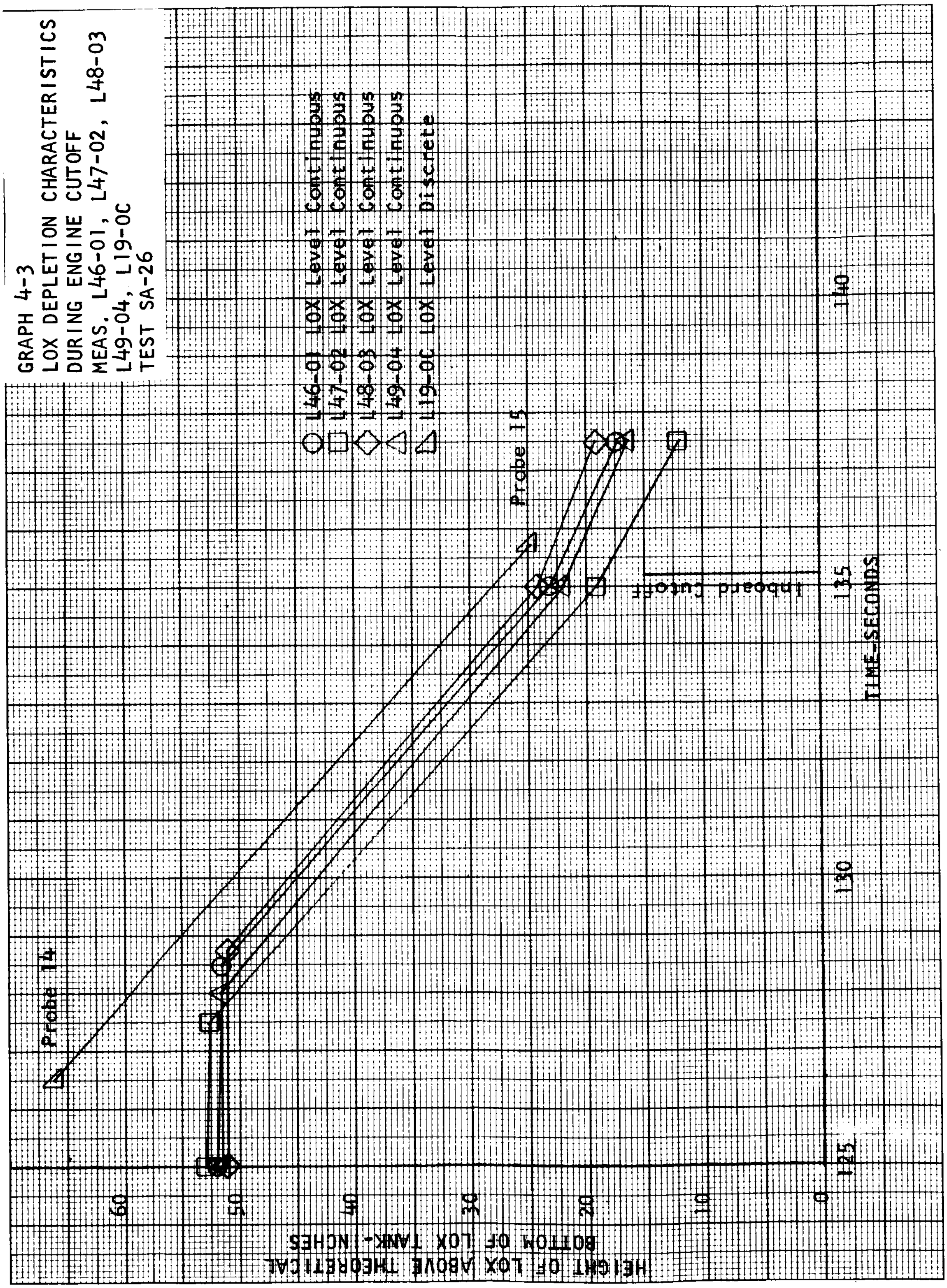
PREVALVE	TEST SA-25		TEST SA-26	
	SIGNAL TO SWITCH (SECONDS)	SWITCH TO SWITCH (SECONDS)	SIGNAL TO SWITCH (SECONDS)	SWITCH TO SWITCH (SECONDS)
LOX 1 Fuel 1	1.335 2.326	.930 1.913	0.977 1.966	0.659 1.617
LOX 2 Fuel 2	⚠1 2.326	⚠1 1.800	0.894 2.051	0.613 1.544
LOX 3 Fuel 3	1.172 2.163	.776 1.750	0.977 2.051	0.620 1.664
LOX 4 Fuel 4	1.335 2.326	.939 1.906	0.977 2.051	0.667 1.671
LOX 5 Fuel 5	1.371 2.284	.953 1.767	1.020 1.928	0.746 1.553
LOX 6 Fuel 6	1.293 2.198	.974 1.757	1.020 1.928	0.731 1.503
LOX 7 Fuel 7	1.123 2.128	.779 1.727	0.942 1.936	0.624 1.554
LOX 8 Fuel 8	1.208 2.376	.920 1.868	0.942 2.102	0.677 1.627

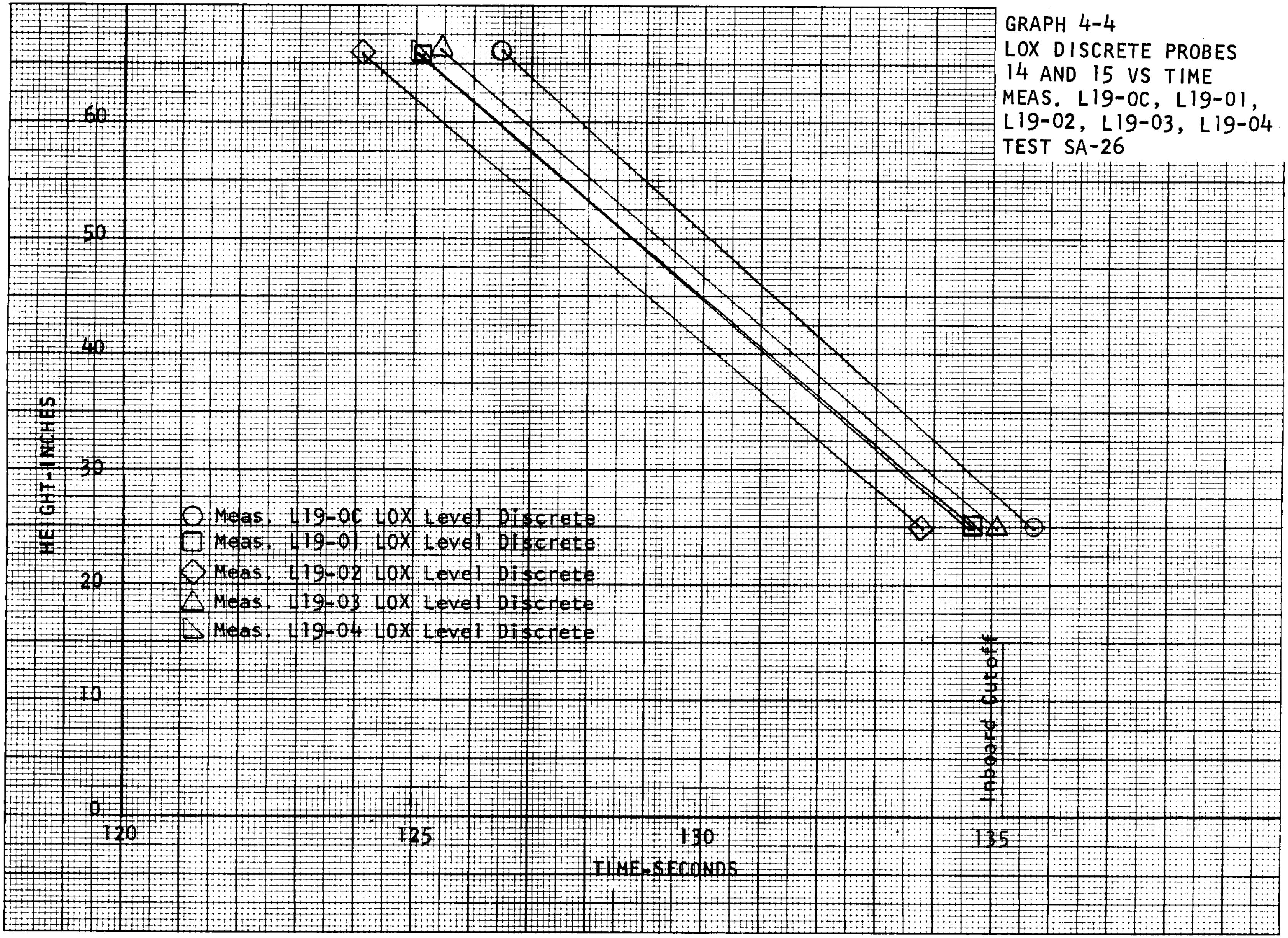
⚠1 Closed indication not received immediately following test SA-25.



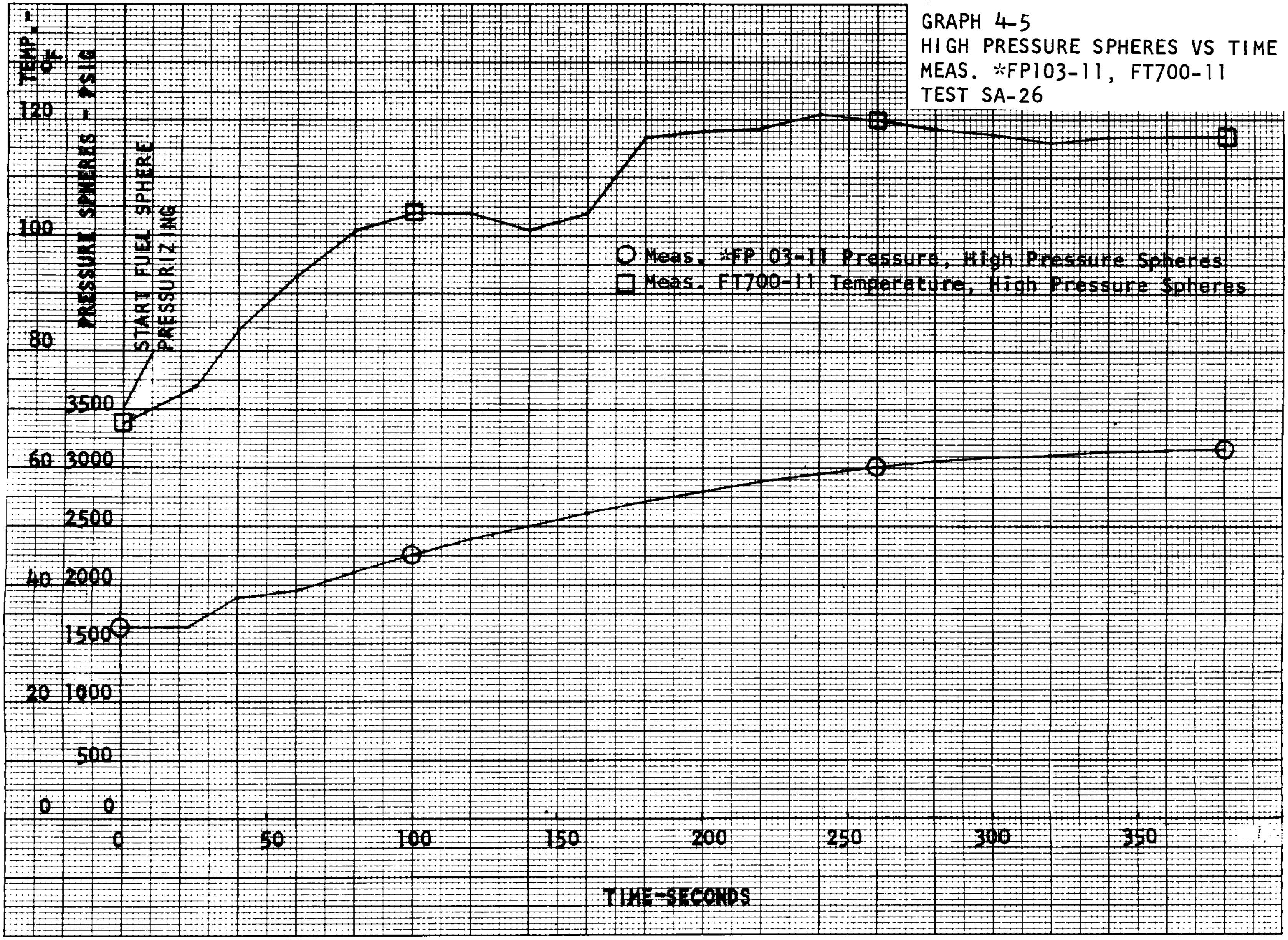
GRAPH 4-1
LOX SYSTEM PRESSURIZATION
CHARACTERISTICS VS TIME
MEAS. *LP102-OC
TEST SA-25 AND TEST SA-26


GRAPH 4-2
GOX FLOW CONTROL VALVE
POSITION VS TIME
MEAS. L0700-9
TEST SA-26
Meas. L0700-9 Position Gox Flow Control Valve
Inboard Cutoff
Outboard Cutoff
Ignition
PERCENT CLOSED
100
80
60
40
20
0
TIME-SECONDS
-10
0
20
40
60
80
100
120
140

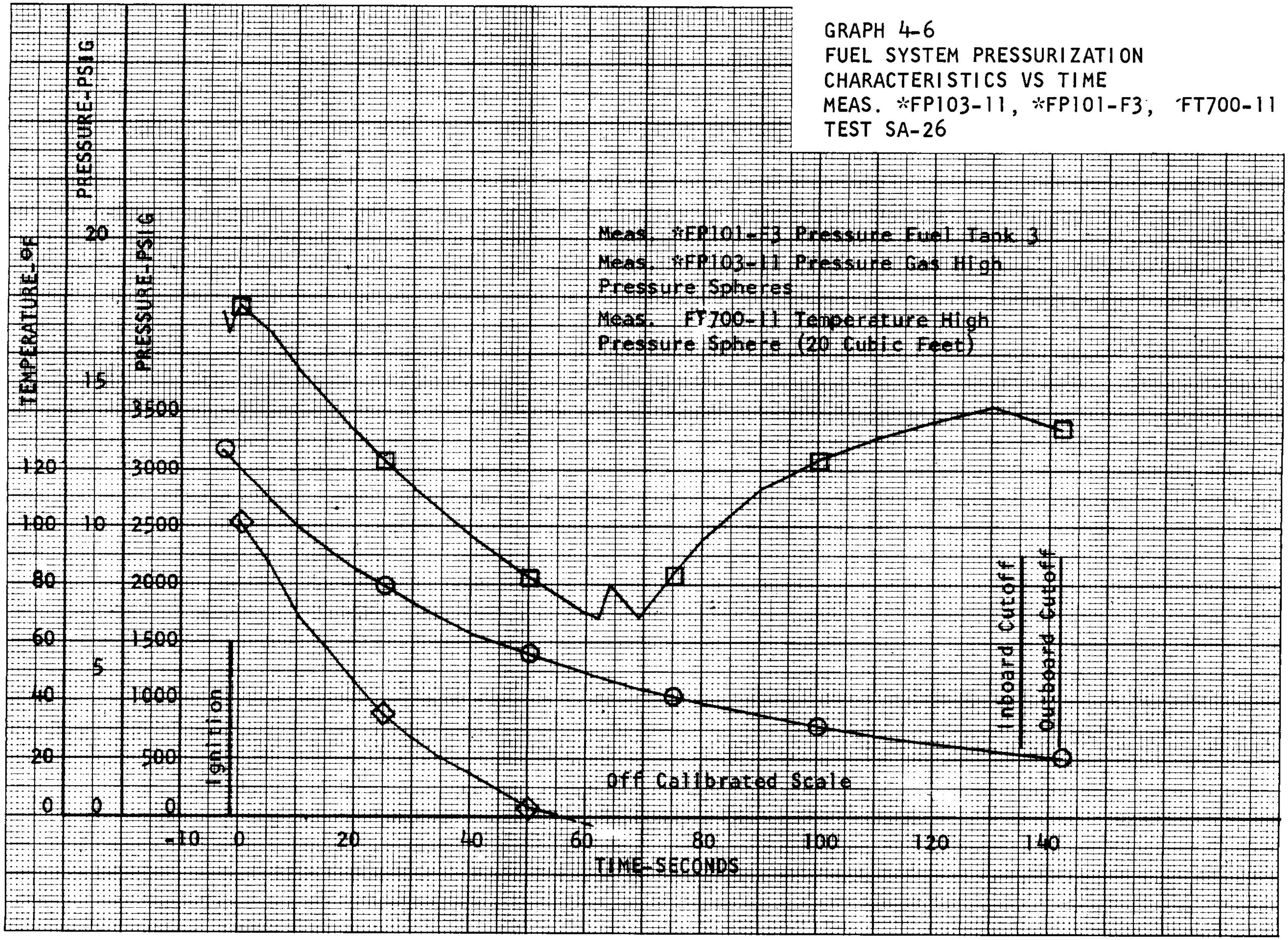

GRAPH 4-3
LOX DEPLETION CHARACTERISTICS
DURING ENGINE CUTOFF
MEAS. L46-01, L47-02, L48-03
L49-04, L19-0C
TEST SA-26
L46-01 LOX Level Continuous
L47-02 LOX Level Continuous
L48-03 LOX Level Continuous
L49-04 LOX Level Continuous
L19-0C LOX Level Discrete
Probe 14
Probe 15
Inboard Cutoff
HEIGHT OF LOX ABOVE THEORETICAL BOTTOM OF LOX TANK-INCHES
TIME-SECONDS
60
50
40
30
20
10
0
125
130
135
140


GRAPH 4-4
LOX DISCRETE PROBES
14 AND 15 VS TIME
MEAS. L19-0C, L19-01,
L19-02, L19-03, L19-04
TEST SA-26
HEIGHT-INCHES
60
50
40
30
20
10
0
120
125
130
135
TIME-SECONDS
Meas. L19-0C LOX Level Discrete
Meas. L19-01 LOX Level Discrete
Meas. L19-02 LOX Level Discrete
Meas. L19-03 LOX Level Discrete
Meas. L19-04 LOX Level Discrete
Inboard Cutoff

