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SYCAMORE TEST REPORT

TR-S1-301-A1-02

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Base Manager

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1.0 INTRODUCTION

The first static firing of a "C" series missile, Run S1-301-A1-02 (301) was successfully conducted at Sycamore Stand 1, on 12 November 1958. The primary purpose was a missile-facility shakedown to prepare for longer duration tests.

The major differences between the 2C and the flight missiles was the addition of a lead ballasted nose cone and the absence of RF and Telemetry systems on Missile 2C.

Prior to the first run an accumulator was installed in the pneumatic sensing line to the sustainer LO_2 liquid regulator. The purpose of this modification was to damp characteristic oscillations in the pneumatic reference regulator pressure.

Spurious engine cutoffs were obtained during checkouts of the sustainer overspeed filter unit. To overcome this a unit was reworked by Rocketdyne and supplied as a prototype unit.

Scheduled run durations were Booster and Sustainer 5 seconds and Vernier 8 seconds. The PU valve was held in the null position during the test. There was no thrust chamber gimbaling. Fuel was tanked to the 150 cu ft. ullage level and LO_2 was tanked to a calculated 2.25 mass ratio based on load cell readings.

Run 301 successfully accomplished test 1 of Test Plan ZB-7-037 Revision '. Run S1-302-A2-02 (302) is currently scheduled for 24 November 1958.

2.0 Summary

2.1 Run S1-301-A1-02, the first static test on "C" series missile configuration was sucessfully conducted at Sycamore Stand 2, Missile 2C on 12 November 1958.

2.2 The following systems performed satisfactorily:

Airframe	Electrical
Propulsion	Flight Control
Pneumatics	Instrumentation
Hydraulics	

2.3 The only hardware damage sustained was a 12' crack in the inner surface of the main flame deflector due to LO_2 start tank venting (Ref. section 5.7).

2.4 The C series flight missile tanking procedure was not evaluated due to failure of the 95% fuel sensor probe to interlock the PU null error panel meter (Ref. section 5.3). The fuel vibrotron malfunctioned and was removed from the missile just prior to the run (See section 5.3 for details).

2.5 Missile-facility compatibility and the ability of the thinner skinned C series propellant tanks to withstand a static firing environment were established.

2.6 The Convair modified FM recording system was utilized for the first time at Sycamore. All measurements on both AM and FM recorders were calibrated by the scale factor method. Recovered data represented 96% of the instrumentation attempted.

3.0 OBJECTIVE LIST

OBJECTIVE Number	Description	Number Runs Required	Run 301-A1
AL70	Structural Integrity	4	Yes
AL71	Ability of fuel tank to withstand thrust and gimbal loads	3	Yes
Propulsion			
PB22	Propulsion-Airframe Compatibility	3	Yes
PH42	Propulsion System Performance	4	Yes
PH65	Start & Operational Characteristics	1	Yes
PN01	Propellant Tanking Procedures	2	No
PN02	Thrust rise-decay	5	Yes
Propellant Utilization			
UNC5	PU null error & tanking sensor control of tanking	2	No
Pneumatics			
FH70	A/B Pneumatic system performance	3	Yes
Electrical			
EB21	Missile-facility system compatibility	2	Yes
General			
LA31	Main flame deflector study	3	Yes
NH30	Adequacy of facility instrumentation	2	Yes
OK30	Reliability study	4	Yes

4.0 CONFIGURATION TABLE

Test Number	Run 301-A1			
	Ground	Airborne		
Pneumatic System	X	X		
Electrical System				
Hydraulic System		X		
Propellant Utilization System				
PU valve nulled	X			
PU valve Programmed				
Closed Loop				
Flight Control System				
Thrust Chambers Nulled	X			
Thrust Chambers Programmed				
Flight Programmer				
C/O, Staging & Switching				
Run Durations	Scheduled		Actual	Total
Booster	5		5.05	5.05
Sustainer	5		5.07	5.07
Vernier	8		7.63	7.63

5.1 Airframe

5.1.1 The two airframe objectives accomplished during this run were as follows:

5.1.2 AL70 Verify the structural integrity of the thin-walled propellant tank section during a static test environment.

5.1.3 AL71 Determine the ability of the thin wall section of the aft bulkhead (apex structure) of the fuel tanks to adsorb the engine thrust load transmitted through the sustainer thrust cone.

5.1.4 Visual inspection of the missile following the test revealed no signs of structural damage or deformation to the missile airframe. The propellant tanks were pressurized and leak checked with satisfactory results. A visual inspection of the fuel tank apex thrust cone with the missile demated revealed no damage or deformation. Strain gage data are not available at this time, however, figure 5.1-1 presents a photographic reproduction of strain measurement traces recorded during the run.

5.2 Propulsion System Performance

5.2.1 There were three primary test objectives for the propulsion system. The first was to perform initial evaluation of propulsion systems compatibility with the airframe and other missile systems (PB22).

5.2.1.1 Compatibility of the propulsion system with the airframe and other missile systems was determined by evaluating the effect of mainstage operation on these systems.

5.2.1.2 There was no apparent adverse effect on any system due to the operating of the propulsion system or the thrust loads imposed during mainstage. Visual inspection of the airframe following the run revealed no structural damage. Although no electrical system measurements were recorded, panel meter readings during the run did not indicate any unusual loads were imposed on the electrical system by the propulsion system. Booster and sustainer control pressures were satisfactorily maintained by the airborne pneumatic system.

5.2.2 The second objective was to determine the start and operational characteristics, and the mainstage transition performance of the propulsion system during the first firing (PH42 & 65).

5.2.2.1 Booster engine performance was satisfactory although somewhat below nominal. B1 and B2 chamber pressures were recorded as 495 psig and 507 psig respectively compared to a nominal of 515 psig. A pump speed for B2 was not obtained due to an instrumentation problem. B1 was 6180 RPM (See Figure 5.2.1-1). Booster gas generator operation was normal with the exception of chamber pressure which recorded 520 psig (nominal 450). Gas generator propellant flows and outlet temperatures were nominal (See Figure 5.2.1-2). LO_2 regulator reference was 515 psig during the run as compared to the nominal setting of 520 psig.

5.2.2.2 Sustainer engine performance cannot be fully evaluated due to the loss of pump speed data. Sustainer chamber pressure surged above nominal (680 psig) during transition to a maximum of 780 psig at 1.3 seconds. Pressure then decreased reaching a steady state value of 615 psig at approximately 2.4 seconds. This overshoot in chamber pressure was accompanied by similar rises in both the sustainer LO_2 and fuel injection manifold pressures. (See Figures 5.2.2-1 & 5.2.2-2). Sustainer gas generator LO_2 regulator pressure spiked to approximately 790 psig at 0.9 seconds, returning to a steady state value of 730 psig in 0.6 seconds. This surge of 60 psig was lower than those obtained on previous B series runs where surges of 125 psig were encountered. However, investigation will be continued on subsequent runs to evaluate the erratic behavior during the starting transient. The gas generator discharge temperature pegged the recorder for 0.9 seconds after cutoff. Post run inspection of the SGG LO_2 purge revealed a bronze chip blocking the orifice in the pressurizing valve. This resulted in a pressure at the check valve inlet of 18 psig (nominal 75 psig $\pm$ 25). This is considered to be a contributing cause for the temperature surge at cutoff. (See Figure 5.2.2-3).

5.2.2.3 Evaluation of the vernier engine performance cannot be made due to the loss of pertinent vernier instrumentation. (See Figure 5.2.3-1)

5.2.2.4 The starting and shutdown sequence of the propulsion system was satisfactory as can be seen by the valve timing data chart on page 5-3 The Sustainer HS valve operation was satisfactory. The PU valve was late in going on control at 2.02 seconds and had only moved to 34.5° at cutoff instead of the nominal angle of 30.4°. The indication of late control may be due to microswitch maladjustment. The HS valve went on control properly at 1.7 seconds, moved to 26.9° at 2.5 seconds and then reopened to 30.9° at cutoff. The action of the HS valve in reopening was in direct response to the steady closing of the PU valve.

5.2.3 The third objective was to determine the propulsion system thrust rise and decay rates and the effects of these rates on the tanked propellants missile structure, and the launcher hold down mechanisms (PN02).

5.2.3.1 B1 thrust rise and decay rates were 0.15 seconds and 0.16 seconds respectively. High speed playback readings of B2 thrust chamber pressure are unavailable at the present time and will be evaluated later. Sustainer thrust rise rate was 0.1 seconds with a decay rate of 0.13 seconds. There was no adverse effect on the propellants, missile structure,or launcher hold down mechanism due to the rapid build up and decay of thrust.