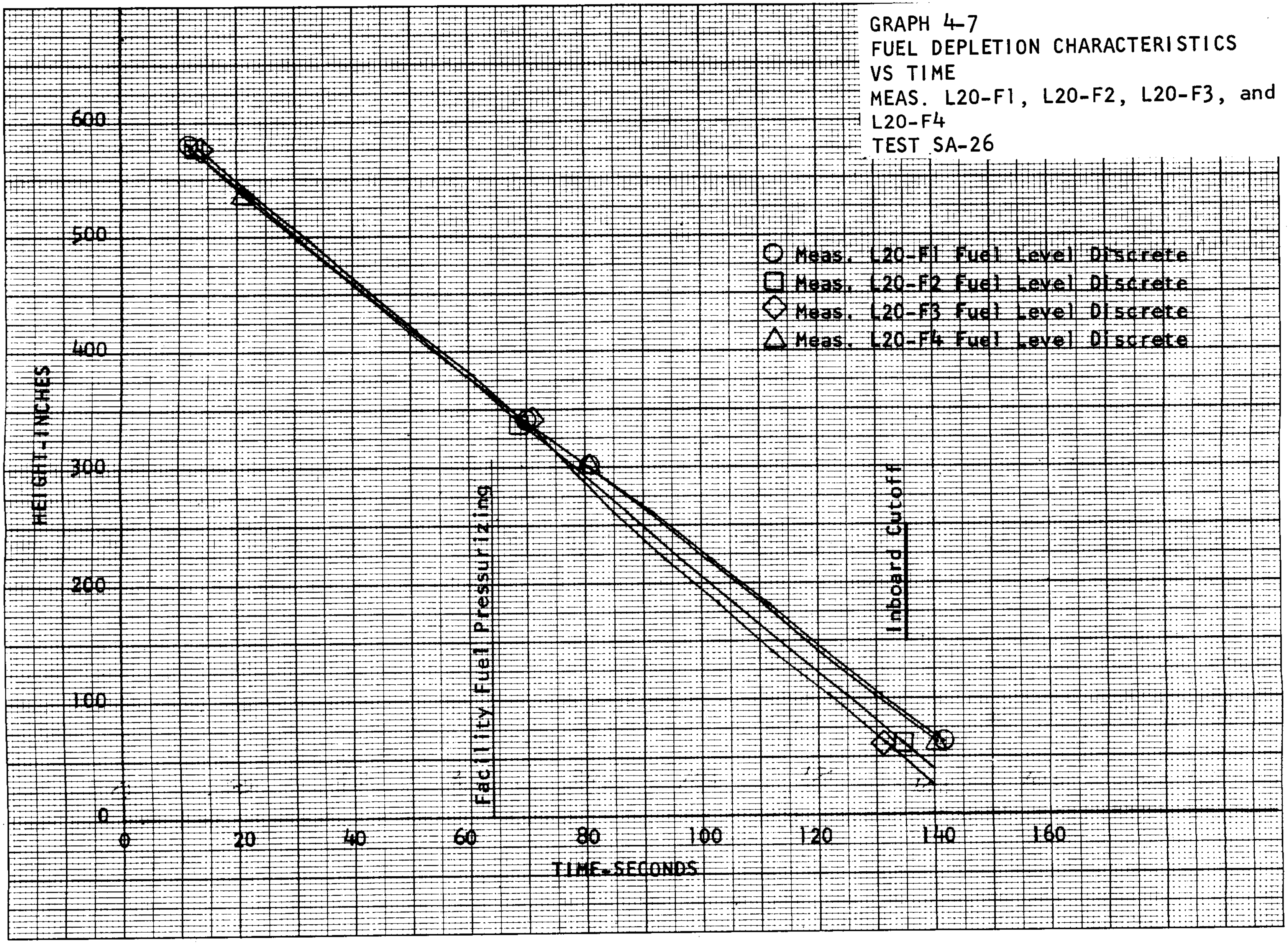
GRAPH 4-5
HIGH PRESSURE SPHERES VS TIME
MEAS. *FP103-11, FT700-11
TEST SA-26

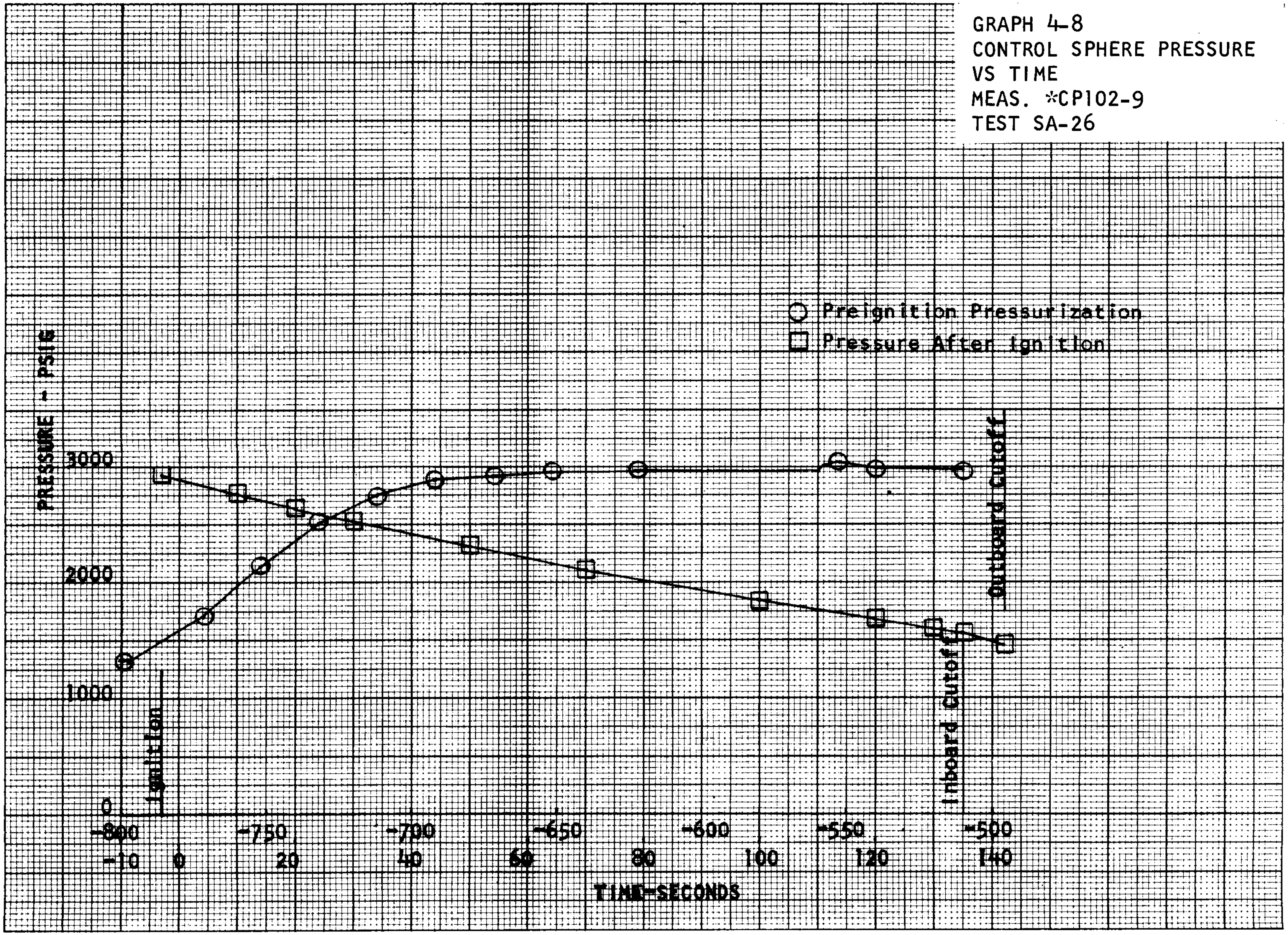


GRAPH 4-6
FUEL SYSTEM PRESSURIZATION
CHARACTERISTICS VS TIME
MEAS. *FP103-11, *FP101-F3, *FT700-11
TEST SA-26



GRAPH 4-7
FUEL DEPLETION CHARACTERISTICS
VS TIME
MEAS. L20-F1, L20-F2, L20-F3, and
L20-F4
TEST SA-26




GRAPH 4-8
CONTROL SPHERE PRESSURE
VS TIME
MEAS. *CP102-9
TEST SA-26
Preignition Pressurization
Pressure After Ignition
PRESSURE - PSIG
3000
2000
1000
0
Ignition
Inboard Cutoff
Outboard Cutoff
-800
-750
-700
-650
-600
-550
-500
-10
0
20
40
60
80
100
120
140
TIME-SECONDS

SECTION 5

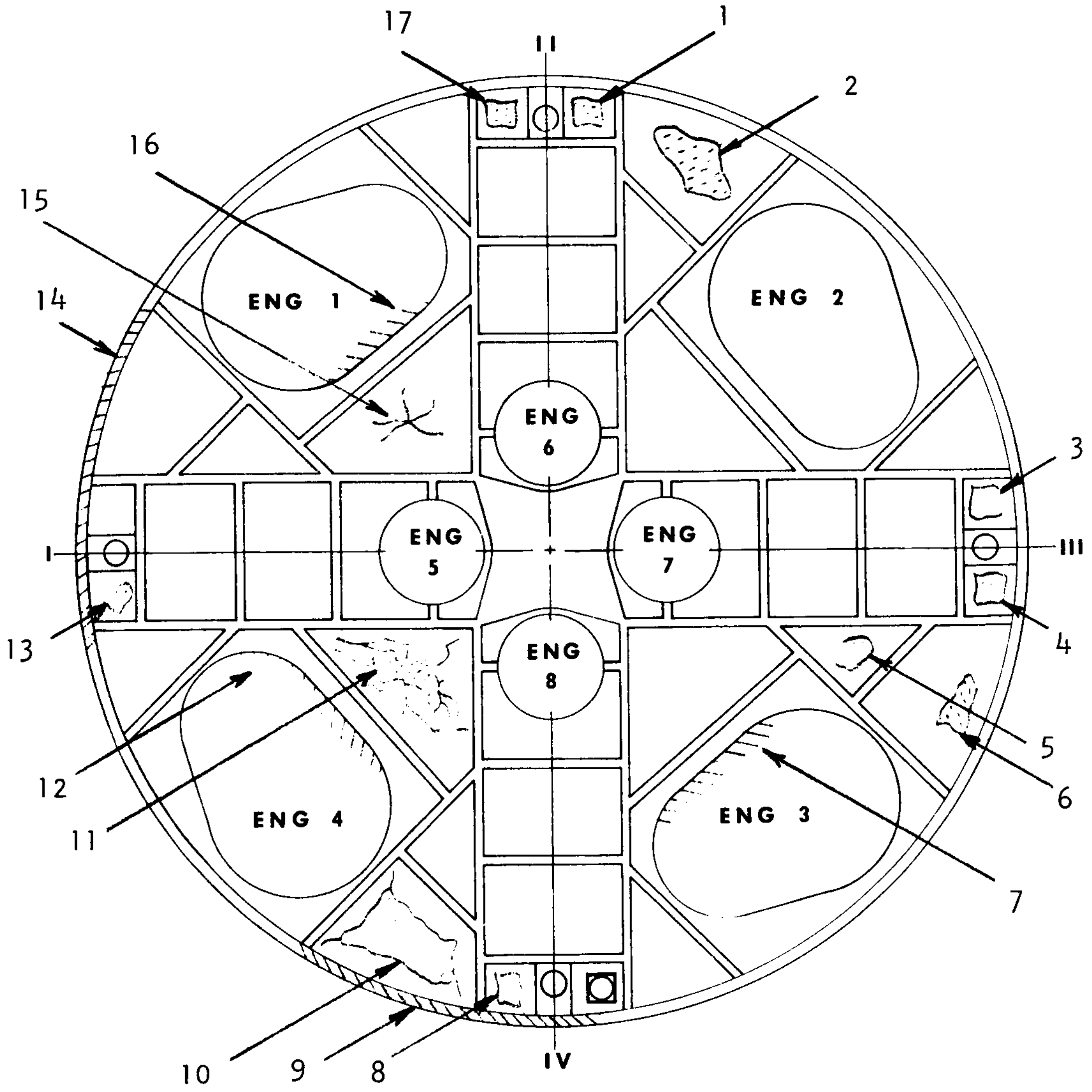
ENGINE COMPARTMENT ENVIRONMENT

Turbine spinner surface temperatures were maintained within the specified limits (40°F to 75°F) by the boattail conditioning system for tests SA-25 and SA-26. Meteorological data for tests SA-25 and SA-26 are tabulated in APPENDIX D. Note that the barometric pressures listed have been corrected from those listed in the "Preliminary Static Test Report" for each test. Post test investigation revealed a calibration error in the recording barometer used for these tests.

Post test inspection of the heat shield panels and the center access chute cover following test SA-25 revealed that only slight damage occurred during the test. No separation of M-31 insulating material from the stage panels occurred. The panels were discolored and large amounts of M-31C were burned away. The surface of the instrumented panel (P/N 10C11457) installed between Fins I and IV next to engine 4 had several cracks. The aft surface of the access chute was charred and completely covered with small cracks to a depth of approximately 1/64 inch. This is considered normal. There was no evidence of any fire or hot gas leaks in the engine compartment.

Post test inspection of the heat shield panels following test SA-26 revealed that the usual damage was incurred during this test. Approximately 1,500 square inches of M-31 insulation material separated from the panels. Part of the remaining M-31 insulation was cracked and loose. The post test status of the heat shield panels is shown in FIGURE 5-1 and TABLE 5-1.

The reflective heat shield curtains were tattered on the inboard quadrants of engines 1, 3, and 4, during test SA-26. The curtain on engine 4 was torn completely through and the flexible gimbal boot was charred approximately 30 square inches. The peripheral static test radiation shield was torn at the Fin I and Fin IV positions. The aspirator covers on all outboard engines were tattered on the inboard quadrants. Only the reflective covering on these covers was damaged. No evidence of any hot gas leaks or engine compartment fire was noted.



AFT LOOKING FORWARD
TEST SA-26

FIGURE 5-1

HEAT SHIELD DAMAGE

TABLE 5-1

HEAT SHIELD DAMAGE

TEST SA-26

REFERENCE FIGURE 5-1	DESCRIPTION
1	120 square inches of M-31 fallen away.
2	170 square inches of M-31 fallen away.
3	120 square inches of M-31 fallen away.
4	150 square inches of M-31 fallen away.
5	120 square inches of M-31 fallen away.
6	150 square inches of M-31 fallen away.
7	Tattered reflective heat shield curtain.
8	120 square inches of M-31 fallen away.
9	Tattered radiation shield curtain.
10	400 square inches of M-31 fallen away.
11	100 square inches of M-31 fallen away and entire panel cracked and loose.
12	Tattered reflective heat shield curtain. Gimbal boot charred (approximately 30 square inches).
13	100 square inches of M-31 fallen away.
14	Tattered radiation shield curtain.
15	150 inches of cracked M-31.
16	Tattered reflective heat shield curtain.
17	100 square inches of M-31 fallen away.

SECTION 6

VIBRATION AND SPECIAL INSTRUMENTATION

A total of 124 vibration measurements were recorded during static tests SA-25 and SA-26. Useful information was obtained on 119 and 122 measurements respectively for tests SA-25 and SA-26. A more detailed discussion of the vibration data can be found in the "Preliminary Static Test Reports" for tests SA-25 and SA-26 and in the "Vibration and Acoustic Evaluation Report, Stage S-IB-1", by Systems Static Test Branch.

During the static tests of S-IB-1, 36 measurements were made for investigation of "Pogo" effect. Root mean square (rms) level readings were taken during a slice time of X+30-35 seconds on test SA-26. These data from test SA-26 are shown in TABLE 6-1 because there was an error in the table where they were shown in the "Preliminary Static Test Report, Stage S-IB-1, Test SA-26." Further analysis of "Pogo" vibration data will be performed by NASA Propulsion and Vehicle Engineering Laboratory.

The Fire Detection System for stage S-IB-1 consisted of 12 Test Laboratory harnesses and 4 flight harnesses. The automatic cutoff 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. All 16 rise rate indicators were active in the cutoff circuit.

During test SA-25, no abnormal LOX dome vibrations were recorded on any engine except at cutoff. Rough Combustion Cutoff (RCC) measurements *PV700-4 and *PV700-8 commenced counting at approximately 1 second after cutoff. Each measurement accumulated a total of 25 counts. Oscillograph records substantiated the high g level at this time. The 25 counts represent a vibration level in excess of 100 g rms for less than 1 millisecond. All engines experienced a definite vibration buildup at cutoff, but only engines 4 and 8 exceeded 100 g rms. RCC measurements indicated a LOX dome vibration level of 3 ± 1 g rms during ignition transition and 8 ± 2 g rms during mainstage.

During test SA-26, no abnormal LOX dome vibrations were recorded on any engine. RCC measurements indicated a LOX dome vibration level of 3 ± 1 g rms during ignition transition and 8 ± 2 g rms during mainstage.

The post test gearcase vibration checks conducted on all engines did not indicate any abnormal conditions.

All fire detection equipment functioned as required and no abnormal temperatures were detected.

TABLE 6-1

"POGO" VIBRATIONS

TEST SA-26

MEASUREMENT	MEASUREMENT NAME	VALUE g rms
AV213-11	Vibration, Station 962, Fin Line 2, Top Spider Beam, Longitudinal	0.67
AV214-F1	Vibration, Station 350, Skin Fuel Tank F-1, Longitudinal	0.46
AV214-F2	Vibration, Station 350, Skin Fuel Tank F-2, Longitudinal	0.25
AV214-F3	Vibration, Station 350, Skin Fuel Tank F-3, Longitudinal	0.64
AV214-F4	Vibration, Station 350, Skin Fuel Tank F-4, Longitudinal	0.64
AV215-01	Vibration, Station 210, LOX Tank 0-1 Horizontal Rib, Bottom LOX Tank Skirt, Longitudinal	0.49
AV215-02	Vibration, Station 210, LOX Tank 0-2 Horizontal Rib, Bottom LOX Tank Skirt, Longitudinal	0.35
AV215-03	Vibration, Station 210, LOX Tank 0-3 Horizontal Rib, Bottom LOX Tank Skirt, Longitudinal	0.47
AV215-04	Vibration, Station 210, LOX Tank 0-4 Horizontal Rib, Bottom LOX Tank Skirt, Longitudinal	0.39
AV216-0C	Vibration, Station 210, Center LOX Tank Horizontal Rib, Bottom LOX Tank Skirt, Longitudinal	0.06
AV217-9	Vibration, Lower Thrust Ring, Fin Line 2, Longitudinal	0.39
AV218-9	Vibration, Outboard Engine Thrust Pad, Engine 2, Longitudinal	0.09

TABLE 6-1 (CONTINUED)

TEST SA-26

MEASUREMENT	MEASUREMENT NAME	VALUE g rms
AV219-9	Vibration, Inboard Engine Thrust Pad Engine 6, Longitudinal	3.17
AV220-9	Vibration, Near Line Inlets on Sump, LOX Tank O-2, Longitudinal	0.53
AV221-9	Vibration, Near Line Inlets on Sump, LOX Tank O-3, Longitudinal	0.78
AV222-9	Vibration, Near Line Inlets on Sump, Fuel Tank F-2, Longitudinal	0.92
AV223-9	Vibration, Near Line Interchange Outlet, Bottom Center LOX Tank, Longitudinal	0.64
AV224-9	Vibration, Engine 6 Fuel Suction Line, Station 114 Downstream, Longitudinal	2.05
AV225-9	Vibration, Engine 6 Fuel Suction Line, Station 114 Upstream, Longitudinal	5.30
AV226-9	Vibration, Engine 6 Fuel Suction Line, Station 145, Longitudinal	0.02
AV227-9	Vibration, Engine 6 Fuel Suction Line, Station 173.7, Longitudinal	2.33
AV228-9	Vibration, Engine 2 Fuel Suction Line, Station 90, Longitudinal	0.92
AV229-9	Vibration, Engine 2 Fuel Suction Line, Station 114 Downstream, Longitudinal	2.47
AV230-9	Vibration, Engine 2 Fuel Suction Line, Station 114 Upstream, Longitudinal	3.88
AV231-9	Vibration, Engine 2 Fuel Suction Line, Station 145, Longitudinal	0.49

TABLE 6-1 (CONTINUED)

TEST SA-26

MEASUREMENT	MEASUREMENT NAME	VALUE g rms
AV232-9	Vibration, Engine 2 Fuel Suction Line, Station 173.7, Longitudinal	0.15
AV233-9	Vibration, Engine 6, LOX Suction Line, Station 90 Downstream, Longitudinal	0.56
AV234-9	Vibration, Engine 6, LOX Suction Line, Station 90 at Elbow, Longitudinal	0.92
AV235-9	Vibration, Engine 6, LOX Suction Line, Station 90 Upstream, Longitudinal	0.35
AV236-9	Vibration, Engine 6, LOX Suction Line, Station 130.1, Longitudinal	2.68
AV237-9	Vibration, Engine 6, LOX Suction Line, Station 157.2, Longitudinal	2.12
AV238-9	Vibration, Engine 2, LOX Suction Line, Station 87, Longitudinal	0.32
AV239-9	Vibration, Engine 2, LOX Suction Line, Station 101 Downstream, Longitudinal	0.56
AV240-9	Vibration, Engine 2, LOX Suction Line, Station 101 Upstream, Longitudinal	0.56
AV241-9	Vibration, Engine 2, LOX Suction Line, Station 130.1, Longitudinal	0.13
AV242-9	Vibration, Engine 2, LOX Suction Line, Station 157.2, Longitudinal	1.76

SECTION 7

ELECTRICAL CONTROL SYSTEMS

NETWORKS

Test SA-25 was terminated as scheduled by the firing panel operator at commit plus 32.17 seconds. Electrical systems in the networks area functioned properly during this test.

Ignition command (X-3 seconds) occurred at 17:02:12.46 CST. Test duration from ignition command was:

Inboard engine cutoff signal :	35.174 seconds
Outboard engine cutoff signal:	35.294 seconds

Termination of test SA-26 was as planned, with inboard engine cutoff being initiated by the switch selector 2 seconds after closure of the LOX low level sensor in LOX tank 0-2. Outboard engine cutoff was initiated 6.8 seconds later by dropout of the Thrust OK pressure switches at engine 1.

Ignition command (X-3 seconds) occurred at 16.38:09.778 CST. Test duration from ignition command was:

Ignition command to inboard cutoff signal :	138.21 seconds.
Ignition command to outboard cutoff signal:	145.01 seconds.

Prior to test SA-25, jumper cables were installed between engine cables 1W4P3, 2W4P3, 4W4P3, 5W11P3, 7W12P3 and their respective Conax valves due to Conax valve mounting problems. This problem is described in the ENGINE SYSTEMS section of this report. The EBW pulse sensor units received with the stage were found to be unqualified for hazardous environments and were exchanged in accordance with Modification Bulletin FD-1600-B1.

A closed indication was not received from the LOX prevalve at engine 2 after termination of test SA-25. Upon return of the prevalve to ambient temperature, operation was normal. This condition was corrected by replacing the prevalve (reference UCR 01155).

As usual, the 7-inch LOX vent valve did not show a closed indication on either test SA-25 or SA-26.

The auxiliary inboard engine LOX dome purge pressure switch did not indicate actuation at inboard engine cutoff on test SA-26. Pretest records and post test checks indicated proper operation of the purge.

The Digital Data Acquisition System (DDAS), installed for S-IB flight systems, was operated initially during test SA-25. Pretest checks revealed DDAS signal interaction between telemetry inflight calibration pulse, switch selector count and the malfunction circuits. Unsatisfactory Condition Report (UCR) 01139 has been written on this problem. Since the required level of confidence has not been established on the DDAS, the following selected stage measurements were hardwired for tests SA-25 and SA-26:

MEAS. NO.	DESCRIPTION	DDAS SIGNAL NO.
K 15-02	LOX Level Sensor	13R05-08
K 16-04	LOX Level Sensor	13R05-09
K 17-F2	Fuel Level Sensor	13R02-02
VK 83/89-9	Fuel Prevalve Closed	13R02-05 Through 13R02-10, 13R03-01 and 13R03-02
VK 91/98-9	LOX Prevalve Closed	13R03-03 Through 13R03-10
K 1-12	Switch Selector Output Pulses	13R08-07

The oscillograms for engines 2, 3, and 4 on test SA-25 indicated the Conax valve fired at the same time the MLV started to close. This discrepancy in data is possible due to the fact that the telemetry submultiplexer is designed to sample each signal only once every 83.3 milliseconds. A change in signal status between samplings would be received at an incorrect (delayed) time. The maximum delay in signals being received through the telemeter submultiplexer to the Digital Data Acquisition System (DDAS) ground station and to the ground support equipment would be 83.3 milliseconds. On subsequent stages all critical events will bypass the submultiplexer.

When the stage cables were disconnected prior to removal of the stage from the static test tower, it was found that pins A and B of connector 9W29/J1 of the lower umbilical plate, Fin IV, were badly pitted at the bottom of the pins. Moisture had apparently leaked into the connector and corroded the pins (reference UCR 01168).

The operating times for major functions from firing command to, reset for test SA-26 are shown in FIGURES 7-1, 7-2, and 7-3.

GIMBAL CONTROLS

Prior to test SA-25 rubber covered Adel clamps were installed on the actuator cables. Actuator clamps specified by Modification Bulletins GM-651-B1, GM-652-B1, GM-653-B1, and GM-654-B1 were too small and not covered which made them unacceptable for use.

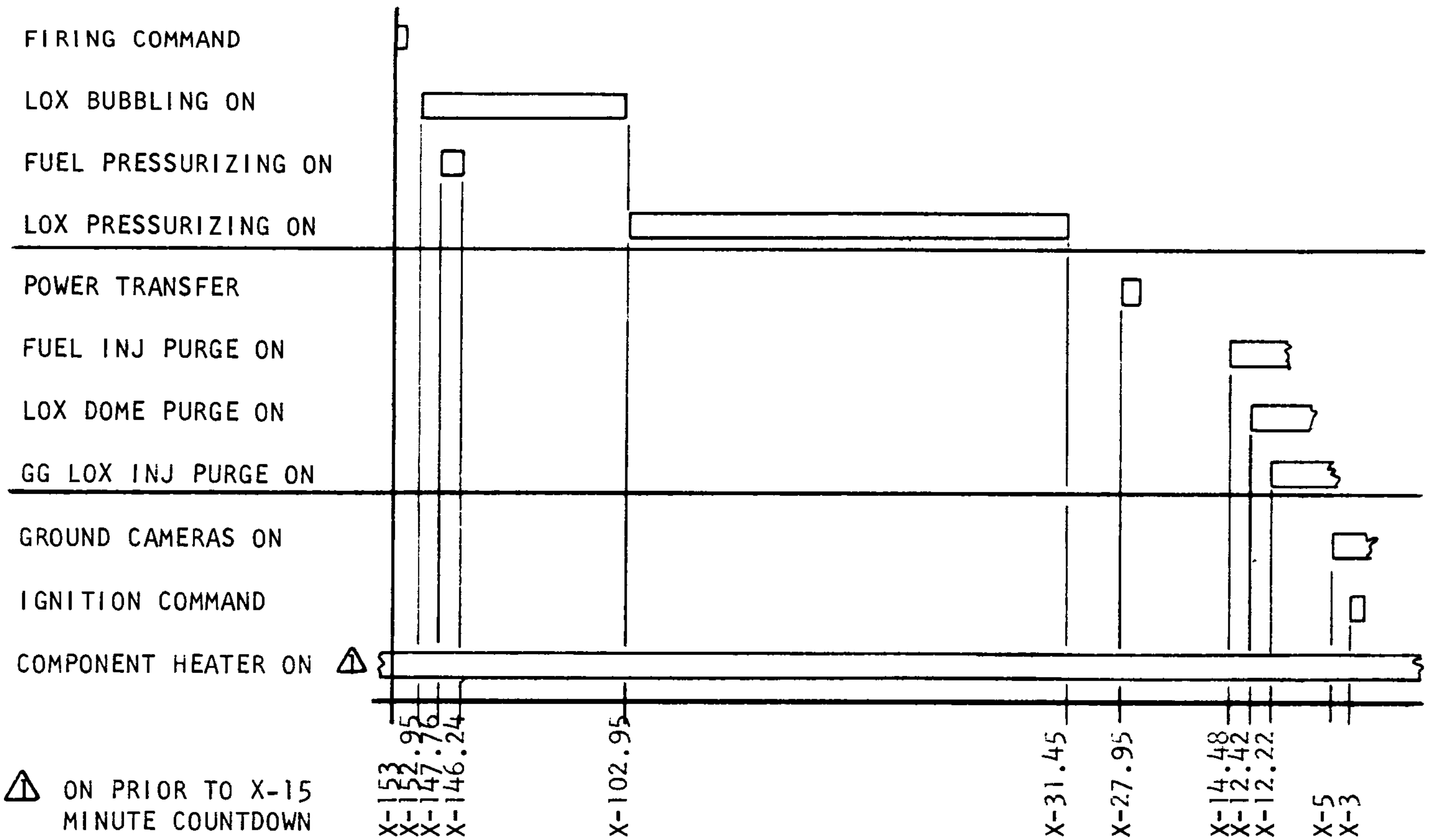
During preliminary checkout of S-IB-1 for test SA-25 a coating of Cera-bend compound was removed from all pump motor and hydraulic fluid temperature OK switches. After cleaning the switches, a loose wire on the pump motor temperature OK thermal switch on engine 3 was discovered and was corrected by resoldering (reference UCR 01138).

The position trace on the oscillograph records for test SA-25 indicated actuator movement lower than specified by the gimbal program. The input signal trace was correspondingly low, indicating systems response was normal. The problem was isolated to incorrect resistance loading of the calibration input signal which was corrected for test SA-26.

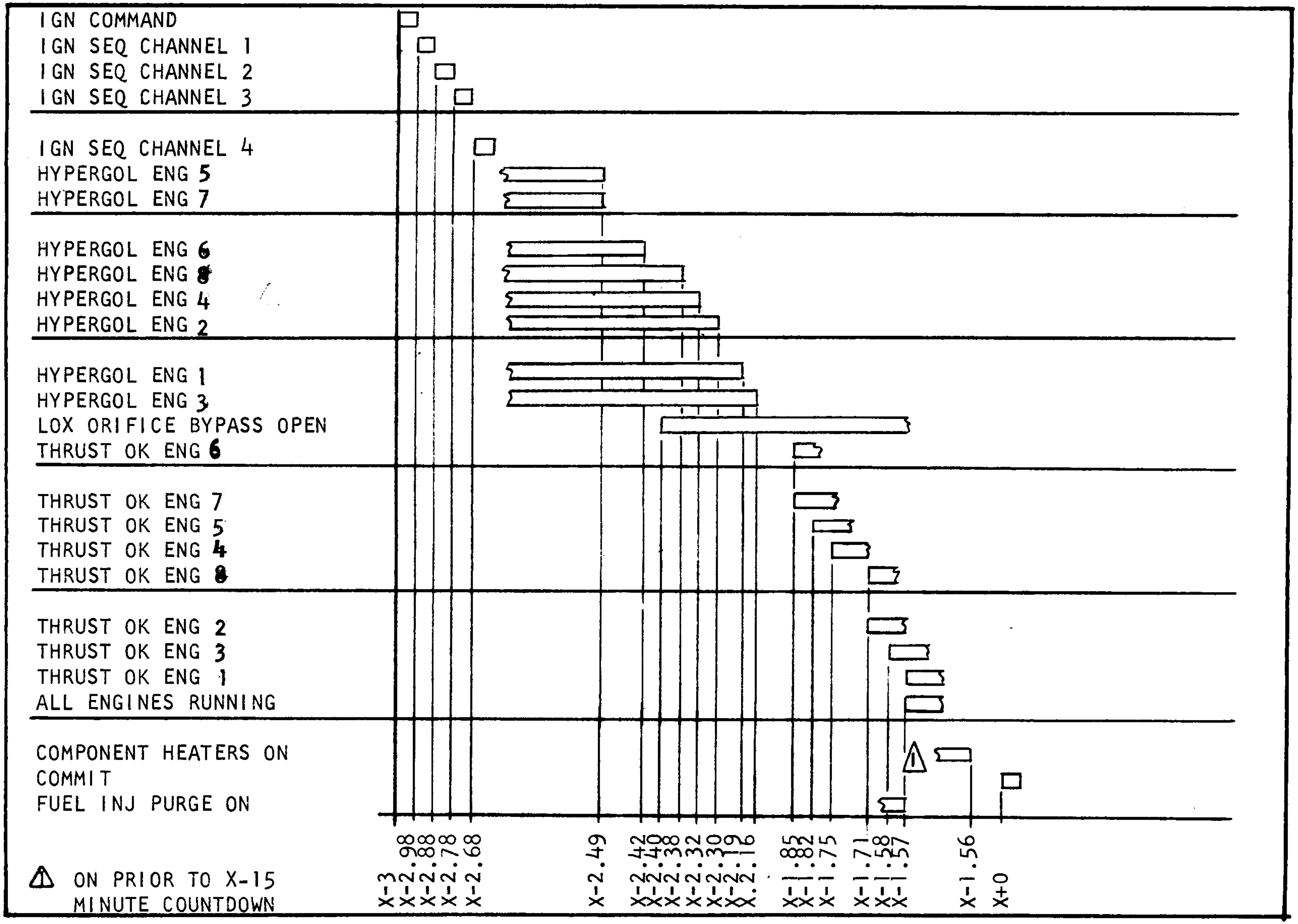
The gimbal program for test SA-26 consisted of an input signal of 0.5 degree with consecutive frequencies of 1 through 20 cycles per second for both pitch and yaw functions. Also included in the program were plus and minus step functions of 2 degrees amplitude for both pitch and yaw and a roll signal of 2 degrees at 0.5 cycle per second.

Oscillograph records of the prestatic gimbal checkout for test SA-26 revealed that the control valve yaw trace of engine 2 was erratic at certain intervals. This fluctuation was in evidence on the yaw actuator position trace indicating an erratic movement of the actuator.

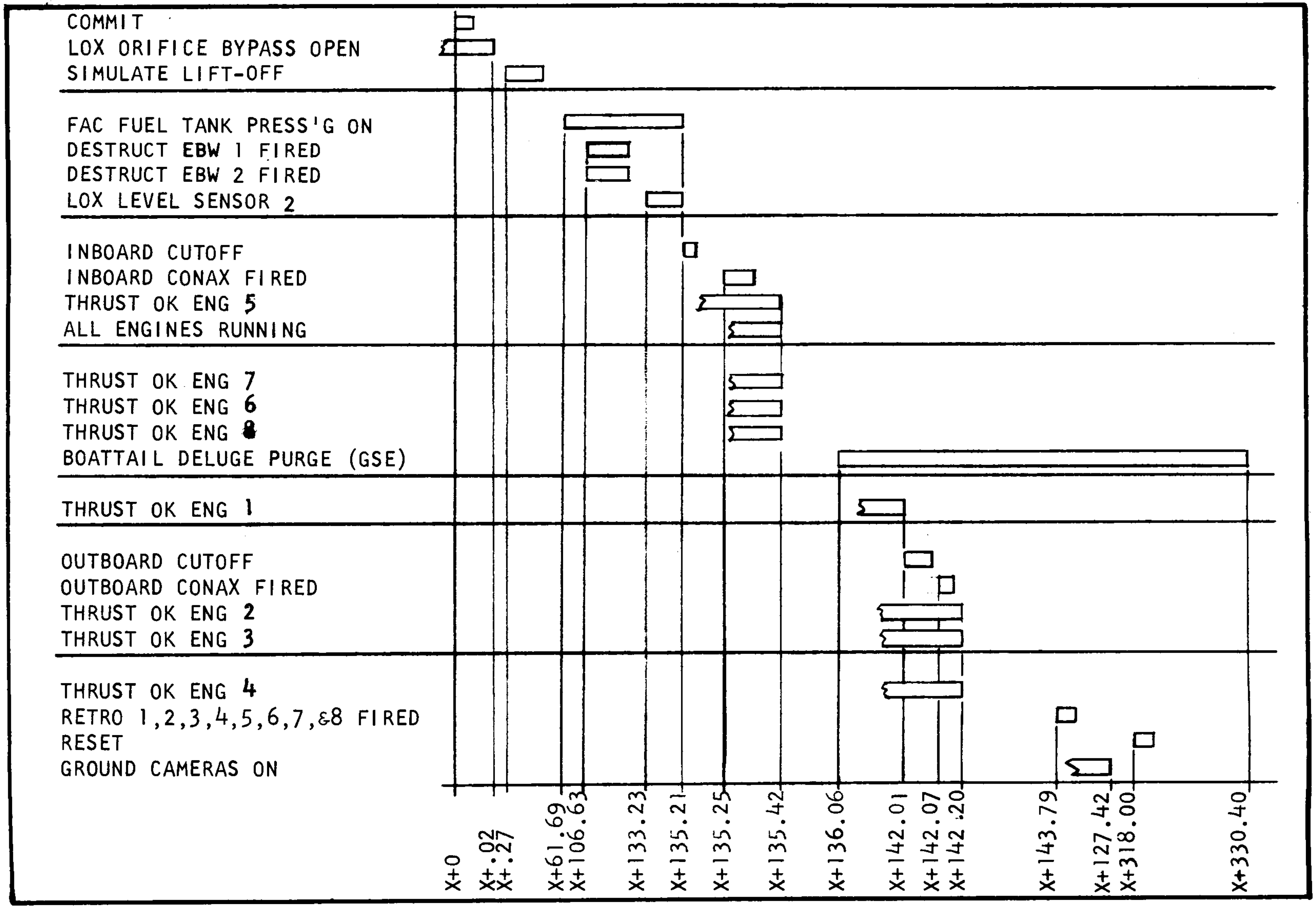
A second prestatic gimbal check was made and the fluctuation was again observed; however, it was not as predominant as in the first prestatic gimbal check. During both test firings, the system performed normally.



FIRING COMMAND TO IGNITION COMMAND
FIGURE 7-1



IGNITION COMMAND TO COMMIT
FIGURE 7-2



COMMIT TO RESET
FIGURE 7-3

SECTION 8

TELEMETRY SYSTEMS

Flight instrumentation requirements for stage S-IB-1 are specified in drawing 60C50005, 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 the static test, signals from the various flight transducers and simulated signals are transmitted via an RF link from the static test tower antennas to the Quality and Reliability Assurance Laboratory ground station.

For stage S-IB-1, 72 flight transducers were disconnected and hardwired to recorders in the Blockhouse. These measurements are required for acceptance test data evaluation and redline monitoring. One hundred and twenty-two transducers, which were hardwired or not installed, were simulated by utilizing a constant signal for checkout of the telemeter system. The remainder of the stage measurements (335) were in flight condition for both static tests.

Results of the static test of stage S-IB-1 indicate that the overall function of the T/M systems was satisfactory. The percentage of T/M system instrumentation discrepancies for tests SA-25 and SA-26 is shown in TABLE 8-1.

PRESTATIC TEST, TELEMETRY OPERATIONS

1. Initial Status of Measurements. Upon initial application of power to stage S-IB-1 following erection in STTE, 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 side band type measurements and the FM/FM type measurements over their broadcast loops. Approximately 88 percent of all measurements required work at Static Test. The majority of measurements that were rejected were strain gage measurements that were calibrated when the stage was in the horizontal position. These required recalibration when the stage was erected in STTE.

2. Flight Measurement Status Prior to Test. All flight measurements were accepted for static firing with the exception of the measurements shown in TABLE 8-2.