5.2.4 An accumulator was installed in the pneumatic sensing line to the sustainer LO_2 liquid regulator. The installatinn, consisting of a 12 cu in ullage tank located between the LO_2 liquid reference regulator and the vent solenoid, was in accordance with GMA 1305. The purpose of the installation was to dampen the pressure surge transient in the LO_2 liquid reference regulator system. Recorded data indicated that the starting surge transient was reduced to approximately 50% of the surges recorded on B series tests conducted at Sycamore.

VALVE TIME DATA
(All Times in Seconds)

VALVE	SEQUENCE		TEST VALUE	SPECIFICATION
BGG BLADE VALVE	1. BGG valve opening control signal until valve reaches full open.		0.56	0.40 to 0.60
	2. BGG valve closing control signal until valve reaches full closed.		0.10	0.05 to 0.14
B1 & B2 MAIN PROP VALVES	3. MLV opening control signal until MLV reaches full open.	No. 1 MLV	0.33	0.30 to 0.46
		No. 2 MLV	0.18	0.18 to 0.26
	4. MLV closing control signal until MLV reaches full closed.	No. 1 MLV	0.38	0.37 to 0.55
		No. 2 MLV	(0.36)	0.37 to 0.55
	5. MFV opening control signal until MFV reaches full open (To be less than item 1 above)	No. 1 MFV	0.25	0.23 to 0.35
		No. 2 MFV	0.25	0.23 to 0.35
	6. MFV closing control signal until MFV reaches full closed	No. 1 MFV	0.29	0.29 to 0.43
		No. 2 MFV	0.29	0.29 to 0.43
	7. LO_2 rich after cutoff. MLV closing time minus MFV closing time.	No. 1 Valve	0.09	0.05 to 0.15
		No. 2 Valve	0.08	0.05 to 0.15
SGG BLADE VALVE	8. SGG valve opening control signal until valve reaches full open		0.37	0.27 to 0.41
	9. SGG valve closing control signal until valve reaches full closed.		0.06	0.06 to 0.09
SUST. MAIN PROP VALVES	10. S MLV opening control signal until valve reaches full open.		(0.37)	0.24 to 0.36
	11. S MLV closing control signal until MLV reaches full closed.		NA	0.24 to 0.32
	12. S MFV opening control signal until MLV reaches full open (To be less than Item 8 above)		0.33	0.22 to 0.34
	13. S MFV closing control signal until MFV reaches full closed.		NA	0.24 to 0.32

( ) Values do not meet specification.

Propulsion System Time Slice Data

Booster

Meas. No.	Description	Nominal or Redline/R	X-0	X+1	X+3	X+5
P1083B	B2 Pump Speed	6170 RPM		6180	6180	6180
P1003P	B2 LO_2 Pump In	41 PSIG	55	41	42	42
P1004P	B2 Fuel Pump In	43 PSIG	59	46	49	49
P1010P	B1 Lube Oil Man	550 PSIG/R	4	4	904	900
P1026P	B LO_2 Reg Ref	520 PSIG	512	549	515	515
P1059P	B2 Thrust Chamber	515 PSIG	0	495	507	507
P1060P	B1 Thrust Chamber	515 PSIG	3	488	495	496
P1075P	G Fuel Start Tank	800 PSIG	790	775	-	-
P1093P	B1 Fuel Inj Man	600 PSIG	1	37	573	573
P1094P	B2 Fuel Inj Man	600 PSIG	14	447	610	610
P1100P	BGG Comb Chan	450 PSIG	-	563	518	518
P1177P	B LO_2 Tank Reg	500 PSIG	509	501	504	503
P1178P	G Fuel St Tk Reg	800 PSIG	803	805	905	886
P1489P	BGG LO_2 Vlv In	500 PSIG	536	555	533	533
P1037R	BGG LO_2 Flow	5.9 lb/sec	0	6.54	5.89	5.94
P1051R	BGG & Ign Fuel	19.5 lb/sec	3.14	20.4	18.6	18.6
P1018T	B1 Turbine In	1400 DEG F/R	78	1240	1255	1262
P1209T	B2 Turbine Brg	600 DEG F/R	70	70	70	72
P1213T	B1 Turbine Brg	600 DEG F/R	67	67	67	80
P1126T	B1 LO_2 Pump Otbd Brg	DEGF	94	94	94	94
P1127T	B2 LO_2 Pump Otbd Brg	DEGF	99	99	99	99

Sustainer

Meas. No.	Description	Nominal or Redline/R	X-0	X+1	X+3	X+5
P1528D	S Main Fuel Vlv	20°/R				34.5@40
P1529D	S Main LO_2 Vlv	35°		82.6	27.4	30.9
P1006P	S Thrust Chamber	682 PSIG		154	626	624
P1055P	S Fuel Pump In	56 PSIG	64	48	47	58
P1056P	S LO_2 Pump In	41 PSIG	58	37	49	77
P1332P	S LO_2 Pump Dis	1050 PSIG/R		835	900	880
P1339P	SGG Disch	610 PSIG	0	371	556	556
P1341P	S Lube Pump Gear	400 PSIG/R		646	772	772
P1344P	S LO_2 Reg Ref	745		788	730	730
P1350P	S Fuel Inj Man	730 PSIG		744	684	670
P1351P	S LO_2 Inj Man	802 PSIG		720	665	682
P1375P	S Ign Fuel Inj Man	PSIG	240	145	671	693
P1007R	S Fuel Flow	82 lb/sec		73	91	90
P1008R	S LO_2 Flow	184 lb/sec		153	172	169
P1333R	SGG LO_2 Flow	1.78 lb/sec		1.5	1.46	1.58
P1334R	SGG Fuel Flow	6.25 lb/sec		1.5	6.71	7.04
P1323T	S Turbine Brg	750 DEGF/R	60	60	62	70
P1324T	S LO_2 Pump Brg	300 DEGF/R		48	49	52
P1336T	SGG Disch	1400 DEGF/R		1200	1200	1150

Vernier

Meas. No.	Description	Nominal	X-4	X-1	X+3	X+5
P1027P	Vernier Fuel Tank	535 PSIG	539	540	VENT	--
P1030P	Vernier LO_2 Tank	520 PSIG	560	552	VENT	--
P1049P	V1 Fuel In	630 PSIG	510	445	587	605
P1050P	V2 Fuel In	630 PSIG	509	437	588	588
P1235P	V LO_2 Tk Reg Out	520 PSIG	564	553	548	537
P1236P	V Fuel Tk Reg Out	535 PSIG	554	558	566	561
P1042R	V LO_2 Flow	5.9 lb/sec	-	4.1	6.0	6.0
P1043R	V Fuel Flow	3.3 lb/sec	-	3.0	-	3.3

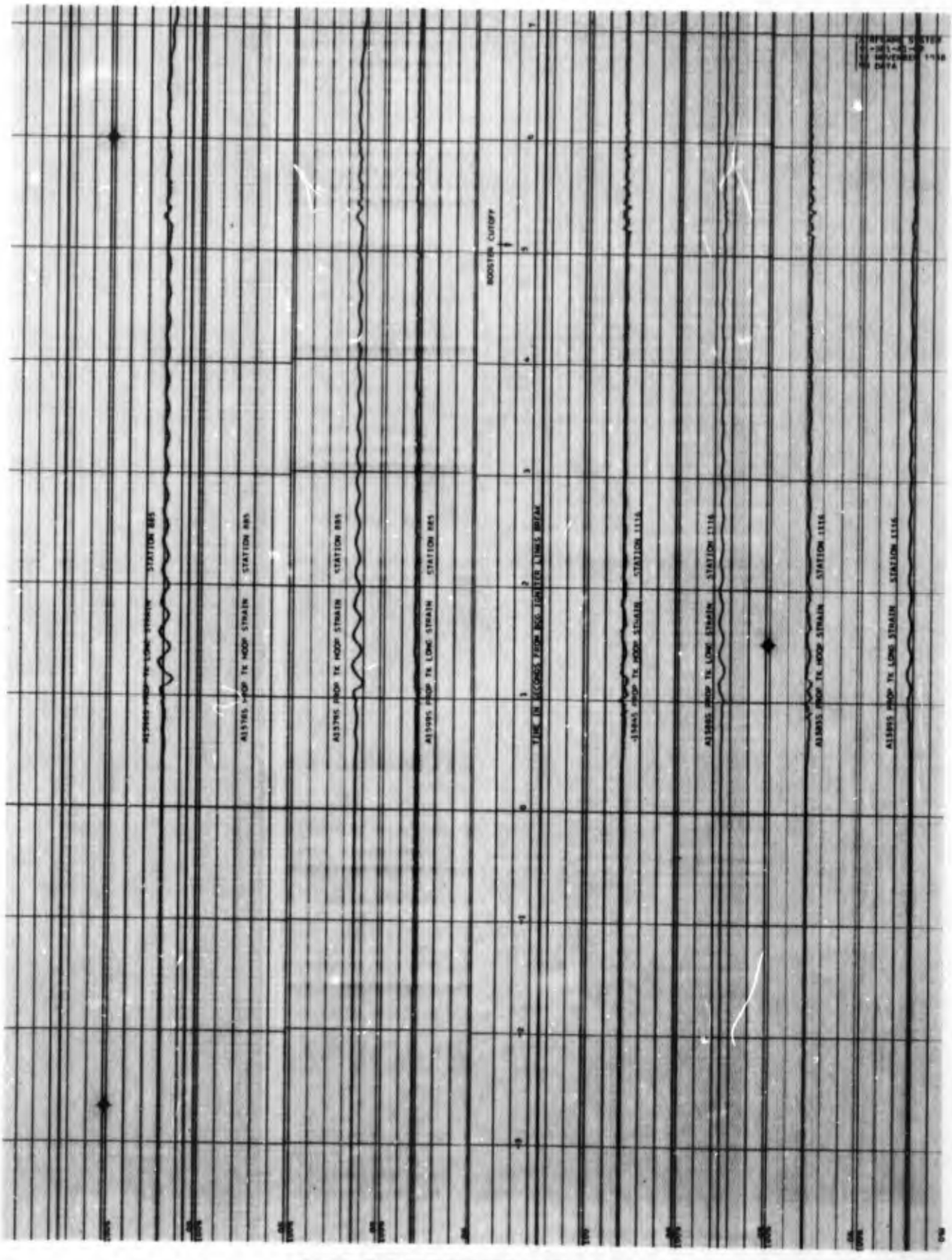

Figure 5.1-1

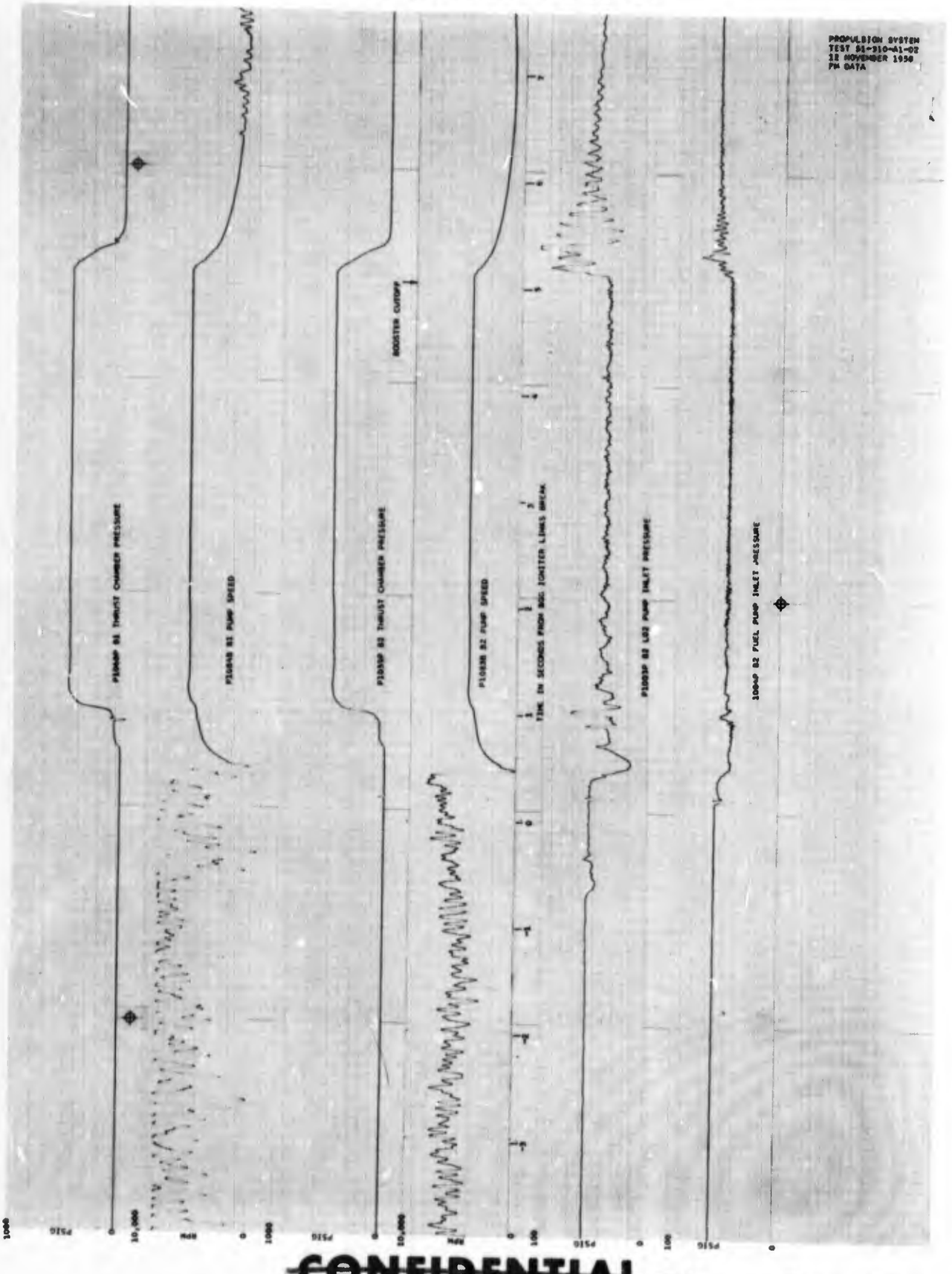

Figure 5.2.1-1

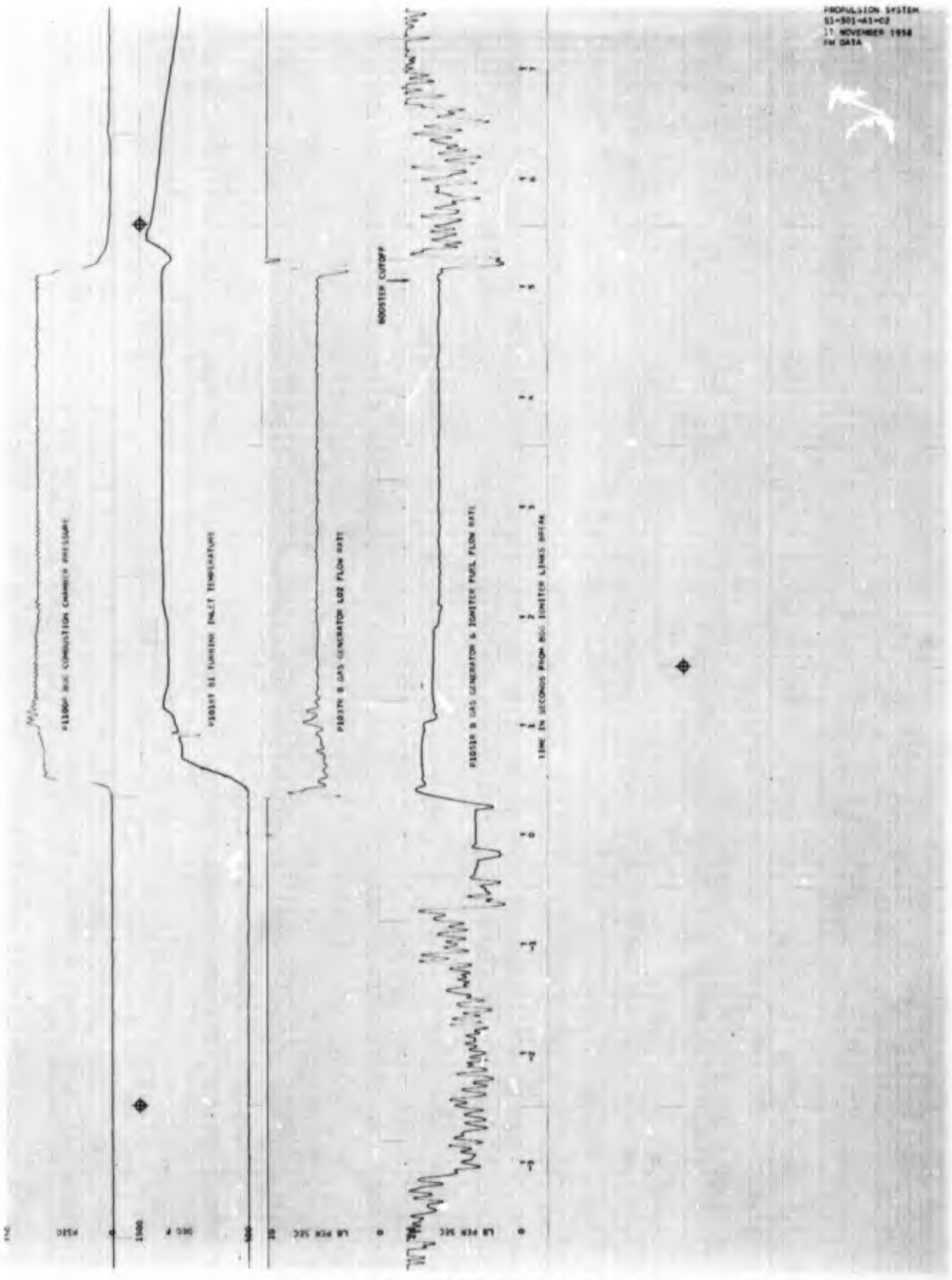

Figure 5.2.1-2

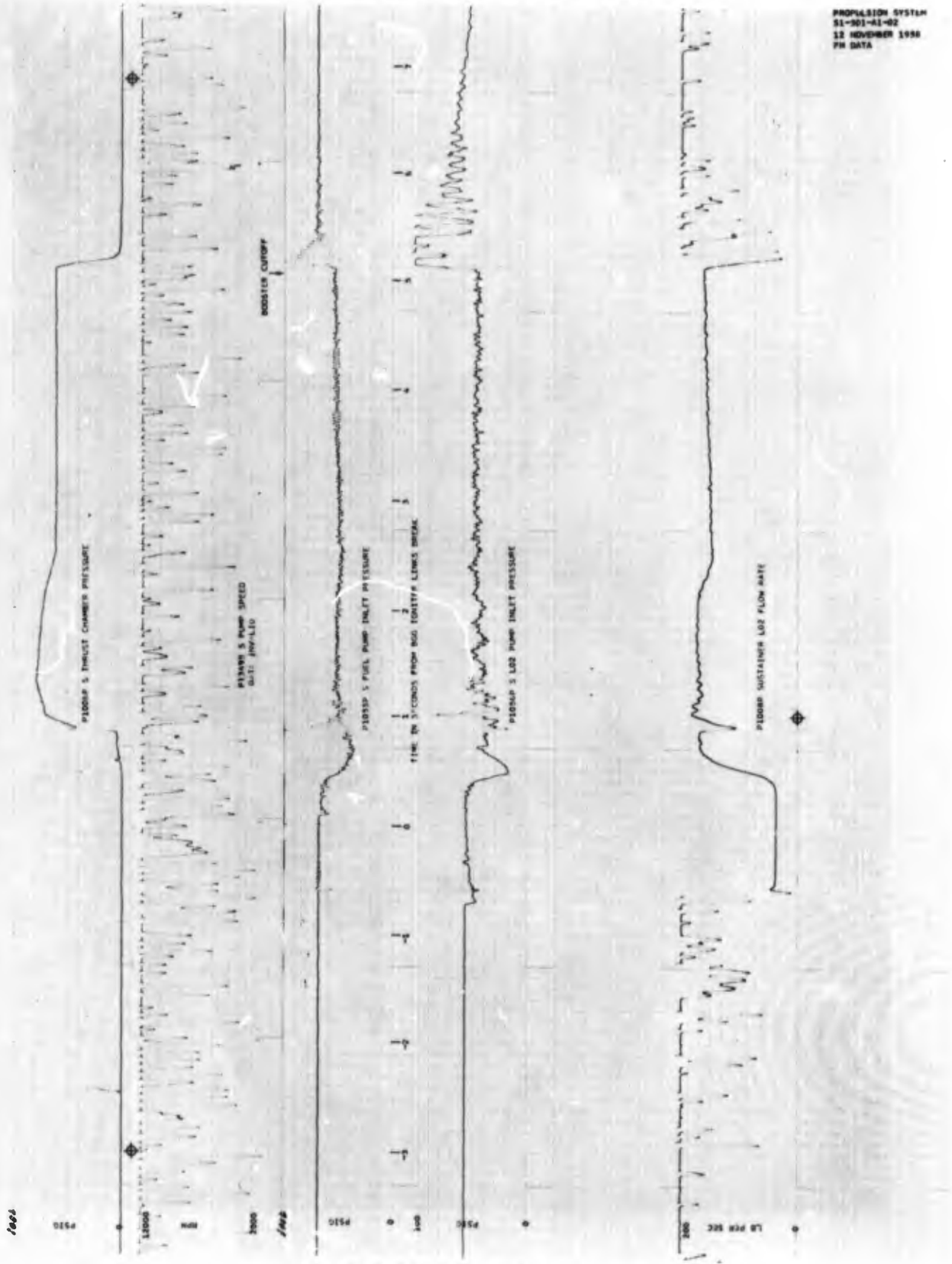

Figure 5.2.2-1

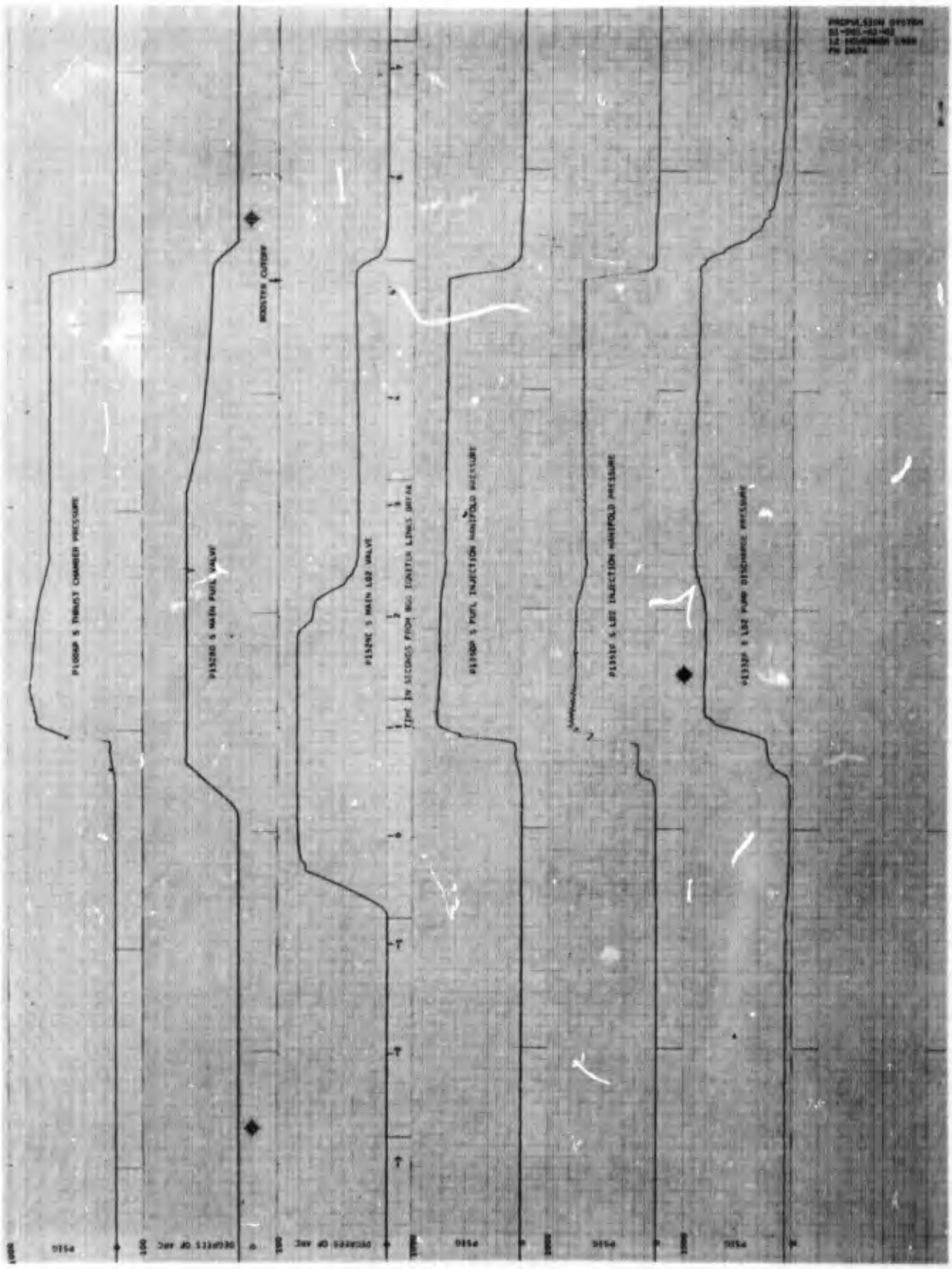

Figure 5.2.2-2

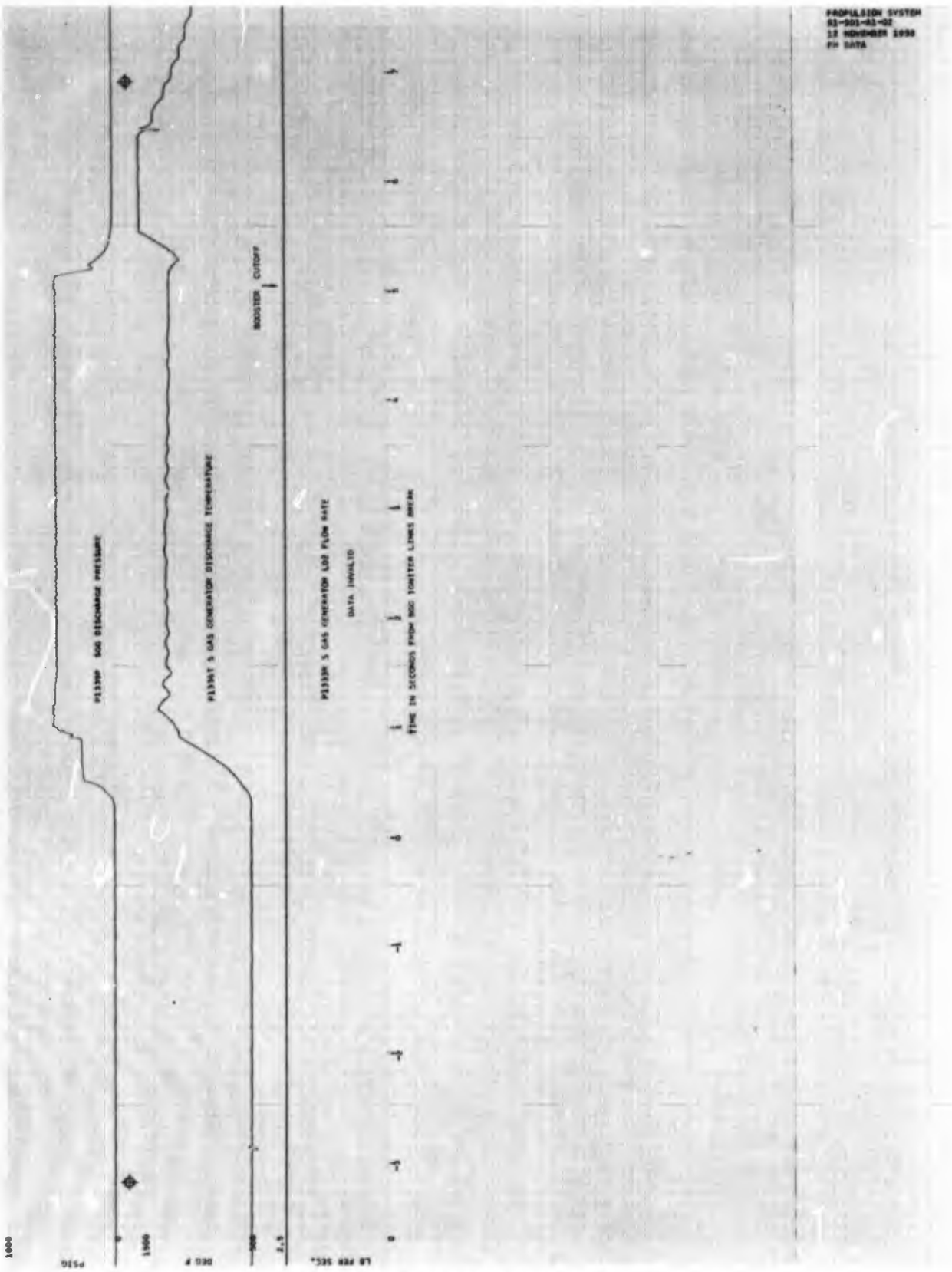

Figure 5.2.2-3

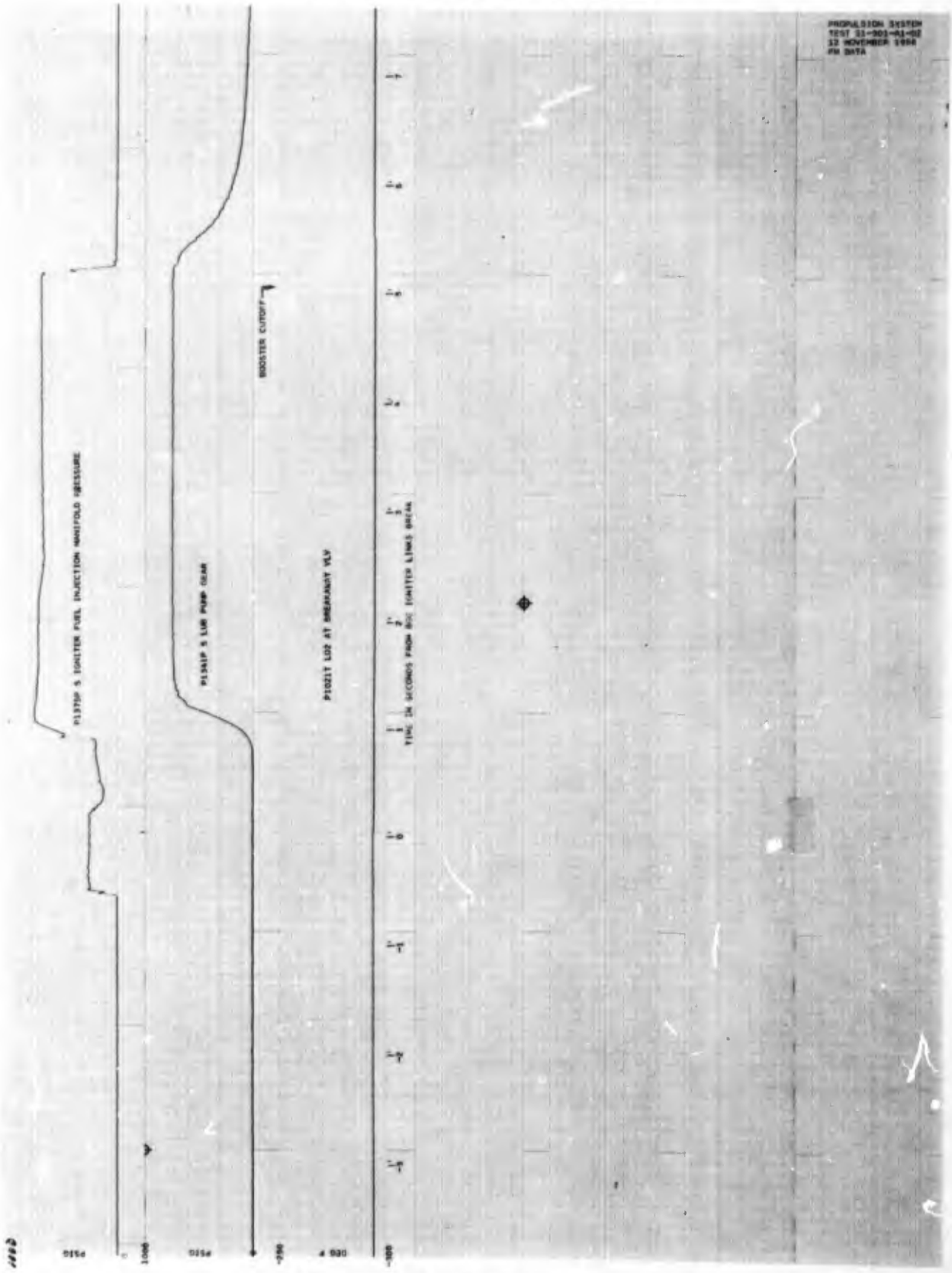

Figure 5.2.2-4

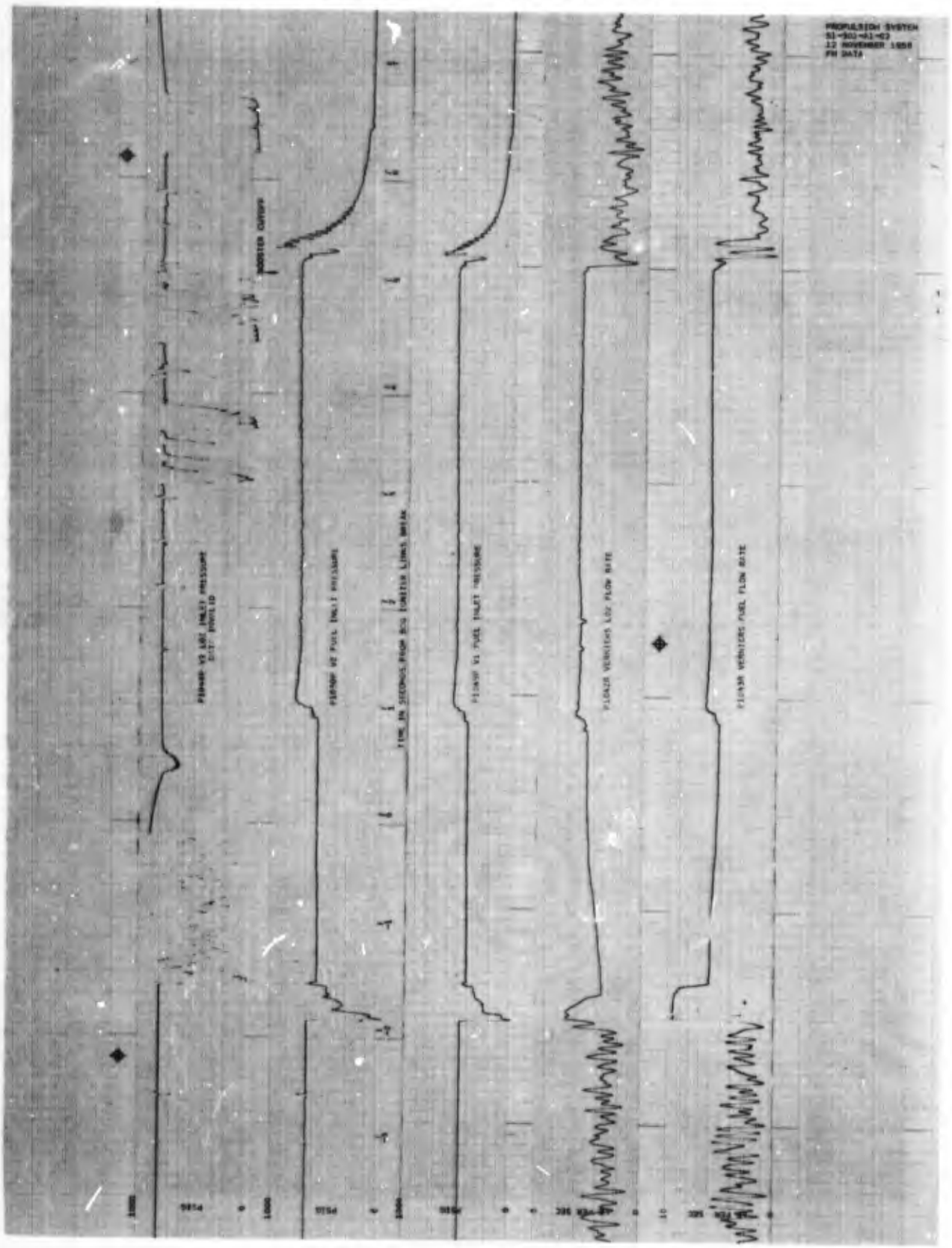

Figure 5.2.3-1

E.A.PEN TIME SEQUENCE
S1-301-A1-02
13 NOVEMBER 1958
ZERO TIME 48.71

TIME	PEN	MEAS #	DESCRIPTION	ACT	DACT
-23.50	12	P1575X	PRE START READY	X	
-12.42	29	P1161X	TCC VERN ENG STR SW	X	
-12.41	25	P1096X	VERN TKS PRES RELAY	X	
-12.41	27	P1078X	VERN LO2 TK PRES SOL	X	
-12.40	23	P1135X	PROP S T PRES RELAY	X	
-12.40	24	P1427X	VERN LO2 VENT CONT		X