3. T/M Packages Frequency and RF Power Measurements. Prior to test SA-25, the frequency and RF power radiated by each of the telemetry packages were measured. All values were within tolerance.

4. Cable Protectors. As a result of damage to engine area cables on previous vehicles (reference Engineering Report, "Cable Damage Problem and Recommended Corrective Measures", dated December 15, 1964), cable protectors were fabricated and installed on this vehicle. Aluminum tape was used for installation in place of rigid fasteners. These protectors present no safety hazard and make a neat installation. No cable damage was incurred where these protectors were utilized, and it is felt that this precaution is justified. It is necessary to re-secure these protectors just prior to each static firing. The re-securing of these protectors will be adopted as standard operating procedure.

5. Liquid Level Discrete Measurements. Prior to test SA-25, four liquid level rack assemblies, P/N 50C12295-1, malfunctioned. One liquid level discrete measurement failed in each of these assemblies. These malfunctions are described in UCR's 01119, 01123, 01124, and 01125. Because of the large number of measurements multiplexed in each rack (15 probes are connected to each rack assembly) and because of the high repetition of failure of the rack assemblies, additional design or quality control in manufacture of these components is indicated.

No additional liquid level discrete measurements malfunctioned during tests SA-25 or SA-26.

6. PCM/RF Assembly. Prior to test SA-25, two PCM/RF assemblies, P/N 50M12187-1, malfunctioned. One PCM/RF assembly, S/N 002, was found to generate no RF power during initial tests. The second PCM/RF assembly, S/N 001, was found to lose RF modulation after being installed for approximately 1 hour. Because of the very short periods of usefulness of these packages, an investigation should be conducted to determine methods of improvement of the quality of these assemblies.

7. P1 Multiplexer. Four channels, P1B0-07-01, P1B0-07-06, P1B0-08-10, and P1B0-09-10, to the P1 multiplexer had no assigned measurements. These channels are wired to open-circuited terminals in a measurement distributor. The 100K input resistors on these sub-multiplexer cards were removed as measurements on these cards are parallel to FM/FM channels. This open-circuited input to the submultiplexer generates approximately 2 volts of noise.

It is recommended that a 100K resistor be installed in the measuring distributors for the unused channels. This will eliminate the open-circuited condition and its inherent excessive noise.

STATIC TEST TELEMETRY OPERATIONS

1. Turbine RPM Measurements T12-1 Through T12-8. For static test, the flight frequency dividers and the Blockhouse measuring equipment were connected in parallel across the tachometers of the turbines. Isolation amplifiers were installed between the tachometers and the Blockhouse to eliminate signal incompatibility between Blockhouse and flight measuring systems. No problems were encountered during tests SA-25 or SA-26 as a result of the parallel connection of this measurement.

A special electronic device has been designed by telemetry personnel that gives an accurate period count of 32 pulses as generated by the frequency dividers. Telemetry turbine rpm data, as reduced by the new system, are compared with Blockhouse readings in TABLE 8-3. All measurements except T12-7 appear realistic during SA-25. A faulty frequency divider was the cause of this malfunction.

Oscillograph records of the turbine rpm measurements revealed that the pulses were of very low amplitude from ignition until simulated lift-off. Following this short period, the amplitude appeared normal, and data generated by the frequency dividers do not appear affected after that time.

Investigation revealed that the frequency dividers are paralleled to both the PCM P1 multiplexer and the PAM, F1, and F2 straight channels until the PCM transfer relay is deenergized. The lower impedance due to this dual load loads the output of the frequency divider to a low value. Following lift-off, the PCM channels are removed from the frequency divider, and the amplitude rises to a higher level.

Additional tests revealed that some frequency dividers had a tendency to divide by 24 instead of 32 whenever the output was loaded by the dual TM channels. They divided properly when loaded by one TM channel only. An input impedance to a single TM channel is normally 100,000 ohms. The input impedance to the multiplexer channel with the 100K resistor removed consisted of a 0.1 microfarad capacitor. At a fundamental frequency of 100 cps, this capacitor presents an impedance of approximately 16,000 ohm. The two parallel channels would present slightly less than 16,000 ohms.

The frequency dividers operated improperly under the 16,000 ohms load and are considered marginal for operation. In view of the above, redesign of the frequency dividers is believed necessary.

2. Pressure, Combustion Chamber Measurements D1-1 Through D1-8. Combustion chamber pressure measurements were calibrated by means of the DDAS. These measurements were also transmitted over a hardwire loop to the Blockhouse. A comparison of these two measurement results is shown in TABLE 8-4. Telemetered data from these measurements were satisfactory with exception of measurement D1-8 during test SA-25, which was satisfactory until lift-off plus 25 seconds. Post test checks revealed a faulty amplifier. Measurement D1-8 was not active during test SA-26. The TM amplifier was rejected during prefiring checkout, and no replacement was available.

3. Inflight Tape Recorder. The flight tape recorder recorded information from the F1 and F2 telemeter packages commencing with step 4 of the switch selector (simulated lift-off plus 39.2 seconds) until 26 seconds after the separation explosive bridge wire (EBW) command. At that time, a signal from the 26-second timer started the tape recorder playback function. The tape recorder played back until step 12 of the switch selector.

During test SA-26, the tape recorder recorded 130.5 seconds of information. The playback function started 26.0 seconds after the separation EBW command, which occurred 9.5 seconds after the LOX low level sensor (K15-02) was energized. The inflight tape recorder operated satisfactorily and good data were obtained.

4. Command Destruct Receivers (CDRs). During test SA-26, an operational check of command destruct receivers 1 and 2 was performed via RF transmission. At simulated lift-off plus 101.5 seconds, the cutoff and destruct signals were initiated from the Quality and Reliability Assurance Laboratory. Three measurements, M11-13 (AGC voltage command), K65-13 (cutoff and destruct indication, CDR 1), and K66-13 (cutoff and destruct indication, CDR 2), were monitored to verify the integrity of the CDR system. Satisfactory results were obtained.

5. Single Side Band Package, S1. Evaluation of the 15 single side band telemetry channels following tests SA-25 and SA-26 revealed an excessive amount of noise on each of the channels. Extensive bench tests on the vibration multiplexer, single side band (S1) package, and the S1 RF assembly revealed that the S1 package was extremely sensitive to noise on the applied +28 volts power. In the bench test, the vibration multiplexer, single side band package, and the RF assembly were connected as a system. A single side band package and the RF assembly were connected as a system without the vibration multiplexer. The output of the 15 channels was monitored via a single side band ground station. First, $2\frac{1}{2}$ volts were applied to all data channels, and the output recorded on oscillograph paper. Secondly, the data were removed and the output revealed quiet response. Finally, an oscillator was connected in series with the +28 volts power to the S1 package to simulate a noisy +28 volts power. The oscillator signal was set to approximately 2.5 volts peak-to-peak, and the frequency was varied from 0 to 75 kc. All channels illustrated the effect of the varying frequency. The amplitude noted in Channel 1 was as high as it would have been with the frequency applied to a data input channel. The amplitude was also high in other channels, with the amplitude decreasing with the higher frequency channels.

Because noise on +28 volts can be passed through the intelligence channels of a single side band package and because of the difficulty in determining the difference between this noise and actual data, it is recommended that all single side band packages be arranged with an internal filter that will efficiently filter +28 volts power to that package.

NEW METHOD OF FLIGHT MEASUREMENT CHECKOUT

Beginning with stage S-IB-1, a new method of checkout of the flight instrumentation was initiated at Static Test.

This new method flight measurement checkout consists of the following steps as described in detail in the "Preliminary Static Test Report, Test SA-25."

i. Calibration of the Telemetry-Airborne DDAS.

2. Automatic scans of all flight measurements to determine the performance characteristics of these measurements.

3. Calibration of discrepant measurements discovered during the automatic scan.

Excellent results are being obtained by use of this new method of checkout, and the method will be continued on subsequent S-IB stages.

COMPARISON OF TELEMETER AND HARDWIRE DATA

TABLE 8-4 presents a comparison of parallel telemeter data and hardwire data for test SA-26. The table of comparisons is revised from TABLE 8-6 as published in the "Preliminary Static Test Report (PSTR), Test SA-26." TABLE 8-6 contained several divergencies in readings between the T/M data and hardwire data which prompted a study to determine why these divergencies existed. As a result of this study, it was found that contributing factors existed in both T/M and hardwire data. These factors are as follows:

1. In two instances, the hardwire data in TABLE 8-6 (PSTR, SA-26) were extracted from oscillograph measurements, *PP106-1 through 4, and *PP107-1 through 4, instead of the more accurate strip chart measurements, *PP113-1 through 4 and *PP114-1 through 4. Measurements *PP113-1 through 4 and *PP114-1 through 4 were used in the revised table.

2. Measurements *PP100-1 through 8 are recorded on oscillograph only and have no comparable strip chart measurements. These hardwire data should not be considered as valid for comparison with telemetry data.

3. The telemeter data, originally used as a basis for comparison, were obtained from the Quality Assurance and Reliability Laboratory ground station. These data were found to have an inadequate time reference base, and it is quite probable the T/M readings were not taken at the same slice time as the hardwire readings, thus introducing an error. The T/M readings contained in TABLE 8-4 were extracted from the Computation Laboratory receiving station digital printouts. An accurate time reference base will be included on the ground station data for subsequent tests to assure a true comparison.

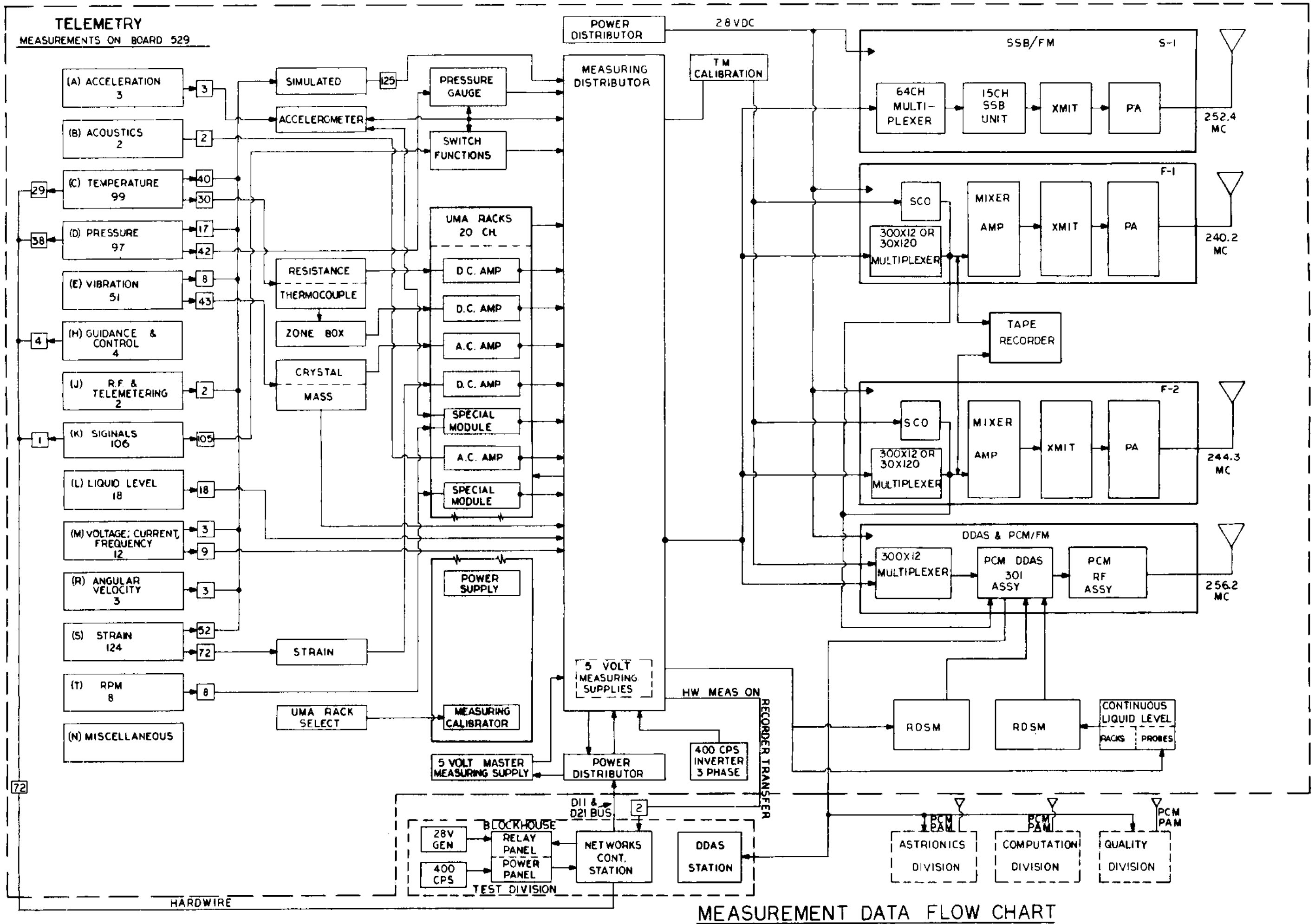
4. The hardwire data were used as the basis for comparison in the revised table, since this data is more accurate.

5. The hardwire pressures (psig) were converted to absolute values for comparison with the absolute telemeter pressures in TABLE 8-4, thus reducing the percentile error.

In those instances where the percent difference between telemeter and hardwire data are in excess of 4 percent ⚠ it appears as though the telemeter data may be in error. Particular attention should be paid to these measurements during the post static checkout at Michoud.

It should also be noted that for the purpose of comparison, both the hardwire data and the telemeter data were taken at a finite time interval (X+30 seconds) rather than over a span of X+29 to 32 seconds. Therefore, the hardwire data as listed in TABLE 8-4 will not necessarily agree exactly with the tabulated hardwire data contained in other sections of this report.

⚠ Excluding the *PP100 measurements that were taken from oscillograph data.



MEASUREMENT DATA FLOW CHART

FIGURE 8-1

TABLE 8-1

PERCENTAGE OF TELEMETRY SYSTEM INSTRUMENTATION DISCREPANCIES

MEASUREMENT DESCRIPTION	TEST SA-25	TEST SA-26
Active Flight Measurements..............	335	335
Discrepant Measurements............	11	13
Percent Failure....................	3.3%	3.8%
Simulated Measurements..................	194	194
Discrepant Measurements............	7	1
Percent Failure....................	3.6%	0.5%
Total Measurements......................	529	529
Total Discrepant Measurements......	18	14
Total Percent Failure..............	3.4%	2.6%

TABLE 8-2

MEASUREMENT STATUS PRIOR TO TEST SA-25

All measurements were accepted for firing except as listed below:

MEASUREMENT NUMBER	REMARKS
S505-11	No Spare Component
S541-11	No Spare Component
E519-12	No Spare Component
B500-11	No Spare Component
L20-F4	No Spare Component
E12-6	Defective Cable

MEASUREMENT STATUS PRIOR TO TEST SA-26

All measurements were accepted for static firing with the exception of the 14 measurements as shown in the table below. The measurements shown in this table will require repair during post static test operations at Michoud.

MEASUREMENT NUMBER	REMARKS
The following measurements were discrepant prior to static test SA-26 and did not depict realistic data.	
D1-8	Defective Amplifier
E506-8	Bias Noisy
L19-02	Pulse #4 Bad; Defective Amplifier
L20-F1	Pulse #15 Bad; Defective Solar Cell
L20-F4	Pulse #1 Bad; Defective Solar Cell
L45-0C	Pin 6, of Cable, Shorted to Ground Inside Tank
S527-11	Defective Strain Gauge
S540-11	Defective Strain Gauge
S541-11	Defective Strain Gauge
The following measurements were discrepant prior to static test SA-26, but were temporarily repaired and depicted good data.	
C61-2	Defective Cable Temporarily Repaired
E11-6	Defective Cable Temporarily Repaired
E12-4	A Non-flight Cable was Used During SA-26
E12-6	Defective Cable Temporarily Repaired
E12-8	Defective Cable Temporarily Repaired

TABLE 8-3

COMPARISON OF TELEMETRY AND HARDWIRE VALUES
OF TURBINE RPM AND CHAMBER PRESSURE (P_c)

TEST SA-25

ENGINE	TELEMETRY RPM VALUE [1]	HARDWIRE RPM VALUE [1]	RPM PERCENT DIFFERENCE	P_c PERCENT DIFFERENCE [2] [3]
1	33,350	33,447	-0.291	0.647
2	33,000	33,008	-0.024	1.297
3	33,540	33,490	0.149	1.203
4	33,260	33,208	0.160	-0.280
5	32,588	32,112	1.461	0.945
6	32,785	32,769	0.049	0.718
7	26,370 [4]	33,030	-25.256	-0.677
8	33,368	33,280	0.264	-1.956

TEST SA-26

ENGINE	TELEMETRY RPM VALUE [1]	HARDWIRE RPM VALUE [1]	RPM PERCENT DIFFERENCE	P_c PERCENT DIFFERENCE [1] [3]
1	33,505	33,490	0.045	+0.213
2	32,985	32,950	0.106	+1.083
3	33,635	33,590	0.134	+1.273
4	33,405	33,360	0.135	-0.071
5	32,860	32,850	0.030	+0.943
6	32,905	32,890	0.046	+0.187
7	32,895	32,870	0.046	-0.657
8	33,455	33,466 [6]	- 0.033	[5]

[1] Values obtained are average for X+29-32 seconds.
[2] Values obtained are average for X+20-21 seconds.
[3] Actual values of P_c can be found in the "Confidential Supplement, Stage S-IB-1."
[4] Frequency divider bad.
[5] Amplifier rejected during prefiring checkout. No replacement was available.
[6] Value corrected from that published in the "Preliminary Static Test Report, Test SA-26."

TABLE 8-4

COMPARISON OF HARDWIRE VS PARALLEL FLIGHT TRANSDUCERS

$$\text{PERCENT DIFFERENCE} = \frac{\text{H.W.} - \text{T.M.}}{\text{H.W.}} \times 100$$

HARDWIRE NUMBER	MEASURED VALUE	FLIGHT NUMBER	MEASURED VALUE	PERCENT DIFFERENCE
*PT107-1	-292.9°F	C54-1	-292.82°F	0.027
*PT107-2	-293.1°F	C54-2	-292.97°F	0.044
*PT107-3	-293.0°F	C54-3	-293.03°F	-0.010
*PT107-4	-293.0°F	C54-4	-292.67°F	0.113
*PT107-5	-293.05°F	C54-5	-292.99°F	0.020
*PT107-6	-293.10°F	C54-6	-293.33°F	-0.078
*PT107-7	-293.35°F	C54-7	-293.03°F	0.109
*PT107-8	-293.4°F	C54-8	-293.22°F	0.061
*FP101-F3	11.28 psig	D2-F3	24.94 psia	3.183
*LP102-0C	40.7 psig	D3-0C	53.70 psia	2.682
*PP114-1	53.19 psig	D13-1	67.9 psia	-0.340
*PP114-2	53.62 psig	D13-2	67.2 psia	1.322
*PP114-3	54.50 psig	D13-3	67.5 psia	2.146
*PP114-4	53.20 psig	D13-4	68.0 psia	-0.473
*PP113-1	27.14 psig	D12-1	39.5 psia △1	5.094
*PP113-2	27.89 psig	D12-2	41.2 psia	2.761
*PP113-3	27.06 psig	D12-3	41.6 psia	-0.144
*PP113-4	27.79 psig	D12-4	38.4 psia △1	9.155
*PP100-1 △2	740 psig	XD34-1	746.5 psia	1.060
*PP100-2 △2	785 psig	XD34-2	731.1 psia	8.555
*PP100-3 △2	745 psig	XD34-3	741.5 psia	2.370
*PP100-4 △2	745 psig	XD34-4	739.1 psia	2.686
*PP100-5 △2	750 psig	XD34-5	726.1 psia	5.023
*PP100-6 △2	735 psig	XD34-6	729.1 psia	2.722
*PP100-7 △2	685 psig	XD34-7	720.7 psia	-3.031
*PP100-8 △2	725 psig	XD34-8	744.8 psia	-0.717
*CP102-9	2518 psig	XD40-9	2554.8 psia	-0.881
*CP100-9	761 psig	XD41-9	961.2 psia △1	-23.946
*FP103-11	1784 psig	D139-11	1822.8 psia	-1.300

△1 TM data appears unrealistic.

△2 *PP100-1/8 hardwire values were taken from oscillograph and should not be considered as valid for comparison.

NOTE: All hardwire measurements reading in psig were converted to absolute values for the purpose of comparison.

SECTION 9

CONCLUSIONS

The following conclusions are based upon an analysis of test data and hardware inspections following tests SA-25 and SA-26.

Overall stage functional performance was acceptable during both tests.

LOX tank pressure, controlled by the airborne GOX system, was higher than required during test SA-25. This pressure was satisfactorily reduced by reorificing the heat exchangers and resetting the GOX flow control valve closed position stop.

Unequal fuel tank ullage pressures resulted in a differential height in fuel levels between tanks F-1 and F-3. The differential height had attained 9 inches at X+70 seconds, when pressurizing from a facility source was initiated. The actuation of the facility fuel tank pressurizing caused further disturbances in the fuel levels. The unequal fuel tank ullage pressures are caused by an unbalanced pressure distribution in the fuel tank pressurizing manifold which results from an unsymmetrical supply system.

Engine 7 (S/N 4046) sustained an internal thrust chamber tube crack during test SA-26, which will necessitate engine replacement after the stage is returned to Michoud.

Vibration data are presented in the "Vibration and Acoustic Evaluation Report, Stage S-IB-1," to be published by Systems Static Test Branch at a later date.

SECTION 10

RECOMMENDATIONS

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

1. Engine Systems. No reorificing is recommended prior to launch.

It is recommended that an adapter, P/N MC237C4W, and a tee, P/N 4R6X-SS-W, be used in place of the tee, P/N MC250C4NW, for measurement D15-6 (*PP704-6) and D37-6. This will prevent any leakage in the turbine exhaust system.

Because of a clearance problem encountered between the Conax valve squib and the main LOX valve control lines, it is recommended that the Conax valves be installed at the launch facility with the Conax valve squib nearest the main fuel valve pointing downward.

Engine 7 (S/N 4046) should be replaced with a spare engine upon return of the stage to Michoud. This engine has an internal thrust chamber tube leak from a longitudinal crack 15/32-inch long by 1/16-inch wide.

The distorted bellows section in the turbine exhaust duct adjacent to the heat exchanger inlet of engine 8 should be replaced at Michoud.

The turbine exhaust system leaks at engines 3, 4, 5, and 6 should be repaired at Michoud.

2. Engine Hydraulic Systems. During pretest functional checks on the engine hydraulic systems prior to test SA-26, slight blips were observed simultaneously in engine 2 yaw actuator control valve trace, position trace, differential pressure trace and supply pressure trace. Investigation at engine 2 revealed no discrepancies, and satisfactory operation was obtained during test SA-26. Since the condition at engine 2 could have been caused by a contaminated or defective servo control valve, it is requested that further investigation be conducted upon return of the stage to Michoud.

Following test SA-26, the static test instrumentation was removed from the engine hydraulic systems. Since the hydraulic systems were opened during the removal of these transducers, it is necessary that each hydraulic system be cleaned and filled per MSFC-PROC-166 upon return of the stage to Michoud.

3. Fuel Tank Pressurization System. It is recommended that the fuel tank supply pressure be routed to the fuel tank pressurizing manifold by two lines, entering the manifold at two ports 180 degrees apart. This will provide a better distribution of pressure to the fuel tanks.

4. Control Pressure System. It is recommended that the GN_2 control pressure supply line orifice be changed from 0.050-inch diameter to 0.055-inch diameter in order to maintain 3,000 psig preignition control sphere pressure with gearcase purges in operation.

5. Telemetry Systems. All single side band T/M packages should be filtered internally to eliminate noisy +28 volts in these packages.

Two PCM/RF assemblies, P/N 50M12187-1, malfunctioned prior to test SA-25. It is recommended that an investigation be conducted to determine methods of improvement of the quality of these assemblies.

Because of the high rate of failure of the liquid level rack assemblies, P/N 50C12295-1, it is recommended that design of the racks or quality control in manufacturing be investigated to provide more reliability.

It is recommended that the design of the frequency dividers for the turbine rpm measurements be reviewed. The frequency dividers operated improperly during test SA-26 from ignition to simulated lift-off, during which time the PCM and PAM T/M channels are connected in parallel across the output of the frequency dividers. This additional load causes the frequency divider to malfunction.

It is recommended that 100K resistors be installed in the measuring distributors for the unused channels in the P1 multiplexer. This will eliminate the open-circuited condition and its inherent excessive noise.

In the comparison of hardwire versus parallel flight transducer measurements, it appears as though the telemeter data on measurements D12-1 and D12-4 may be in error. Telemeter measurement XD41-9 was discrepant during test SA-26. Particular attention should be paid to these measurements during the post static checkout at Michoud.

APPENDIX A

REFERENCES

REFERENCES

Confidential Supplement, Stage S-IB-1, April 27, 1965.

Preliminary Static Test Report, Stage S-IB-1, Test SA-25, April 20, 1965.

Preliminary Static Test Report, Stage S-IB-1, Test SA-26, May 4, 1965.

Vibration and Acoustic Evaluation Report, Stage S-IB-1.

Cable Damage Problem and Recommended Corrective Measures, December 15, 1964.

Saturn S-IB Static Test Plan, Stage S-IB-1, January 15, 1965.

APPENDIX B

REDLINE AND BLUELINE VALUES FOR STAGE S-IB-1

APPENDIX B

REDLINE AND BLUELINE VALUES FOR STAGE S-IB-1

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

The following measurements will be monitored to assure vehicle safety during static test operations. If any redline tolerance is exceeded, cutoff will be initiated by the panel observer. The person initiating cutoff shall then inform the Test Conductor of the reason for initiating cutoff.

1. Prerun Verifications (Redline). The following measurements will be monitored from LOX loading to ignition to ensure that a satisfactory engine compartment environment is maintained through ignition:

Measurement Number	Description	Maximum	Minimum
*PT700	Temperature, Turbopump Bearing No. 1		0° F
*PT701	Temperature, Oronite	156° F [1]	105° F
*PT101	Temperature, Turbine Spinner Surface	75° F	40° F
*PP101	Pressure, GG LOX Injector Manifold	185 psig	165 psig

[1] Limit changed from that listed in the "Saturn S-IB Static Test Plan, Stage S-IB-1". Old limit was 145° F.

2. Preignition Verifications (Redline).

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
*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 to be 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	

Measurement Number	Description	Maximum	Minimum
*LP102-0C	Pressure, LOX Tank Ullage	56 psig ⚠1	5 psig
*FP101-F3	Pressure, Fuel Tank Ullage	25 psig	2 psig
*PP115	Pressure, Turbopump Bearing No. 1 Lube Jet (within 10 seconds after Ignition Command)		75 psig
*CP102-9 ⚠2	Pressure, Control Sphere		1,000 psig
*PP114	Pressure, LOX Pump Inlet If the recorder pegs down-scale 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.		20 psig
*PP113	Pressure, Fuel Pump Inlet If the recorder pegs down-scale 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 pre-valve position indicator.		5 psig
RP200 RP201	Pressure, Deflector Water Cutoff shall be initiated only if the corresponding pressure switch indication is obtained.		65 psig

⚠1 Limit changed from that listed in the "Saturn S-IB Static Test Plan, Stage S-IB-1". Old limit was 66 psig.

⚠2 Redline limit added since the publication of the "Saturn S-IB Static Test Plan, Stage S-IB-1".

Measurement Number	Description	Maximum	Minimum
*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 *DT101 *DT700 *DT701 *DT702 *DT703	Fire Detection System The fire detection system for stage S-IB-1 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 one-half second for the flight harnesses. 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 division 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 harness pegs downscale - no action.

4. If static test fuel harness pegs 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. Preignition Verifications (Blueline).

Measurement Number	Description	Maximum	Minimum
*HT700	Temperature, Hydraulic Oil	210° F	40° F
*H0700	Position, Hydraulic Reservoir Piston	68 percent	18 percent
*PP112	Pressure, Gearcase	7 psig	2 psig
*PT700	Temperature, Turbopump Bearing No. 1		0° F
*FP103-11 ⚠1	Pressure, High Pressure Spheres	3,100 psig	2,800 psig
*CP102-9	Pressure, Control Spheres	3,100 psig	2,800 psig
ST100-9	Temperature, GOX Line		-200° F

The following measurement will be monitored during filling of the 20 cu. ft. fuel tank pressurization spheres.

FT700-11 ⚠2	High Pressure Spheres Temperature	300° F	

2. Mainstage Verification (Blueline).

Measurement Number	Description	Maximum	Minimum
*HT700	Temperature, Hydraulic Oil	275° F	
*H0700	Position, Hydraulic Reservoir Piston		10 percent

⚠1 Measurement number changed since the publication of the "Saturn S-IB Static Test Plan, Stage S-IB-1". Old number was *CP101-1.

⚠2 Blueline limit added since the publication of the "Saturn S-IB Static Test Plan, Stage S-IB-1."

Measurement Number	Description	Maximum	Minimum
*PT700	Temperature, Turbopump Bearing No. 1		0° F
*PT108	Temperature, Turbopump Bearing No. 8	600° F	
*CP102-9 ⚠1	Pressure, Control Sphere		1,100 psig

⚠1 Blueline limit added since the publication of the "Saturn S-IB Static Test Plan, Stage S-IB-1".

APPENDIX C

STAGE AND GROUND SUPPORT
TEST DATA SHEETS
STAGE S-IB-1

APPENDIX C

STAGE AND GROUND SUPPORT
TEST DATA SHEET
STAGE S-IB-1

1. TEST NUMBER:.................................... SA-25

2. TIME AND DATE:......17:02:15.460 CST (Commit).... April 1, 1965

3. DURATION (referenced from ignition command, X-3):

   a. Inboard engine cutoff signal................. 35.174 Seconds
   b. Outboard engine cutoff signal................ 35.294 Seconds

4. ENGINE NUMBERS:

Position 1 H-7046	Position 2 H-7047	Position 3 H-7048	Position 4 H-7049
Position 5 H-4044	Position 6 H-4045	Position 7 H-4046	Position 8 H-4047

5. TEST OBJECTIVES:

   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.
   f. LOX boiloff rate analysis.
   g. Determination of bulk LOX density.

6. TEST CONDITIONS:

   a. Cutoff will be initiated by Firing Panel Operator.
   b. Center LOX tank orifice diameter - 19.75 inches.
   c. Propellants (at X-153 Seconds)

LOX	655 inches (LOX Tank O-C)	1.7% ullage
Fuel	634.5 inches	2.0% ullage

   d. Engines to be gimbaled as outlined in the gimbal program (see TABLE 3-1).

e. Fuel emergency pressurizing armed at power transfer and disarmed at cutoff.
f. The LOX vents will be closed during LOX bubbling.

7. COMMENTS:

a. New normally open LOX and fuel prevalves will be used for this test.
b. Fleming initiators will be used for this test.
c. The ground LOX pressurizing orifice diameter has been decreased to 0.100 inches (from 0.125 inches) to increase pressurizing time with the reduced ullage volume.
d. The LOX bubbling rate will be 45 SCFM instead of 70 SCFM to decrease surface disturbance.

8. STAGE PRESSURE SWITCHES:

Description	Actuation	Deactuation
a. LOX Tank Pressurized	60.0 ± 1.5 psia	55.5 psia min
b. LOX Tank Emergency Vent	67.5 ± 1.5 psia	64.0 psia min
c. Fuel Tank Pressurized	32.4 psia max	29.6 psia min
d. Fuel Tank Emergency Vent	37.5 psia max	35.5 psia min
e. Fuel Spheres Pressurized	2965 ± 30 psia	2835 psia min
f. Control Sphere Pressurized	2965 ± 30 psia	2835 psia min
g. Control 750 OK	625 ± 25 psig	550 psig min
h. Thrust OK	840 ± 12 psia	N/A

9. STAGE RELIEF VALVES:

Description	Cracking	Reseat
a. Fuel Vent Valves No. 1 & 2	21.0 ± 0.5 psig	19.0 psig min
b. LOX Relief Valves No. 1 & 2	60.0 ± 5 psig	53.0 psig min

10. STAGE ORIFICES:

Description	Number	Diameter (Inches)
a. Fuel Tank Pressurizing	1	0.210 (sonic)
b. Fuel Bubbling	8	0.018
c. LOX Bubbling	8	0.102
d. 105-Inch LOX Tank Sump	1	19.75

11. GSE PRESSURE SETTING:

Description	Setting (psig)
a. Fuel Bubbling (GN_2) Pressure Switch	110 ± 15
b. LOX Bubbling (Helium) Pressure Switch	315 ± 15

	Description	Setting (psig)
c.	LOX Dome Purge Pressure Switch	195 $\pm$ 15
d.	GG LOX Injector Purge Pressure Switch	270 $\pm$ 15
e.	Fuel Injector Purge Pressure Switch	375 $\pm$ 15
f.	Turbine Spinner Pressure Switch	40 $\pm$ 10
g.	Gearcase Pressure Switch	12
h.	Facility Helium Pressure Switch	3000 $\pm$ 50
i.	Facility GN_2 Pressure Switch	3000 $\pm$ 50
j.	LOX Dome Purge Regulator Output	250
k.	GG LOX Purge Regulator Output	300
l.	Fuel Injector Purge Regulator Output	490
m.	LOX Bubbling Regulator Output	394
n.	Fuel Bubbling Regulator Output	140
o.	LOX Dome Purge Bypass Regulator Output	250
p.	Auxiliary LOX Dome Purge Regulator Output	650
q.	Emergency Fuel Pressurizing Switch	5

12. GSE ORIFICES:

	Description	Number	Diameter (inches)
a.	Ground LOX Pressurizing (Helium)	1	0.100
b.	Fuel Sphere Supply (Helium)	1	0.100
c.	Control Spheres Supply	1	0.050
d.	Fuel Jacket Fill Line	1	0.189
e.	Ground LOX Orifice Bypass	1	0.370
f.	Facility LOX Pressurizing (GN_2)	1	0.537

13. ENGINE DATA:

TEST SA-25

ENGINE POSITION	ENGINE SERIAL NUMBER	ENGINE ORIFICES (INCHES DIAMETER)							
		(1) GG LOX	GG FUEL	TURBINE SPINNER	MLV CONTROL	MFV CONTROL	MAIN LOX	MAIN FUEL	LOX TO H.E.
1	H-7046	0.379	0.700	0.875	0.116	0.073	None	2.688	0.108
2	H-7047	0.377	0.700	0.875	0.116	0.073	None	2.726	0.108
3	H-7048	0.380	0.700	0.875	0.116	0.073	None	2.672	0.108
4	H-7049	0.398	0.700	0.875	0.116	0.073	None	2.692	0.108
5	H-4044	0.368	0.700	0.875	0.116	0.073	None	2.770	0.108
6	H-4045	0.370	0.700	0.875	0.116	0.073	None	2.860	0.108
7	H-4046	0.393	0.700	0.875	0.116	0.073	None	2.618	0.108
8	H-4047	0.389	0.700	0.875	0.116	0.073	None	2.602	0.108

(1) All 200K engines are equipped with dual orifices in the GG LOX bootstrap line. A fixed orifice of 0.400 inch is plumbed in series with the variable orifice listed above.

APPENDIX C (CONTINUED)

STAGE AND GROUND SUPPORT
TEST DATA SHEET
STAGE S-IB-1

1. TEST NUMBER:.. SA-26

2. TIME AND DATE:......16:38:12.778 CST (Commit)..... April 13, 1965

3. DURATION (referenced from ignition command, X-3).
   a. Inboard engine cutoff signal.................. 138.210 Seconds
   b. Outboard engine cutoff signal................. 145.010 Seconds

4. ENGINE NUMBERS:

Position 1 H-7046	Position 2 H-7047	Position 3 H-7048	Position 4 H-7049
Position 5 H-4044	Position 6 H-4045	Position 7 H-4046	Position 8 H-4047

5. TEST OBJECTIVES:

   a. Verification of airborne/ground control systems compatibility.
   b. Determine propellant tank draining rates and terminal LOX draining characteristics.
   c. Verification of engine performance.
   d. Check performance of gimbal control system.
   e. Fuel tank pressurization characteristics during mainstage using helium.
   f. Verify reliability and performance of telemetry equipment.
   g. Obtain LOX boiloff evaluation data and verify bulk LOX density measured during initial tanking.

6. TEST CONDITIONS:

   a. Cutoff will be initiated by LOX cutoff sensor actuation.
   b. Center LOX tank orifice diameter - 19.75 inches.
   c. Propellants (at X-153 Seconds)

LOX	624 inches (LOX Tank O-C)	6.0% ullage
Fuel	634.5 inches	2.0% ullage

   d. Engines to be gimbaled as outlined in the gimbal program (see TABLE 3-2).

e. Fuel emergency pressurizing armed at power transfer and disarmed at cutoff.
f. The LOX vents will be closed during LOX bubbling.

7. COMMENTS:

a. Normally open LOX and fuel prevalves are installed.
b. Fleming initiators will be used for this test.
c. The LOX bubbling rate will be 45 SCFM.
d. Southwestern thrust OK pressure switches, P/N PS5807A-800 will be installed (800 ± 12 PSI).
e. LOX heat exchanger orifices were changed after test SA-25 from 0.108 to 0.104 inch diameter and the GOX flow control valve, which had a closed stop setting of 0.290 inch, was replaced with one with a setting of 0.255 inch.