-12.40	26	P1079X	VERN FUL TK PRES SOL	X	
- 4.62	20	P1186X	TCC FUEL S T FULL LT		X
- 2.59	30	P1568X	STRT TKS PRESS TIMER	X	
- 2.57	28	P1516X	VERN SQUIBS FIRING	X	
- 2.00	31	P1165X	VERN ENG LOKIN RELAY	X	
- 2.00	32	P1167X	VERN PV OPEN CTL	X	
- 2.00	131		SPARE	X	
- .99	39	P1510X	TCC VERN COMPLETE LT	X	
- .98	36	P1166X	B6S FUEL INJ PRG SOL	X	
- .80	45	P1139X	B LO2 V OPEN CTL SOL	X	
- .80	112	P1512X	B2 LO2 V CLOS CTL SOL	X	
- .80	113	P1149X	B1 LO2 V CLOS CTL	X	
- .78	66	P1506X	S ING FUEL V OPN CTL	X	

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-	.78	67	P1196X	SUSTAINER HSV SOL B	X	
-	.78	74	P1197X	SUSTAINER HSV SOL A	X	
-	.72	68	P1199X	S LO2 HSV CLOSED MSW		X
-	.70	43		SPARE		X
-	.70	48	P1067X	B2 LO2 VLV CLSD MSW		X
-	.67	46	P1068X	B1 LO2 VLV CLSD MSW		X
-	.62	49	P1169X	B2 LO2 VLV OPEN MSW	X	
-	.47	47	P1170X	B1 LO2 VLV OPEN MSW	X	
-	.41	69	P1198X	S LO2 HSV OPEN MSW	X	
-	.32	44	P1397X	GG SQUIBS TIMER	X	
-	.31	50	P1142X	TCC IGN COMPLETE LT	X	
-	.20	44	P1397X	GG SQUIBS TIMER		X
	.00	51	P1143X	B GAS GEN IGN LINK		X
	.01	57	P1145X	BGG VLV OPEN CTL SOL	X	
	.01	115	P1146X	BGG VLV CLOS CTL SOL	X	
	.01	116	P1595X	SGG VLV CLOSING SOL	X	
	.02	52	P1148X	B FUEL VLV OPEN CTL SOL	X	
	.02	114	P1150X	B FUEL VLV CLOS CTL	X	
	.03	75	P1201X	SUSTAINER PUV SOL E	X	
	.03	77	P1587X	S GG VLV OPEN CTL	X	
	.04	56	P1166X	B&S FUEL INJ PRG SOL		X
	.04	71	P1200X	SUSTAINER PUV SOL F	X	
	.09	78	P1335X	SGG VALVE CLSD MSW		X
	.10	58	P1071X	BGG VLV CLOSED MSW		X
	.15	53	P1070X	B1 FUEL VLV CLSD MSW		X
	.15	55	P1069X	B2 FUEL VLV CLSD MSW		X

.27	54	P1194X	B1 FUEL VLV OPEN MSW	X	
.27	56	P1195X	B2 FUEL VLV OPEN MSW	X	
.36	73	P1202X	S FUEL PUV OPEN MSW	X	