8. STAGE PRESSURE SWITCHES:

	Description	Actuation	Deactuation
a.	LOX Tank Pressurized	60.0 ± 1.5 psia	55.5 psia min
b.	LOX Tank Emergency Vent	67.5 ± 1.5 psia	64.0 psia min
c.	Fuel Tank Pressurized	32.4 psia max	29.6 psia min
d.	Fuel Tank Emergency Vent	37.5 psia max	35.5 psia min
e.	Fuel Spheres Pressurized	2965 ± 30 psia	2835 psia min
f.	Control Sphere Pressurized	2965 ± 30 psia	2835 psia min
g.	Control 750 OK	625 ± 25 psig	550 psig min
h.	Thrust OK	800 ± 12 psia	N/A

9. STAGE RELIEF VALVES:

	Description	Cracking	Reseat
a.	Fuel Vent Valves No. 1 & 2	21.0 ± 0.5 psig	19.0 psig min
b.	LOX Relief Valves No. 1 & 2	60.0 ± 5 psig	53.0 psig min

10. STAGE ORIFICES:

	Description	Number	Diameter (inches)
a.	Fuel Tank Pressurizing	1	0.210 (sonic)
b.	Fuel Bubbling	8	0.018
c.	LOX Bubbling	8	0.102
d.	105-Inch LOX Tank Sump	1	19.75

11. GSE PRESSURE SETTING:

	Description	Setting (Psig)
a.	Fuel Bubbling (GN_2) Pressure Switch	110 ± 15
b.	LOX Bubbling (Helium) Pressure Switch	315 ± 15

	Description	Setting (Psig)
c.	LOX Dome Purge Pressure Switch	195 ± 15
d.	GG LOX Injector Purge Pressure Switch	270 ± 15
e.	Fuel Injector Purge Pressure Switch	375 ± 15
f.	Turbine Spinner Pressure Switch	40 ± 10
g.	Gearcase Pressure Switch	12
h.	Facility Helium Pressure Switch	3000 ± 50
i.	Facility GN_2 Pressure Switch	3000 ± 50
j.	LOX Dome Purge Regulator Output	250
k.	GG LOX Purge Regulator Output	300
l.	Fuel Injector Purge Regulator Output	490
m.	LOX Bubbling Regulator Output	394
n.	Fuel Bubbling Regulator Output	140
o.	LOX Dome Purge Bypass Regulator Output	250
p.	Auxiliary LOX Dome Purge Regulator Output	650
q.	Emergency Fuel Pressurizing Switch	5

12. GSE ORIFICES:

	Description	Number	Diameter (inches)
a.	Ground LOX Pressurizing (Helium)	1	0.149
b.	Fuel Sphere Supply (Helium)	1	0.100
c.	Control Spheres Supply	1	0.050
d.	Fuel Jacket Fill Line	1	0.189
e.	Ground LOX Orifice Bypass	1	0.370
f.	Facility LOX Pressurizing (GN_2)	1	0.537

13. PROPELLANT LOW LEVEL SENSORS:

	Description	Level (inches above theoretical tank bottom)
a.	LOX Low Level Sensors, Tanks O-2 and O-4	28.24
b.	Fuel Low Level Sensors, Tanks F-2 and F-4	33.42

14. ENGINE DATA:

TEST SA-26

ENGINE POSITION	ENGINE SERIAL NUMBER	ENGINE ORIFICES (INCHES DIAMETER)							
		GG LOX [1]	GG FUEL	TURBINE SPINNER	MLV CONTROL	MFV CONTROL	MAIN LOX	MAIN FUEL	LOX TO H.E. [2]
1	H-7046	0.379	0.700	0.875	0.116	0.073	None	2.688	0.104
2	H-7047	0.377	0.700	0.875	0.116	0.073	None	2.726	0.104
3	H-7048	0.380	0.700	0.875	0.116	0.073	None	2.672	0.104
4	H07049	0.398	0.700	0.875	0.116	0.073	None	2.692	0.104
5	H-4044	0.368	0.700	0.875	0.116	0.073	None	2.770	0.104
6	H-4045	0.370	0.700	0.875	0.116	0.073	None	2.860	0.104
7	H-4046	0.393	0.700	0.875	0.116	0.073	None	2.618	0.104
8	H-4047	0.389	0.700	0.875	0.116	0.073	None	2.602	0.104

[1] All 200K engines are equipped with dual orifices in the GG LOX bootstrap line. A fixed orfice of 0.400 inch is plumbed in series with the variable orifice listed above.

[2] This orifice was changed following test SA-25 from 0.108 inch to 0.104 inch.

APPENDIX D

METEOROLOGICAL DATA

TESTS SA-25 AND SA-26

METEORLOGICAL DATA

TEST SA-25

LOCATION	BLOCKHOUSE			TOP STATIC TEST TOWER	
TIME OF DAY	TEMP. (^{O}F) ⚠1	BAROM. PRESS. (IN. HG.) ⚠1	REL. HUMIDITY (PERCENT) ⚠1	WIND VEL. (MPH)	WIND DIR. (DEGREES) ⚠2
10:00 a.m.	47	29.493	75	8	160
10:30 a.m.	47	29.489	74	9	155
11:00 a.m.	48	29.487	73	7	180
11:30 a.m.	49	29.470	70	6	150
12:00 m.	49	29.457	67	0	185
12:30 p.m.	50	29.442	65	1	176
1:00 p.m.	51	29.437	62	0	205
1:30 p.m.	52	29.417	58	2	180
2:00 p.m.	53	29.407	57	5	170
2:30 p.m.	54	29.383	55	2	155
3:00 p.m.	55	29.397	52	8	140
3:30 p.m.	56	29.383	49	4	105
4:00 p.m.	57	29.382	47	8	130
4:30 p.m.	58	29.402	47	8	125
5:00 p.m.	57	29.412	48	7	135

⚠1 Data corrected from that published in the "Preliminary Static Test Report, Test SA-25."

⚠2 Wind is from the direction given in degrees starting north going clockwise.

METEOROLOGICAL DATA

TEST SA-26

LOCATION	BLOCKHOUSE			TOP STATIC TEST TOWER	
TIME OF DAY	TEMP (^{o}F) ⚠1	BAROM. PRESS. (IN.HG.) ⚠1	REL. HUMIDITY (PERCENT) ⚠1	WIND VEL. (MPH)	WIND DIR. (DEGREES) ⚠2
10:00 a.m.	62	29.523	40	10	40
10:30 a.m.	63	29.521	38	6	20
11:00 a.m.	64	29.517	36	10	340
11:30 a.m.	65	29.512	32	12	350
12:00 m.	66	20.507	31	11	325
12:30 p.m.	67	29.507	29	13	335
1:00 p.m.	68	29.507	27	10	335
1:30 p.m.	69	29.498	26	10	350
2:00 p.m.	69	29.492	26	9	340
2:30 p.m.	69	29.483	26	13	5
3:00 p.m.	70	29.477	25	12	340
3:30 p.m.	71	29.480	24	11	350
4:00 p.m.	70	29.482	24	9	350
4:30 p.m.	69	29.482	24	6	325
5:00 p.m.	69	29.482	26	8	345

⚠1 Data corrected from that published in the "Preliminary Static Test Report, Test SA-26."

⚠2 Wind is from the direction given in degrees starting north going clockwise.

APPENDIX E

OPERATING TIME/CYCLE HISTORY
OF STAGE S-IB-1 COMPONENTS
WHILE AT STATIC TEST

APPENDIX E

OPERATING TIME/CYCLE HISTORY OF STAGE S-IB-1 COMPONENTS AT STATIC TEST

COMPONENT	OPERATION	
	CYCLES	MINUTES
LOX Prevalve, Engine 1	222	-
LOX Prevalve, Engine 2	205	-
LOX Prevalve, Engine 3	192	-
LOX Prevalve, Engine 4	198	-
LOX Prevalve, Engine 5	180	-
LOX Prevalve, Engine 6	184	-
LOX Prevalve, Engine 7	173	-
LOX Prevalve, Engine 8	176	-
Fuel Prevalve, Engine 1	214	-
Fuel Prevalve, Engine 2	197	-
Fuel Prevalve, Engine 3	181	-
Fuel Prevalve, Engine 4	191	-
Fuel Prevalve, Engine 5	177	-
Fuel Prevalve, Engine 6	175	-
Fuel Prevalve, Engine 7	171	-
Fuel Prevalve, Engine 8	169	-
Master Measuring Power Supply	75	5812.8
Fuel Vent Valve 1	184	-
Fuel Vent Valve 2	185	-
LOX Relief 1 and 7-inch Vent	212	-

COMPONENT	OPERATION	
	CYCLES	MINUTES
LOX Relief 2	235	-
LOX Emergency Pressurizing Switch	13	-
RF Assembly F1	153	3151.8
RF Assembly F2	200	2282.2
RF Assembly S1	129	2084.4
Switch Selector	70	-
PCM/DDAS Assembly	-	3337.9
Vibration Multiplexer	129	2084.4
SS/FM Assembly F1	153	3151.8
PCM/RF Assembly P2	194	1453.7
Command Destruct Receiver 1	-	1609.7
Command Destruct Receiver 2	-	1610.5
22.5-Volt Power Supply	-	5771.0
Thrust OK Pressure Switches ⚠1		
Engine 1, Switch 1	20	-
Engine 1, Switch 2	27	-
Engine 2, Switch 1	23	-
Engine 2, Switch 2	19	-
Engine 3, Switch 1	21	-
Engine 3, Switch 2	18	-
Engine 4, Switch 1	22	-

⚠1 Values given are approximate.

APPENDIX E (CONTINUED)

COMPONENT	OPERATION	
	CYCLES	MINUTES
Engine 4, Switch 2	16	-
Engine 5, Switch 1	19	-
Engine 5, Switch 2	[1]	-
Engine 6, Switch 1	36	-
Engine 6, Switch 2	[1]	-
Engine 7, Switch 1	25	-
Engine 7, Switch 2	[1]	-
Engine 8, Switch 1	54	-
Engine 8, Switch 2	[1]	-

[1] Values given are approximate. Values for the number 2 switch on engines 5, 6, 7, and 8 were lost due to a patching error.

APPENDIX F

UNSATISFACTORY CONDITION REPORTS

APPENDIX F

UNSATISFACTORY CONDITION REPORT

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01101	Caster A10424049 N/A	Immediately after removal of S-IB-1 from the barge Palaemon the caster on the draw bar rear dolly of the transporter was found to be damaged. The caster was bent, causing the caster wheel to roll at an angle approximately 15° from the vertical.	It appears that the caster can be straightened, since the damage is not extensive and it is suggested that corrective action be taken at Michoud.
01102	Air Supply Line N/A N/A	The air supply line to the rear transporter dolly on the control side, had a small hole in it, therefore allowing the air pressure to bleed off when the transporter was parked.	The leaking air line causes loss of air pressure on the brakes after the transporter has been parked. It is suggested that corrective action be taken at Michoud.
01103	Tube Assembly 60C10457 N/A	The control sphere fill line has a nick approximately 1/16 inch deep and 1/16 inch long.	It is recommended that the tube assembly be replaced during Post Static Test checkout at Michoud. This tube assembly is acceptable for Static Test firings.
01104	Union MC164D6 N/A	Leak at the LOX tank side of the bulkhead union in control line from tank 0-4 to F-3.	Crush washer installed on each side of the discrepant union. Recommend this union or the parent tube assembly be replaced during Post Static Test Checkout and that the system be leak checked.
01105	Angle Support 10C10837 N/A	The four holes for mounting the angle support P/N 10C10837 per DWG 60C10016 have not been drilled. This condition exists at each inboard engine position.	It is felt that angle support P/N 10C10837 can be eliminated since it is a Static Test item and the overboard drain lines are firmly supported without it.
01106	Radiation Shield Installation Hardware N/A N/A	None of the installation hardware for radiation shield DWG 10C11441 has been shipped to CCSD Huntsville. Specifically: 80 bolts P/N MS35308-9 8 bolts P/N MS35308-12 88 washers P/N AN960C416 88 nuts P/N MS20500-428	The radiation shield was installed using bolts, nuts, and washers available from facility supply.
01107	Rivet CR6634-4-6 N/A	The installation rivets for access chute DWG 60C10002 have not been shipped to CCSD Huntsville. For proper installation 70 rivets are required.	The access chute was installed using rivets which had been shipped to CCSD-Huntsville for use on S-I-10 but received too late to use. Since this is a continuing Static Test requirement, the rivets should be provided with each vehicle.
01108	GG Injector Purge Check Valve 557772 6309986	When the valve at engine 4 was removed for a contamination check, it was discovered that the O-ring MS28778-4 on the downstream side of the check valve was missing. The ommission of the O-ring could have resulted in a high pressure LOX leak.	There was no contamination or damage evident in the check valve, therefore it was reinstalled using new O-rings. In the future more care should be exercised in the installation of the GG LOX injector purge check valve.
01109	Pressure Gage 50C12012 30702	Calibration pressures were applied to transducer 5A468 and the output voltage was monitored over the Digital Data Acquisition System and recorded. Of five points tested, three points were out of tolerance. Applied Pressure PSIA / Voltage Output Should be / Was 400 / 2.49±0.05 / 2.34 600 / 3.74±0.05 / 3.57 800 / 4.99±0.05 / 4.75	This transducer was replaced by S/N 30696. It is recommended that the malfunction be investigated in bench tests, and that this UCR be compiled into a history record of failures of this type transducer.
01110	Pressure Gage 50C12012 30695	Calibration pressures were applied to transducer 3A485 and the output voltage was monitored over the Digital Data Acquisition System and recorded. Of five points tested two points were out of tolerance. Applied Pressure PSIA / Voltage Output Should be / Was 600 / 3.74±0.05 / 3.67 800 / 4.99±0.05 / 4.90	This transducer was replaced by S/N 30700. It is recommended that the malfunction be investigated in bench tests, and that this UCR be compiled into a history record of failures of this type transducer.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01111	Pressure Gage 50C12012 30694	Calibration pressures were applied to transducer 2A403 and the output voltage was monitored over the Digital Data Acquisition System and recorded. Of 5 points tested two points were out of tolerance. Applied Pressure PSIA / Voltage Output Should be / Was 600 / 3.71±0.05 / 3.80 800 / 4.98±0.05 / 5.08	This transducer was replaced by S/N 30712. It is recommended that this UCR be compiled into a history of failures of this type transducer.
01112	PCM/RF Assembly 50C12187-1 002	While performing an RF power radiated test (procedure 3CH S-IB-516) it was found that no indication of RF power was seen on the thruline RF wattmeter. An investigation revealed that +28 and ground were applied to the package in a proper manner. Subsequent bench tests revealed that the package was faulty.	This package was replaced by S/N 001. The cause of the malfunction should be investigated, and this UCR should be compiled into a historical record of RF assemblies of this type.
01113	Flexitallic Gasket 20C00441 N/A	While performing a heat exchanger leak check at Engine 6, excessive leakage was noted at the LOX inlet flange on the heat exchanger. An inspection revealed that a neoprene O-ring had been coated with an excessive amount of lubricant (specific type unknown) and installed at the heat exchanger LOX inlet flange.	An analysis was made of the lubricant to determine LOX compatability and the results indicated 3.9 milligram NVR (Non Volatile Residue). The LOX specification states 1 milligram NVR but since no lubricant was noted inside the heat exchanger LOX inlet tube, the flanges were cleaned and the correct gasket (Flexitallic P/N 20C00441) installed. It is recommended that more care be exercised during stage assembly.
01114	Hose Assemblies 60C00520 N/A	While performing an engine purge checkout on Engine 3, it was discovered that the hose assemblies P/N 60C00520 from the stage purge panel to the engine customer connect panel for the fuel injector purge, gas generator LOX injector purge, and the LOX dome purge were improperly connected. The hose assemblies were crossed such that the fuel injector purge was connected to the gas generator LOX injector purge, the gas generator LOX injector purge to the LOX dome purge, and the LOX dome purge to the fuel injector purge.	The hose assemblies were changed to the proper configuration and a gas sample was taken of the fuel injector purge at the customer connect panel to check the NVR count, result of which proved negative (No contamination). In the future more care should be exercised in the installation of the purge lines.
01115	PCM/RF Assembly 50M12187-1 001	On 27 March 1965, procedure 3CH SIB-516 was performed on the PCM/RF assembly. The package was found to meet minimum RF power requirements (13.0 watts radiated was required and 13.0 watts was obtained). On 30 March 1965, the package malfunctioned while broadcasting a PCM wavetrain. It was found that while the carrier continued to exist, modulation of the RF carrier failed completely. During a subsequent bench test, the carrier was observed to have modulation at first application of power, but this modulation gradually "died" completely.	On 23 March 1965, RF power checks were performed on RF assembly SN 002 (procedure 3CH SIB-516). No RF power was noted during this first test, reference UCR 0112. It is possible that the package arrived at STTE in a faulty condition. The second package, SN001, (this UCR) was found to have a malfunction after about one hour operating time. The above indicates that this type package may be unreliable and investigation should be conducted to determine areas of possible redesign and/or additional quality control in manufacturing.
01116	LOX Prevalve 60C20339 114	The LOX prevalve on Engine 4 failed to give a closed indication when it was cycled during the propellant loading test with LOX loaded aboard the stage.	It is recommended that a failure analysis be conducted on the prevalve.
01117	Liquid Level Probe 50M10205 N/A	On 4-6-65 it was noted during a FM/FM telemeter scan that pulse 1 of the fuel discrete level measurement L20-F4 was missing. Investigation of the missing pulse revealed that the solar cell output voltage was zero.	It is recommended that the discrete probe 1 be investigated and replaced at CCSD - Michoud.

NOTES: 1. UCR 01117 was originally written on "---pulse 4 of the fuel discrete level measurement L20-F4---". UCR 01192 made corrections to read "---pulse 1 of the---".
2. UCR 01117 was subsequently reissued in a "CORRECTED COPY", as printed above, and UCR 01192 cancelled.