.40	79	P1499X	SGG VLV OPEN MSW	X	
.51	72	P1203X	S FUEL PUV CLSD MSW		X
.57	59	P1147X	BGG VLV OPEN MSW	X	
.70	42	P1299X	B IGN DETR DELAY-PU	X	
1.57	27	P1078X	VERN LO2 TK PRES SOL		X
1.71	35	P1302X	B FUEL VLV OPEN TIMER		X
1.72	22	P1503X	GFST VENT CTL		X
1.73	23	P1135X	PROP S T PRES RELAY		X
1.74	64	P1303X	S FUEL VLV OPEN TIMER	X	
1.76	26	P1079X	VERN FUL TK PRES SOL		X
1.76	67	P1196X	SUSTAINER HSV SOL B		X
1.76	71	P1200X	SUSTAINER PUV SOL F		X
1.76	131		SPARE		X
1.77	25	P1096X	VERN TKS PRES RELAY		X
1.82	69	P1198X	S LO2 HSV OPEN MSW		X
2.02	73	P1202X	S FUEL PUV OPEN MSW		X
2.05	95	ST008X	90% FUEL TANK SENSOR		X
2.15	63	P1441X	B IGN STAGE TIMER	X	
5.03	128		SPARE	X	
5.04	103	P1561X	B LO2 REF REG VENT	X	
5.05	11	P1137X	ETP PREP COMPLETE LT		X
5.05	28	P1516X	VERN SQUIBS FIRING		X
5.05	29	P1161X	TCC VERN ENG STR SW		X

5.05	60	P1072X	B COF RELAY LOCKIN	X	
5.05	105	P1592X	BOOSTER ENG CUTOFF	X	
5.05	112	P1512X	B2 LO2 V CLOS CTL SOL		X
5.05	115	P1146X	BGG VLV CLOS CTL SOL		X
5.06	12	P1575X	PRE START READY		X
5.06	42	P1299X	B IGN DETR DELAY-PU		X
5.06	45	P1139X	B LO2 V OPEN CTL SOL		X
5.06	50	P1142X	TCC IGN COMPLETE LT		X
5.06	57	P1145X	BGG VLV OPEN CTL SOL		X
5.06	63	P1441X	B IGN STAGE TIMER		X
5.06	91	P1155X	OBSERVER CUTOFF	X	
5.06	107	P1598X	VERNIER ENG CTOF	X	
5.06	113	P1149X	B1 LO2 V CLOS CTL		X
5.06	114	P1150X	B FUEL VLV CLOS CTL		X
5.06	133		SPARE	X	
5.06	137		SPARE	X	
5.07	31	P1165X	VERN ENG LOKIN RELAY		X
5.07	32	P1167X	VERN PV OPEN CTL		X
5.07	35	P1302X	B FUEL VLV OPEN TIMER		X
5.07	52	P1148X	B FUEL VLV OPEN CTL SOL		X
5.07	80	P1347X	S COF RELAY LOCKIN	X	
5.07	102	P1582X	S LO2 REG VENT V CTL	X	
5.07	106	P1593X	SUSTAINER ENG CUTOFF	X	
5.08	38		SPARE	X	
5.08	64	P1303X	S FUEL VLV OPEN TIMER		X
5.08	66	P1586X	S ING FUEL V OPN CTL		X

5.08	75	P1201X	SUSTAINER PUV SOL E		X
5.08	77	P1587X	S GG VLV OPEN CTL		X
5.08	116	P1595X	SGG VLV CLOSING SOL		X
5.09	30	P1568X	STRT TKS PRESS TIMER		X
5.09	39	P1510X	TCC VERN COMPLETE LT		X
5.10	74	P1197X	SUSTAINER HSV SOL A		X
5.13	49	P1169X	B2 LO2 VLV OPEN MSW		X
5.13	59	P1147X	BGG VLV OPEN MSW		X
5.13	79	P1499X	SGG VLV OPEN MSW		X
5.14	78	P1335X	SGG VALVE CLSD MSW	X	
5.15	47	P1170X	B1 LO2 VLV OPEN MSW		X
5.15	54	P1194X	B1 FUEL VLV OPEN MSW		X
5.15	56	P1195X	B2 FUEL VLV OPEN MSW		X
5.15	58	P1071X	BGG VLV CLOSED MSW	X	
5.18	72	P1203X	S FUEL PUV CLSD MSW	X	
5.20	68	P1199X	S LO2 HSV CLOSED MSW	X	
5.22	91	P1155X	OBSERVER CUTOFF		X
5.34	53	P1070X	B1 FUEL VLV CLSD MSW	X	
5.34	55	P1069X	B2 FUEL VLV CLSD MSW	X	
5.41	43		SPARE	X	
5.41	48	P1067X	B2 LO2 VLV CLSD MSW	X	
5.43	46	P1068X	B1 LO2 VLV CLSD MSW	X	
6.09	91	P1155X	OBSERVER CUTOFF	X	
7.32	91	P1155X	OBSERVER CUTOFF		X
8.42	7	P1443X	LO2 PRE VALVE OPEN		X
8.49	3	P1445X	B FUEL PRE VLV OPEN		X

9.35	2	P1446X	B FUEL PRE VLV CLSD	X	
9.36	4	P1580X	S FUEL PRE VLV CLSD	X	
10.02	128		SPARE		X
10.29	51	P1149X	B GAS GEN IGN LINK	X	
10.30	24	P1427X	VERN LO2 VENT CONT	X	
10.30	60	P1072X	B COF RELAY LOCKIN		X
10.30	80	P1347X	S COF RELAY LOCKIN		X
10.32	103	P1561X	B LO2 REF REG VENT		X
10.32	106	P1593X	SUSTAINER ENG CUTOFF		X
10.36	102	P1582X	S LO2 REG VENT V CTL		X
10.36	105	P1592X	BOOSTER ENG CUTOFF		X
10.36	107	P1598X	VERNIER ENG CTOF		X
10.36	133		SPARE		X
10.36	137		SPARE		X
10.38	38		SPARE		X
12.58	6	P1444X	LO2 PRE VALVE CLOSED	X	
13.64	6	P1444X	LO2 PRE VALVE CLOSED		X
15.89	7	P1443X	LO2 PRE VALVE OPEN	X	
30.26	147	P1232X	OBSERVER CUTOFF S TANK	X	
30.29	91	P1155X	OBSERVER CUTOFF	X	
30.29	105	P1592X	BOOSTER ENG CUTOFF	X	
30.29	107	P1598X	VERNIER ENG CTOF	X	
30.29	133		SPARE	X	
30.29	137		SPARE	X	
30.30	60	P1072X	B COF RELAY LOCKIN	X	
30.30	80	P1347X	S COF RELAY LOCKIN	X	

30.30	102	P1582X	S LO2 REG VENT V CTL	X	
30.30	128		SPARE	X	
30.31	38		SPARE	X	
30.31	103	P1561X	B LO2 REF REG VENT	X	
30.31	106	P1593X	SUSTAINER ENG CUTOFF	X	
30.33	51	P1143X	B GAS GEN IGN LINK		X
30.45	24	P1427X	VERN LO2 VENT CONT		X
30.49	147	P1232X	OBSERVER CUTOFF S TANK		X
30.50	91	P1155X	OBSERVER CUTOFF		X
31.07	147	P1232X	OBSERVER CUTOFF S TANK	X	
31.11	91	P1155X	OBSERVER CUTOFF	X	
31.95	147	P1232X	OBSERVER CUTOFF S TANK		X
31.99	91	P1155X	OBSERVER CUTOFF		X
33.53	24	P1427X	VERN LO2 VENT CONT	X	
33.54	51	P1143X	B GAS GEN IGN LINK	X	
33.54	80	P1347X	S COF RELAY LOCKIN		X
33.55	60	P1072X	B COF RELAY LOCKIN		X
33.57	103	P1561X	B LO2 REF REG VENT		X
33.57	106	P1593X	SUSTAINER ENG CUTOFF		X
33.57	128		SPARE		X
33.61	102	P1582X	S LO2 REG VENT V CTL		X
33.61	133		SPARE		X
33.61	137		SPARE		X
33.62	38		SPARE		X
33.62	105	P1592X	BOOSTER ENG CUTOFF		X
33.62	107	P1598X	VERNIER ENG CTOF		X

39.27	7	P1443X	LO2 PRE VALVE OPEN		X
42.65	6	P1444X	LO2 PRE VALVE CLOSED	X	
56.95	24	P1427X	VERN LO2 VENT CONT		X
	5	P1581X	S FUEL PRE VLV OPEN		X
	8		SPARE		X
	9		SPARE		X
	10		SPARE		X
	13		SPARE		X
	14		SPARE		X
	15		SPARE		X
	16		SPARE		X
	17		SPARE		X
	18		SPARE		X
	19		SPARE		X
	33		SPARE		X
	34		SPARE		X
	37		SPARE		X
	40	P1519X	VERN STRT DY COF TMR		X
	62		SPARE		X
	65	P1501X	IGN STAGE TIMER COF		X
	70		SPARE		X
	76		SPARE		X
	82	P1515X	VERN SRT DY COF		X
	83	P1192X	B1 ROUGH COMB COF		X
	84	P1193X	B2 ROUGH COMB COF		X
	85	P1438X	ROUGH COMB COF S		X

86	P1588X	S TBN OVERSPEED TRIP		X
87	P1156X	B1 TBN OVRSPEED TRIP		X
88	P1157X	B2 TBN OVRSPEED TRIP		X
89	P1304X	FUEL VLV IGN COF		X
90	P1136X	B IGN DETR DELAY COF		X
92	P1158X	PREP INCOMPLETE COF		X
93	P1566X	DC DC GRND PWR FAIL COF		X
94		SPARE		X
96		SPARE		X
97		SPARE		X
98		SPARE		X
99		SPARE		X
100	ST009X	95% FUEL TANK SENSOR		X
104	P1591X	S HYD PRESS SW	X	
108	P1154X	TCC B ENGINE COF SW		X
109	P1594X	TCC SUSTAINER COF SW		X
110	P1164X	TCC VERN ENG COF SW		X
111	P1398X	S HYD LO PRESS COF		X
117	ST010X	100% FUEL TANK SENSOR		X
118	P1596X	HOLD DN PRE-LEASE		X
119	ST011X	FUEL OVERFILL		X
120	P1504X	GFST F & C CTL		X
122	ST012X	95% LOX TANK SENSOR		X
123	ST013X	LOX OVERFILL		X
124		SPARE		X
125		SPARE		X