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01118	Pneumatic Solenoid Valve MV130-T B10437739 1143	During simulated flight of vehicle S-IB-201 at STTE on 3/23/65, fuel bubbling solenoid valve failed to close when power was removed from the valve	Valve was replaced by a similar item which functioned properly.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01119	Rack Assembly 50C12295-1 306049	During prefiring checkout while performing procedure 3-CH SIB-506, there was no response from measurement L19-OC. A wet condition was simulated by paralleling the output of the discrete probe (#1) with a 1K resistance. When the 1K was lifted,the measurement should have responded with a one pulse output. There was no response.	Prior to test SA-25, four rack assemblies of this type malfunctioned (reference UCR 01123, 01124). It is recommended that the cause of the malfunction be investigated.
01120	Frequency Divider 50C10695 23568	Prior to test SA-25, a checkout was performed (procedure 3-CH SIB-510) on measurement T12-5, turbine RPM. When the simulated signal (from a portable oscillator) was applied to the input of the frequency divider, SN 23568, no output response at all was noted at a telemetry ground station. The problem was eliminated when spare frequency divider, SN 23511, was installed in place of the faulty frequency divider.	It is recommended that an investigation be conducted to determine the cause of the malfunction of the frequency divider.
01121	Zone Box 50C10403-1 2140	During prefiring checkout while performing procedure 3-CH SIB-502 it was noticed that the leads to the zone box were frayed. Except for the damaged insulation, the zone box performed in a satisfactory manner.	It is recommended that zone boxes with this type insulation be replaced by zone boxes with more rugged insulation.
01122	LOX Prevalve 60C20339 105	During the propellant loading test the LOX prevalve on Engine 2 failed to give a closed indication whenever it was cycled, except once. The closing time for the one time that a closed indication was received was 4.9 seconds signal to switch.	It is recommended that a failure analysis be performed on this valve.
01123	Rack Asembly 50C12295-1 402011	During prefiring checkout while performing procedure 3-CH SIB-406, there was no response from measurement L19-03. A wet condition was simulated by paralleling the output of the discrete probe (#15) with a 1K resistance. When the 1K was lifted the measurement should have responded with a one pulse output. There was no response. Other discrete measurements do respond to the same test procedure.	It is recommended that an investigation of the malfunction of the rack assembly be undertaken. Prior to test SA-25, four rack assemblies malfunctioned. (reference UCR 01119, 01124).
01124	Rack Assembly 50C12295-1 402013	During prefiring checkout while performing procedure 3-CH SIB-506 there was no response from measurement L20-F1. A wet condition was simulated by paralleling the output of the discrete probe (#15) with a 1K resistance. When the 1K was lifted the measurement should have responded with a one pulse output. There was no response. Other discrete measurements do respond to the same test procedure.	Prior to test SA-25, four rack assemblies of this type malfunctioned (reference UCR 01119, 01123). It is recommended that these malfunctions be investigated.
01125	Rack Assembly 50C12295-1 403018	During prefiring checkout while performing procedure 3-CH SIB-506, there was no response from measurement L20-F4. A wet condition was simulated by paralleling the output of the discrete probe (1) with a 1K resistance. When the 1K was lifted the measurement should have responded with a pulse output. There was no response. Other discrete measurements do respond to the same test procedure.	Prior to test SA-25, four rack assemblies of this type malfunctioned (ref. UCR 01119, 01123, and 01124). An investigation into the cause should be conducted and redesign or additional quality control in manufacture should be initiated.
01126	Amplifier 50C10388-41 0054	During prefiring checkout while performing procedure 3-CH SIB-509, it was discovered that measurement S505-11 was faulty. The amplifier produced the same symptom in another measurement channel. Further investigation revealed that the balance potentiometer was "noisy".	The amplifier was replaced by spare amplifier, S/N 0314. It is recommended that this UCR be compiled into a historical record of this type malfunction to determine whether or not inferior potentiometers are being installed in the amplifiers.
01127	Amplifier 50C10388-43 0160	Prior to test SA-25, a test was made of flight instrumentation. At this time, the output of measurement S531-11 was noted to be incorrect. When an attempt was made to adjust the output by use of a bias potentiometer located on the associated amplifier, the output could not be changed with this potentiometer. The measurement performed properly when spare amplifier SN0337, was installed. (Reference DMN H00231).	It is recommended that a post test investigation be conducted to determine the cause of the faulty amplifier, and that this UCR be complied into a historical record of this type malfunction.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01128	Zone Box 50C10403 2078	During prefiring checkout while performing procedure 3-CH SIB-502, measurement C61-1 indicated no output. Further investigation revealed that the zone box leads were open circuited. Since the zone box is sealed, the exact location of the open circuit could not be determined. There was no visible evidence of damage.	It is recommended that an investigation be conducted to determine the location and cause of the open circuit, and that this UCR be compiled into a historical record of this type malfunction.
01129	Cable 50C03753-1 N/A	During prefiring checkout while performing procedure 3-CH SIB-504, measurements E12-6 (turbine gear box vibration) indicated zero output. Further investigation revealed that the subject cable was shorted.	A temporary cable was installed for static firing. This cable should be replaced at Michoud. On this cable, P2 is loosely attached. Because of this, slight twisting of the cable relative to the connector causes the wires inside to short together. It is felt that a more rugged tie cable is needed.
01130	Microphone 50C10399 N/A	During prefiring checkout, while performing procedure 3-CH SIB-501, measurement B500-11 indicated zero output in hi cal. By substituting a simulated signal into the input, it was established that the circuitry was good. When the microphone was re-connected there was no output from the amplifier.	It is recommended that an investigation be conducted to determine the cause of the malfunction.
01131	Thrust OK Pressure Switch NA-27359-1A 25358	A visual inspection of the Thrust OK Pressure Switches revealed a damaged (outboard) Thrust OK Pressure Switch (P/N PS5807A840, S/N 25358) on Engine 2 (S/N H-7046). The electrical connector was bent approximately 10 to 15 degrees and the switch housing was dented in several places.	The damaged Thrust OK Pressure Switch was replaced. It is felt that the possibility of pressure switch damage would be greatly reduced if the housing material were strengthened.
01132	Amplifier 50C10394-21 1629	During prefiring checkout while performing procedure 3-CH SIB-502 measurement C9-8 (gas generator chamber temperature) indicated no output.	The problem was corrected. It is recommended that the malfunction be investigated in bench tests, and that this UCR be compiled into a history record of failure for this amplifier.
01133	Cable 50C03753 N/A	During prefiring checkout while performing procedure 3-CH SIB-504 measurement E519-12 (Distributor 12A1 Longitudinal Vibration) indicated zero in the hi cal position. Further investigation revealed that cable connector, P2, which connects to the accelerometer had been improperly assembled. The key-way insert had been installed rotated 90° from its proper position.	This cable was repaired and reinstalled. It is recommended that this UCR be compiled into a historical record of this type problem. Should similar problems reoccur, additional quality control should be initiated.
01134	PCM/DDAS Assembly 60C50079-1 001	Prior to test SA-25, a "PCM versus predirected" scan of measurements was performed with a computer over the DDAS coaxial cable loop. The PCM wavetrain contains up to 810 channels (not including synchronization pulses) with each channel being made up of 10 bits in binary form. It was noted that the 8th bit of all channels remained in the off (or zero) position, and it also was off in the synchronization pulses. The failure of the 8th bit would cause all measurements to be in error by about 20 millivolts. At a later time, the bit 8 on all channels was observed to be working properly.	It is recommended that this package be subjected to a bench test following static testing to determine the cause of the marginal operation of bit 8. Since most flight measurements appear on DDAS, necessary redesign or additional quality control during manufacture should be initiated to improve reliability of this DDAS system.
01135	Cable 50C03753-7 N/A	During prefiring checkout while performing procedure 3-CH SIB-504, measurement E11-6 (thrust chamber dome vibration) indicated zero output. Further investigation revealed that the subject cable had broken wire inside 3 inches from connector. A tempoary cable built at Static Test is being used for static firing. This cable should be replaced at Michoud.	On this cable, P2 is very loosely attached to the cable. Because of this, twisting the cable slightly relative to the connector, causes the wires inside to short together. It is recommended that a more rugged type cable be used.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01136	Frequency Divider 50C10695 23559	Prior to test SA-25, a checkout was performed (procedure 3-CH SIB-510) on measurement T12-1, turbine RPM. When the simulated signal (from a portable oscillator) was applied to the input of the frequency divider, the output reading at the telemetry ground station was found to be incorrect as shown below:	It is recommended that an investigation be conducted to determine the cause of the malfunction, and that this UCR be compiled into a historical record of malfunctions of this type frequency divider.

Input to Frequency Divider		Output as Read In TM Ground Station	
VOLTS (RMS)	Frequency	Reading (CPS)	Should Be (CPS)
1	1600	66	50
2.5	3200	132	100

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01137	Auxiliary Hydraulic Pump 20C85064 MX100724A	Upon receiving stage S-IB-1 at Static Test Tower East, a new low pressure flex hose assembly was installed in Engine 2 hydraulic system in compliance with modification bulletin No. FH-651-B1-"A". When filling and cleaning Engine 2 hydraulic system as per procedure 6 CH SIB-307, an unusual noise was heard in the auxiliary pump. As the temperature of the hydraulic oil approached the normal operating range, this noise became increasingly worse.	The defective auxiliary pump (P/N 20C85064, S/N MX100724A) and corresponding motor (P/N 20C85053, S/N 1335456) were removed from engine 2 hydraulic package (P/N 20C85053, S/N 135) and sent to Michoud for further investigation. A new auxiliary pump (P/N 20C85064, S/N MX100728A) and motor (P/N 20C85065, S/N 1335457) were removed from the logistic spares hydraulic package (P/N 20C85053, S/N 130) and installed in engine 2 hydraulic system. Following installation of the new pump and motor, engine 2 hydraulic system was filled and cleaned per procedure 6-CH SIB-307.
01138	Thermal Motor A-1 Switch 20C85065 N/A	During purging and bleeding of the hydraulic actuator assemblies, it was noticed that the temperature O.K. indication for the auxiliary hydraulic pump motor on Engine 3 was not being received. Investigation of Cable 3W5/P3 revealed that voltage was being applied across the thermal switch terminals for this indication. The thermal switch cover was removed and it was found that one of the wires had seperated from the plug mounted in the thermal switch cover.	System performance is normal after the junction was cleaned and re-soldered. It is understood that an investigation has been conducted to check the effect of Cera-bend on solder joints under controlled conditions by a CCSD-Michoud chemist and has verified that such corrosion action does occur. It is recommended that other methods be used to check the operation of these switches or the thermal switches and related solder connections be thoroughly cleaned and checked prior to delivery of future stages to Static Test.
01139	Schematic Drawing 40M03450 Page 94	An inflight calibration pulse, when manually sent from the T.M. ground station, blockhouse measuring panel, or the Static Tower T.M. station, will energize the switch selector count and switch selector malfunction circuits through the DDAS ground station giving a switch selector count and switch selector malfunction indication on the G.S.E. console. Also when running an automatic sequence test, the in-flight calibration pulse, triggered by the switch selector will give a switch selector malfunction indication. This malfunction indication is energized by getting bits one and two of the ten bit word from T.M. to the D.D.A.S. ground station.	The two signals coming from the D.D.A.S. ground station which energize the switch selector count and malfunction circuits were removed from the D.D.A.S. patch and, the switch selector count circuitry was hardwired by patching from the read pulse of the substitute flight computer to the switch selector counter. The system should be redesigned to inhibit the switch selector count and switch selector malfunction circuitry when giving an in-flight calibration. The possibility of using other bits than bits 1 and 2 in the 10 bit work should be explored and also the possibility of hardwiring these functions should be investigated.
01140	Valve Assembly 1804001 N/A	During installation of the explosive conax valve assembly per procedure 6-CH SIB-343 there was insufficient clearance between the lower conax squib and the housing of the gas generator control valve P/N 307454 to allow connection of the engine harness connector, Bendix 10-281302-4F. If the conax valves were inverted so that the squib nearest the manifold was on top, severe interference resulted between the squib and the main LOX valve closing control line 12-601585 on engines 1, 2, 4, and 7 which might have resulted in high-pressure fuel leak at the conax manifold seal.	The conax valves at engines 1, 2, 4, and 7 were installed with the low side squib down next to the gas generator control valve housing, and a jumper cable was employed with connector MS3106E-10SL-4S in order to allow connection. This discrepancy should have been noted during engine retrofit firing and necessary correction made. In order to facilitate ease of connecting the engine harness without major engine modification, the present connector Bendix P/N 10-281302-4F should be changed to a Cannon connector P/N MS3106E-10SL-4S.

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01141	Panel, Measuring 60C11101-1 N/A	Calibration of the measuring panel, P/N 60C11101-1, associated with flight measurements D15-6 and D37-6 revealed that the calibration valve associated with measurement D15-6 and one of the calibration valves associated with measurement D37-6 were installed backwards. An O-ring which appeared to be P/N MS29512-4 was found between the tee, P/N MC250C4NW, and the calibration valve associated with measurement D37-6. When the valves were installed properly and the proper packing, P/N MC266F904, installed between the tee and valve of measurement D37-6, the connection leaked and could not be sealed. The calibration valve associated with measurement D37-6 was bypassed to prevent leakage for test SA-25.	A morestringent inspection should be followed during installation to prevent improper installation of hardware which can be attached backwards. It is recommended that an adapter, P/N MC237C4W, and a tee, P/N 4R6X-SS-W, be used in place of the tee, P/N MC250C4NW.
01142	Seal - Naflex RD 261-3010-0138 None	During the removal of the LOX pump inlet screens (P/N 20C01026-1) following the initial propellant loading test, an excessive amount of LOX lubricant (P/N EC-1730) was found on the LOX pump inlet Naflex seal (P/N RD 261-3010-0138) and on the inside of the LOX pump volute adapter.	There is no requirement for lubrication on Naflex seals, as they are teflon coated. Recommend more stringent inspection of installations.
01143	Gasket 8-2857-1PNA None	During a turbine exhaust system leak check, following the short duration static test, SA-25, leakage was noted at the flange between the turbine assembly (P/N 454204) and the exhaust duct assembly (P/N 307691) on engine 2 (S/N H-7047). There was no evidence of hot gas leakage during the short duration static test.	Recommend that after lubrication is applied to the gasket, extreme care be taken to avoid contact of the gasket with any metal shavings or foreign particles to prevent reoccurrenceof subject leaks.
01144	Gasket AN901-4C N/A	Post test SA-25 investigation revealed a leak existed between the thrust chamber and measurement number D-1 at Engine 5 during the short duration SA-25. After removing the D-1 measurement transducer, it was noted that the sealing gasket (P/N AN901-4C) had slipped down during installation and a portion pinched enough to prevent a proper seal at high pressure.	Recommend investigation into the possibility of redesign of the copper gasket to provide a better sealing surface.
01145	7-Inch LOX Vent Valve 20M30122 CH 874	During the components test procedure (6-CH SIB-220) after SA-25 the 7-inch LOX vent failed to give the closed indication. However the valve was visually verified to be opening and closing properly. Similiar conditions existed on the 7-inch LOX vent valve on previous stages. (Reference UCR # 234, 231, and 73.)	The vent valve microswitch failed to function properly. This valve is acceptable for Static Test, but it is recommended that the valve be changed during post static checkout.
01146	Pressure Transducer 20C85079 1029	During the quick-look data session following test SA-25 it was noted that the output of measurement No. HP702-2 (Hydraulic oil supply pressure) was erratic. One-half second after turning the auxiliary pumps on, the trace dropped from approximately 3,220 psig to 1,280 psig. The fluctuations to some extent continued throughout the test.	The potentiometric transducer appears to be in error since a static installed transducer sensing the same pressure had no fluctuations. UCR'S have been written against these transducers at Static Test on the last three stages. Attached to this UCR is a sketch comparing the pressures traces on the flight and static transducer during an erratic period. A tri-axial transducer mounted on the hydraulic package indicated no abnormal vibrations in this area. It is suggested by the author that a non-potentiometric transducer be acquired for this measurement.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

<table>
<tr><th>UCR NUMBER</th><th>PART NAME
PART NUMBER
SERIAL NUMBER</th><th>DESCRIPTION</th><th>REMARKS</th></tr>
<tr><td>01147</td><td>Pressure Transducer
20C85079
1034</td><td>The static test data on test SA-25 indicated that engine 3 measurement No. HP702-3 (Hydraulic Oil Supply Pressure) was fluctuating. The fluctuations occurred throughout the test but were most pronounced after engine cutoff (during pressure delay). The fluctuations after cutoff had an amplitude of approximately 800 psig.</td><td>The flight transducer appears to be erratic since the Wiancko transducer sensing the same pressure didn't show the fluctuations.

UCR'S have been written against these type transducers on the last three stages. A sketch is attached to this UCR comparing the flight measurement to the Static measurement. A tri-directional accelerometer located on the hydraulic package indicated no abnormal vibrations in the area. It is suggested that a non-potentiometric type transducer be used for this measurement.</td></tr>
<tr><td>01148</td><td>Pressure Transducer
20C85079
1032</td><td>The review of data for test SA-25 disclosed that the trace for Measurement HP702-1 (hydraulic oil supply pressure) transducer indicated fluctuations. These fluctuations occurred after ignition with a maximum amplitude of 270 psig.</td><td>UCR's have been written against this model transducer for three stages. A comparison of the flight transducer trace with the static installed transducer is attached. A tri-directional vibration accelerometer mounted in close proximity to the flight transducer indicated no abnormal vibration levels in this area. It is suggested that a nonpotentiometric transducer be acquired for these measurements.</td></tr>
<tr><td>01149</td><td>Frequency Divider
50C10695
23566</td><td>Prior to test SA-26, a checkout was performed (procedure 3-CH SIB-510) on measurement T12-7, turbine RPM. A simulated signal (from a portable oscillator) was applied to the input to the frequency divider, and the output was monitored at a telemetry ground station. The test was performed under two conditions: (1) with the PCM Transfer Relay (K13) energized and (2) with the PCM Transfer Relay de-energized. When the relay is energized, the output of the frequency divider is fed in parallel to two different telemetry channels, GF1-11 and GP1B0-09-08, but when the relay is de-energized, the output is fed only to channel GF1-11. The results are tabulated below.

<table>
<tr><th>PCM Transfer Relay</th><th>Freq. Divider Input</th><th>TM. Gnd. Sta. Output</th><th>Should be</th></tr>
<tr><td>energized</td><td>1V/1600 cps</td><td>2V/66 cps</td><td>50 cps</td></tr>
<tr><td>energized</td><td>2.5V/3200 cps</td><td>2V/132 cps</td><td>100 cps</td></tr>
<tr><td>de-energized</td><td>1V/1600 cps</td><td>6V/66 cps</td><td>50 cps</td></tr>
<tr><td>de-energized</td><td>2.5V/3200 cps</td><td>6V/132 cps</td><td>100 cps</td></tr>
</table></td><td>Because the frequency divider is very sensitive to an output load impedance (a change from 100K to 14K affects its operation), the operation of the component becomes marginal and unreliable. An investigation should be undertaken to eliminate this marginal operation. For SA-26 this divider may be used as is. Even though its operation is marginal, reliable data may be expected after PCM transfer (at lift-off).</td></tr>
<tr><td>01150</td><td>Frequency Divider
50C10695
23565</td><td>Prior to test SA-26, a checkout was performed (procedure 3-CH SIB-510) on measurement T12-7, turbine RPM. A simulated signal (from a portable oscillator) was applied to the input to the frequency divider, and the output was monitored at a telemetry ground station. The test was performed under two conditions: (1) with the PCM Transfer Relay (K13) energized and (2) with the PCM transfer relay de-energized. When the relay is energized, the output of the frequency divider is fed in parallel to two different telemetry channels GF1-11, and GP1B0-09-08; but when the relay is de-energized the output is fed only to channel GF1-11. The results are tabulated below.

<table>
<tr><th>PCM Transfer Relay</th><th>Freq. Divider Input</th><th>TM. Gnd. Sta. Output</th><th>Should be</th></tr>
<tr><td>energized</td><td>1V/1600 cps</td><td>2V/66 cps</td><td>50 cps</td></tr>
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<tr><td>de-energized</td><td>1V/1600 cps</td><td>6V/66 cps</td><td>50 cps</td></tr>
<tr><td>de-energized</td><td>2.5V/3200 cps</td><td>6V/132 cps</td><td>100 cps</td></tr>
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</table>

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01151	Frequency Divider 50C10695 23577	Prior to test SA-26, a checkout was performed (procedure 3-CH SIB-510) on measurement T12-5, turbine RPM. A simulated signal (from a portable oscillator) was applied to the input to the frequency divider, and the output was monitored at a telemetry ground station. The test was performed under two conditions, (1) with the PCM transfer relay (K13) energized and (2) with the PCM transfer relay de-energized. The results are tabulated below. When the relay is energized, the output of the frequency divider is fed in parallel to two different telemetry channels GF1-10 and GP1B0-07-09, but when the relay is de-energized the output is fed only to channel GF1-10.	Because the frequency divider is very sensitive to an output load impedance (a change from 100K to 14K affects its operation), the operation of the component becomes marginal and unreliable. An investigation should be undertaken to eliminate this marginal operation.

PCM Transfer Relay	Freq. Divider Input	TM. Gnd. Sta. Output	Should be
energized	1V/1600 cps	2V/66 cps	50 cps
energized	2.5V/3200 cps	2V/132 cps	100 cps
de-energized	1V/1600 cps	2V/50 cps	50 cps
de-energized	2.5V/3200 cps	6V/100 cps	100 cps

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01152	Liquid Level Rack 50M12295-1 403018	Prior to SA-25 static firing, it was noted that pulse 4 of measurement L20-F4 was missing. A new liquid level rack was installed on 3-31-65, the day prior to firing.	Return liquid level rack to CCSD - Michoud for investigation.
01153	Frequency Divider 50C10695 23564	When the evaluation of TM records of test SA-25 was performed, it was found that measurement T12-7 indicated 26370 RPM at about 30 seconds following ignition. The same measurement as read over the hardwire loop indicated 33,030 RPM. Except for the incorrect value broadcast by this measurement over the TM loop, the waveform appeared to be satisfactory.	It is recommended that the frequency divider be subjected to a bench test during post static test operations to determine the cause of the malfunction.
01154	Cable 50C03753 N/A	During prefiring checkout while performing procedure 3-CH SIB-504, measurement E12-4 (turbine gear box vibration) indicated zero output. Further investigation revealed that the connector (P2) was not making good connection.	An identical collar was obtained from logistics. It is recommended that this UCR be compiled into a historical record of this type malfunction. Should the problem reoccur, additional quality control is recommended during manufacture.
01155	LOX Prevalve 60C20339 119	The LOX prevalve on Engine 2 failed to give a closed indication when it was closed immediately after test SA-25. After the valve had achieved ambient conditions the closed indication was received.	Reference UCR number 01116 and 01122. This valve was replaced by SN 109 It is recommended that a failure analysis be conducted on the prevalve.
01156	Auxiliary Hydraulic Pump 20C85064 MX99281	The hydraulic supply pressure transducer at Engine 1 was replaced (P/N 20C85079, S/N 1032 out, S/N 12292 in) due to erratic operation during test SA-25. During cleaning operation following replacement of this transducer, it was noted that the auxiliary pump had a discharge pressure of only 87 psig.	The defective auxiliary pump (P/N 20C85064, S/N MX99281) and corresponding motor (P/N 20C85065, S/N 1335440) were removed from Engine 1 hydraulic package (P/N 20C85053, S/N 124) and sent to Michoud for further investigation. A new auxiliary pump (P/N 20C85064, S/N MX100735A) and motor (P/N 20C85065, S/N 1335447) were installed at Engine 1, and the hydraulic system was recleaned per procedure 6-CH SIB-307.
01157	Valve, Air, High-Pressure Charging 18659 N/A	When precharging Engine 1 hydraulic package (P/N 20C85053, S/N 124) prior to performing a functional check, GN_2 leakage was observed at the P/N 18659 high-pressure charging valve.	The damaged high-pressure charging valve was removed and replaced (S/N N/A out, S/N 130 in).
01158	Cable (9W30) 60C40240 N/A	During the performance of procedure 2-CH SIB-557, a discrepancy was discovered on measurement XE57-3 (RCC). The discrepancy was found while making system capacitance measurements. Further investigation revealed the subject cable had a low impedance between conductor and shield.	On April 15, 1965, the cable was meggered with a 500VDC megger. The megger test showed a satisfactory reading of over 200 megohms.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01159	Cable (9W30) 60C40240 N/A	During the performance of procedure 2-CH SIB-557 a discrepancy was discovered on measurement XE57-1 (RCC). The discrepancy was found while making system capacitance measurements. Further investigation revealed the subject cable had a low impedance between conductor and shield.	On April 14, 1965, the cable was meggered with a 500VDC megger. The megger test showed a shorted pin shield.
01160	Cable 50C03753 N/A	Prior to test SA-25, measurement E12-6 (turbine gear box vibration) indicated zero output following a LOX on board vehicle condition. Subsequent investigation revealed moisture inside a connector associated with the accelerometer cable.	Accelerometers for these measurements are mounted between the LOX pump and fuel pump. At present, the accelerometer cable to the vehicle cable is mounted directly over the LOX pump. When LOX flows through this pump, the subject cable and connector frost completely over, subjecting the cable and connector to moisture. Temporary failures have been traced to this condition. It is recommended that this cable be rerouted to avoid this frosting condition. The cable could be routed over the fuel pump. The cables associated with measurements E12-1 through E12-8 all are affected.
01161	Recessed Receptacle 50C10622 000052	Pin 6 of the dual receptacle of the center LOX tank liquid level probe reads zero ohms to ground.	Repair of this continuous level probe would require entry into the center LOX tank. Considering the magnitude of this task and its effect on the overall test schedule, repair was not attempted at Static Test.
01162	Telemeter Assembly (S1) 50M12195-1 001	Evaluation of the 15 single side band telemetry channels following tests SA-25 and SA-26 revealed an excessive amount of noise on each of the channels. Extensive bench tests revealed that the single side band package was extremely sensitive to noise on the applied +28 volts power. It was found that certain frequencies of noise on +28 volts affected all channels. Channels #1 and #2 were found to pass noise on +28 with approximately the same efficiency (same amplitude) as it would have passed if that amplitude of noise had been applied to a data input channel.	It is recommended that an efficient filter be designed and installed on this S1 package and on all other S1 packages to be installed on Chrysler built vehicles.
01163	Tape Recorder 50M10338 070	During prefiring checkout, while performing an operational test of the airborne tape recorder, the following discrepancies were noted during tape recorder playback. 1. No 120KC tape speed compensation freq. was being transmitted on channel 1. 2. Channel 1 output amplitude was approximately 4DB higher than the input level to the recorder, resulting in excessive deviation of the RF assembly. 3. Channel 2 120KC tape speed compensation amplitude was approximately 3DB too high, resulting in excessive deviation of the RF Assembly.	Tape recorder was removed from vehicle and properly adjusted by CCSD Static Test personnel. Recommend that tape recorders on future vehicles be properly adjusted in the laboratory prior to being installed on the vehicle.
01164	RF Assembly 50M12196-5 001	Evaluation of the single side band time correlation signal following SA-25 and SA-26 revealed an intermittent deterioration while the vehicle was under extreme vibration.	It is recommended that this UCR be compiled into a historical record to determine whether or not this problem will occur again.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

<table>
<tr><th>UCR NUMBER</th><th>PART NAME
PART NUMBER
SERIAL NUMBER</th><th>DESCRIPTION</th><th>REMARKS</th></tr>
<tr><td>01165</td><td>Pressure
Combustion
Chamber
50C12012
30712</td><td>On March 27, 1965, calibration pressures were applied to the transducer, and the output voltage was monitored over the DDAS (Digital Data Acquisition System) and recorded. Of 5 points (Ambient, 25%, 50%, 75%, and 100% of full scale) tested three points as shown below were out of allowed tolerance.
<table><tr><th>Applied Pressure PSIA</th><th>Voltage Output Should be</th><th>Was</th></tr><tr><td>400</td><td>2.47±0.05</td><td>2.374</td></tr><tr><td>600</td><td>3.72±0.05</td><td>3.615</td></tr><tr><td>800</td><td>4.98±0.05</td><td>4.841</td></tr></table>A new calibration curve was drawn and used for static firing only, since no replacement component was available. Good data was obtained from Test SA-26 by use of the new curve.</td><td>It is recommended that this UCR be compiled into a history of failures of this type transducer. It is further recommended that this transducer be subjected to a new bench test to determine whether or not this transducer is flight worthy. If it is flight worthy, a new calibration curve should be issued.</td></tr>
<tr><td>01166</td><td>AC Amplifier
50C10382-3
C121</td><td>It is extremely difficult to adjust the gain and bias potentiometers on the amplifier.</td><td>This condition existed on several other amplifiers and it is recommended that this condition be brought to the attention of Quality Control.</td></tr>
<tr><td>01167</td><td>Pressure
Combustion
Chamber
50M12012
30700</td><td>On March 27, 1965, calibration pressures were applied to the transducer, and the output voltage was monitored over the DDAS (Digital Data Acquisition System) and recorded. Of five points tested (Ambient, 25%, 50%, 75%, 100% of full scale), three points as shown below were out of tolerance.
<table><tr><th>Applied Pressure PSIA</th><th>Voltage Output Should be</th><th>Was</th></tr><tr><td>400</td><td>2.48±0.05</td><td>2.564</td></tr><tr><td>600</td><td>3.73±0.05</td><td>3.892</td></tr><tr><td>800</td><td>4.97±0.05</td><td>5.123</td></tr></table>A new calibration curve was drawn to be used for static firing only since no replacement component was available. Good data were obtained during test SA-26 by use of the new curve.</td><td>It is recommended that this UCR be compiled into a history record of failures of this type transducer. It is further recommended that this transducer be subjected to a new bench test to determine whether or not this transducer is flight worthy. If it is within specification, a new calibration curve should be issued.</td></tr>
<tr><td>01168</td><td>9W29 Umbilical
60C40240
N/A</td><td>Upon inspection it was found that 9W29 connector pins A and B of the lower umbilical plate Fin IV were badly pitted at the bottom of the pins.</td><td>The 9W29 connector on the vehicle should be replaced. A method is being investigated at Static Test which will draw umbilicals up tight enough to make the proper seal.</td></tr>
<tr><td>01169</td><td>Sliding Pin
30M00427
N/A</td><td>Post test inspection after SA-26 revealed that three fuel tank sliding pins were slightly galled. These pins are located on (1) Fuel tank No. 1 next to LOX tank No. 2, (2) Fuel tank No. 3 next to LOX tank No. 4, (3) Fuel tank No. 4 next to LOX tank No. 1.</td><td>The pins will be lubricated and inspected for contamination prior to each LOX loading.</td></tr>
<tr><td>01170</td><td>Measurement
Distributor
60C41000-1
C0001</td><td>While performing the initial application of power test (procedure I-CH SIB-402) on S-IB-1, it was found that the fuse in the command recorder transfer circuit was blown. In the process of trouble-shooting the circuit, it was discovered that an intermittent short to ground occurred in measuring distributor 12A26, pin D of connector J11.

The measuring distributor was removed from the vehicle and the covers removed. No short could be discovered from visual inspection or continuity checks.

Distributor 12A26 was reinstalled and the recorder transfer circuit operated properly.</td><td>It is recommended that this problem be further investigated during post static firing checkout.</td></tr>
<tr><td>01171</td><td>DC Amplifier
50M10394-137
N/A</td><td>During the simulation of the fin measurements, it was discovered that the DC Amplifier (C 547-20) was missing. This amplifier was not listed as a missing component or listed in the Shipped Short Items.</td><td>Ascertain that all components are installed on vehicle or listed in the shipped Short Item List.</td></tr>
</table>

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01172	TM Calibrator 50M12011-3 11	During prefiring checkout while performing an operational test of the single side band telemetry system, it was noted that the system would not preflight calibrate.	It is recommended that the correct wiring change be made on this calibrator and on all subsequent units. The wiring change should be in accordance with drawing 50M12011-3.
01173	Servo Actuation Assembly 60C60001 306	During pretest functional checks, slight blips were indicated simultaneously by the supply pressure trace (Measurement HP702-2), the yaw actuator control valve trace (measurement GM 104), the yaw actuator position trace (Measurement HD101-2), and the yaw actuator differential pressure trace (Measurement HP700-2) for Engine 2. Investigation revealed no discrepancies, and the above condition did not reoccur during test SA-26.	Recommend that this condition be throughly investigated upon return of the stage to Michoud.
01174	Amplifier 50M10388-15 14244	Evaluation of oscillograph records of test SA-25 revealed that measurement D1-8, pressure combustion chamber, did not respond to pressure changes. Investigation revealed that the associated signal conditioning amplifier, S/N 14244, failed to produce an output.	It is recommended that an investigation be conducted into the cause of the malfunction during post test operations. It is also recommended that this UCR be compiled into a historical record of this type malfunction.
01175	Liquid Level Adapter 50C10699 39	During SA-26 prefiring checkout, it was noted that L42-F2 could not be placed in the high cal condition. C3 and R2 on the liquid level adapter would not null and R6 would not produce a 3 level counting.	Replaced the liquid level adapter. Recommend an investigation be made on this unit by CCSD Michoud.
01176	Amplifier 50C10382-3 C152	After SA-25, the single side band telemeter record revealed that measurement E33-7 did not respond to vibrational changes.	The signal conditioning amplifier associated with E33-7 had developed a short resulting in failure of the 22.5V power supply. Replaced the amplifier and accelerometer kit. Recommend that the amplifier be returned to CCSD Michoud for investigation.
01177	Power Supply 50M10363-1 051	Following test SA-25, a test of rack power supplies was performed. At this time it was found that power supply, P/N 50M10363-1, S/N 025, produced no output. Measurements that depend upon this power supply are E11-8, E12-8, E530-22, E502-9, and E503-9. Since the measurements operated during the firing, it is believed that the power supply failed shortly after the firing.	Since this type power supply is usually associated with more than one measurement (six with this supply), its failure is considered serious; therefore, it is recommended that an investigation be conducted during post static test operations to determine cause of the failure and appropriate action taken to prevent future failures.
01178	Power Supply 50M10363-1 034	Evaluation of oscillograph records of test SA-25 revealed that measurements E11-2, Vibration thrust chamber dome, lateral, and E12-2 Vibration Turbine, Gear Box, failed during the firing. Investigation revealed that an associated 22.5 volts power supply, SN 034, produced no output voltage.	Since this type power supply is usually associated with more than one measurement, its failure is considered serious; therefore, it is recommended that an investigation be conducted during post static test operations to determine cause of the failure and appropriate action taken to prevent future failures.
01179	Power Supply 60C50071 036	Following test SA-25, power supply, part number 50C10363-1, S/N 034, was found to be defective. This power supply was replaced by spare supply, part number 60C50071, S/N 036. It was found that pin 8 of the spare power supply was not connected to case ground in accordance with drawing 60C56003.	This jumper was left out during manufacture. This jumper was installed on supply S/N 036, at STTE by a qualified technician under surveilance of Chrysler Quality Control personnel. It is recommended that Quality Control personnel at the manufacturer ensure that the jumper is installed in power supplies of this type.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01180	Power Supply 60C50071 025	Following test SA-25, power supply, P/N 50C10363-1, S/N 051, was found to be defective. This power supply was replaced by spare, P/N 60C50071, S/N 025. It was found that pin 8 of the supply, S/N 025, was not connected to case ground in accordance with drawing 60C560023.	This jumper was left out during manufacture. This jumper was installed on supply, S/N 025, at STTE by a qualified technician under surveilance of Chrysler Quality Control personnel. It is recommended that Quality Control personnel at the manufacturer ensure that the jumper is installed in power supplies of this type.
01181	Interconnect Cable 50C10225 C006	While making a visual inspection of the vehicle instrumentation after SA-25, it was discovered that the interconnect cable for Measurement C61-2 located on the flame shield on Engine 2 near the zone box had the insulation damaged and the wire was exposed.	Once a slight break occurs on this insulation, it unravels very easily. It is recommended that zone boxes be used that have a more ruggedized insulation.
01182	Accelerometer 50C10105 240	During prefiring checkout it was noted that the output wave form of the amplifier associated with E33-1 (longitudinal thrust chamber dome vibration) was extremely distorted when system was placed in the high cal condition.	Replaced the accelerometer - amplifier kit. Recommend that the accelerometer - emitter follower unit be returned to CCSD Michoud for investigation.
01183	Zone Box 50C10402-1 Unknown	During removal of the GG combustion chamber temperature measurement C9-8, it was noted that the associated zone box had no reference designator number.	Ascertain that all reference designators numbers are installed during manufacturing.
01184	Thermocouple 50C10340 RA0087	Following removal of the gas generator temperature thermocouple (measurement C9-1) the braided insulation was found damaged near the probe, being frayed approximately 1/4 inch. These probes are removed to prevent possible probe deterioration during static firing.	In the future these probes will not be removed at Static Test since the flight probes are enclosed in a stainless steel encasement.
01185	Cable 50C03753-1 N/A	During SA-26 prefiring checkout, it was noted that Pin D of the interconnect cable located between the transducer and vehicle harness was open.	A temporary repair was made to check-out E12-8. Recommend that CCSD Michoud replace or repair the cable.
01186	Container Unit Assembly, Fuel 3 60C10011-1 N/A	During stage removal from the Static Test Tower it was discovered that fuel tank F-3 had 5 ripples in the side of the tank. The attached sketch and photographs describe the ripples.	Similar ripples were noted on stage S-I-10 after S-IB-1 had undergone (1) erection, (2) propellant loading test (fuel and LOX), (3) LOX loading (without fuel onboard), and (4) short duration firing. A visual inspection prior to the long duration firing from approximate stage station 200 and 770 did not indicate ripples at this time.
01187	Strain Gage C12-141-R2T N/A	Upon arrival of S-IB-1 at STTE, an initial automatic scan of measurements was performed. At this time it was found that measurement S541-11 strain, radial, produced no output. Investigation revealed that the gage, P/N C12-141-R2T, was faulty.	It is recommended that the faulty gage be replaced during post static test operations at Michoud.
01188	Strain Gage C12-141-R2VC N/A	After SA-25 the telemetry records revealed that S 527-11 (Strain Cross Beam) did not have an output.	It is recommended that CCSD Michoud replace the faulty gage and investigate its failure.
01189	Strain Gage C-12-141-R2VC N/A	After SA-25 the telemetry records revealed that S-540-11 (Strain Residual) did not have an output.	It is recommended that CCSD Michoud replace the faulty gage and investigate its failure.

APPENDIX F

UNSATISFACTORY CONDITION REPORT (CONTINUED)

UCR NUMBER	PART NAME PART NUMBER SERIAL NUMBER	DESCRIPTION	REMARKS
01190	Measurement Rack Assembly 60C50048-5 N/A	During post static firing (SA-25) checks, it was noted on the oscillograph records that the vibration measurements using 22.5 v dc dropped out at ignition +9 seconds. An investigation revealed no power supply failure. However, during the long duration firing (SA-26) vibration measurements dropped out at ignition +23 seconds. A post firing investigation revealed pin 2 bent in the measuring rack amphenal connector, channel 10. This channel is occupied by the measurement T12-4. The 22.5 v dc power supply can be made intermittent by the turbine rpm module T12-4.	Ascertain a better Quality Control of measuring racks during manufacturing.
01191	Bearing Heim Spher HMFX - 12 G N/A	During transportation of stage SA-201 from the Static Test Tower to the barge, control of the left wheel on the rear dolly was lost. The difficulty was found to be a broken "bearing Heim spher" on the steering cylinder. The "bearing heim spher" is a clevis which attaches the steering cylinder shaft to the wheel steering arm.	The clevis (bearing Heim spher) had failed completely in tension, pulling completely free from the wheel steering arm. Closer inspection of the failed part indicated a partial fracture had occurred at an earlier date.
01192	Liquid Level Probe 50M10205 N/A	This UCR revises UCR No. 01117 dated April 22, 1965. Block No. 49, description of condition, should be corrected to read as follows: "On 4-6-65 it was noted during a FM/FM telemeter scan that pulse 1 of the fuel discrete level measurement L20-F4 was missing. Investigation of the missing pulse revealed that the solar cell output voltage was zero".	NOTE: UCR 01117 was subsequently reissued in a "CORRECTED COPY". UCR 01192 was cancelled.
01193	Digital Data Acquisition System N/A	The output of the Switch Selector (Flight Measurement K1-12 is an analog signal of 2.5 VDC under normal conditions for a count of the Switch Selector. However, if a malfunction occurs, this output will increase to approximately 4.5 VDC. This voltage is then converted to digital form and fed to the DDAS ground station as a 10-bit work where each bit eventaully energizes a relay in the Relay Driver Panel. The ESE control panel in turn sees this operation as a count when Bit # 1 relay only is energized, but as a malfunction if both Bit # 1 and # 2 relays are energized. During S-IB-1 pre-firing checks a malfunction indication was being received intermittently.	A change to the Switch Selector to provide a count signal of approximately 2.2 VDC instead of the 2.5 VDC modification to the DDAS ground station should be considered.

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