126		SPARE	X
127		SPARE	X
129		SPARE	X
130		SPARE	X
131		SPARE	X
132		SPARE	X
134		SPARE	X
135		SPARE	X
136		SPARE	X
138		SPARE	X
139		SPARE	X
140		SPARE	X
142		SPARE	X
143		SPARE	X
144		SPARE	X
145		SPARE	X
146	P1231X	OBSERVER CUTOFF N TANK	X
148	P1219X	#1 OBSERVER CUTOFF	X
149	P1220X	#2 OBSERVER CUTOFF	X
150	P1221X	#3 OBSERVER CUTOFF	X
151	P1222X	#4 OBSERVER CUTOFF	X
152	P1223X	#5 OBSERVER CUTOFF	X
153	P1224X	#6 OBSERVER CUTOFF	X
154	P1225X	#7 OBSERVER CUTOFF	X
155	P1226X	#8 OBSERVER CUTOFF	X
156	P1227X	#9 OBSERVER CUTOFF	X

157	P1228X	#10 OBSERVER CUTOFF	X
158	P1229X	#11 OBSERVER CUTOFF	X
159	P1230X	#12 OBSERVER CUTOFF	X
160		SPARE	X

5.3 Propellant Tanking

5.3.1 The propellant tanking objective for this test was to evaluate the tanking procedures for "C" series missiles.

5.3.2 The missile fuel tank was filled to approximately 100% based on load cell and totalizer readings. The 90% probe light indicated properly. Normally the 90% probe locks out the 95% probe circuit and interlocks the PU system null meter. This circuit was modified so that both the 90% and 95% probes would indicate fuel tank levels. This modification also transferred the PU null meter interlock from the 90% probe to the 95% probe. The 95% light flickered momentarily and went out and the PU null meter interlock was never obtained. Tanking was stopped before the 100% probe was reached. Fuel was drained from 11,440 gal. to 10,530 gal. using the totalizer reading. The load cell reading was 69,000 pounds or 10,264 gal. The fuel vibrotron was removed from the missile just prior to the run and returned to the manufacturer for rework. It was suspected that the system was inoperative due to an internal short.

5.3.3 The following table is a comparison of readings taken during fuel tanking.

% per Load Cells	Load Cells		Totalizer		Digitizer		Scheduled
	lbs.	gal.	lbs.	gal.	lbs.	gal.	lbs.
10%	7636	1136			7731	1150	
20%	15,272	2272			14,992	2230	
30%	22,908	3408	24,068	3580	23,126	3440	
40%	30,554	4545	31,866	4740	30,044	4469	
50%	38,180	5679	39,059	5810	38,038	5658	
60%	45,816	6815	47,127	7010	46,004	6843	
70%	53,452	7951	55,329	8230	54,092	8046	
80%	61,088	9087	62,670	9322	61,332	9123	
90%	68,723	10,222					
Ignition	69,000	10,264	70,791	10,530			70,517

5.3.4 LO_2 was to be tanked by means of the PU null indicator. However, the indicator was inoperative for two reasons.

1) The 95% fuel tank probe, which was interlocked with the PU indicator, failed.

2) During LO_2 tanking the fuel level was below the 95% probe (some had been drained to obtain a 150 cu. ft. ullage).

In the future it is planned to jumper the interlock so that the PU null meter circuitry will be operative in the event of probe failures.

5.3.4 (Cont'd)

The PU null meter normally begins to register at approximately the 80% LO_2 level. When it became apparent that the PU null meter was not functioning it was decided to complete LO_2 tanking by using load cell readings based on a 2.25 LO_2/Fuel Mass Ratio. Instrumentation indicated a 2.9% mass ratio error at ignition. The LO_2 vibrotron operated satisfactorily during tanking.

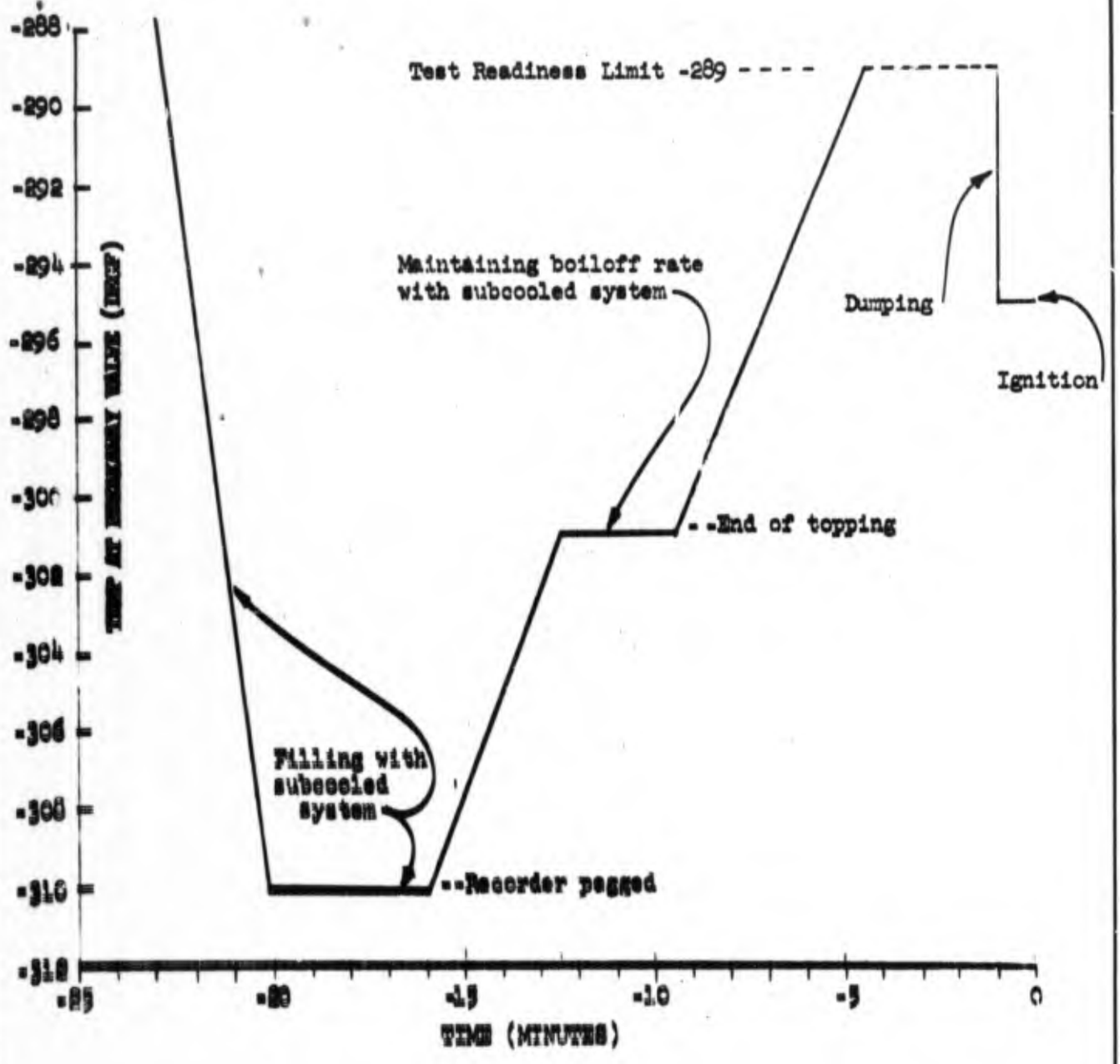
5.3.5 The following table is a comparison of readings taken during LO_2 tanking.

% per Load Cells	Load Cells		Digitizer	Vibrotron		Scheduled
	lbs.	gal.	gals.	lbs.	gal.	lbs.
10%	15,866	1686	2120			
20%	31,733	3372	3984	35,000	3719	
30%	47,599	5058	5726	52,350	5563	
40%	63,465	6744	7505	65,950	7008	
50%	79,332	8430	9167	83,900	8915	
60%	95,198	10116	10564	99,915	10617	
70%	111,064	11802	12633	115,450	12268	
80%	126,930	13488	14405	131,715	13996	
90%	142,797	15174	16093	147,300	15652	
95%	151,000	16045	16973	154,480	16415	
Final Before Dump	160,200	17023		161,750	17188	
Ignition	160,200 approx.			159,160	16871	
Start	156,000 approx.			156,160	16553	158,663

5.3.6 The LO_2 topping system functioned satisfactorily while operative during the tanking operation. Topping was completed at approximately X-9 1/2 minutes. At X-4 1/2 minutes the temperature at the LO_2 breakaway valve rose to the test readiness limit of -289 DGF. Approximately 3000 pounds of LO_2 was dumped at the beginning of the 60 second time count. The temperature dropped to -293 DGF at ignition. Although the topping system performed as intended, the dumping operation was still necessary to maintain LO_2 temperature within specified limits. The procedure for LO_2 topping during the period immediately preceding the firing will be modified to eliminate the necessity for LO_2 dumping.

5.3.6 (Cont'd)

The following graph shows temperature at the breakaway valve before ignition. Reference P1021T figure 5.2.2-4.



5.3.7 Instrumentation traces of the propellant utilization measurements are presented in figure 5.3-1.

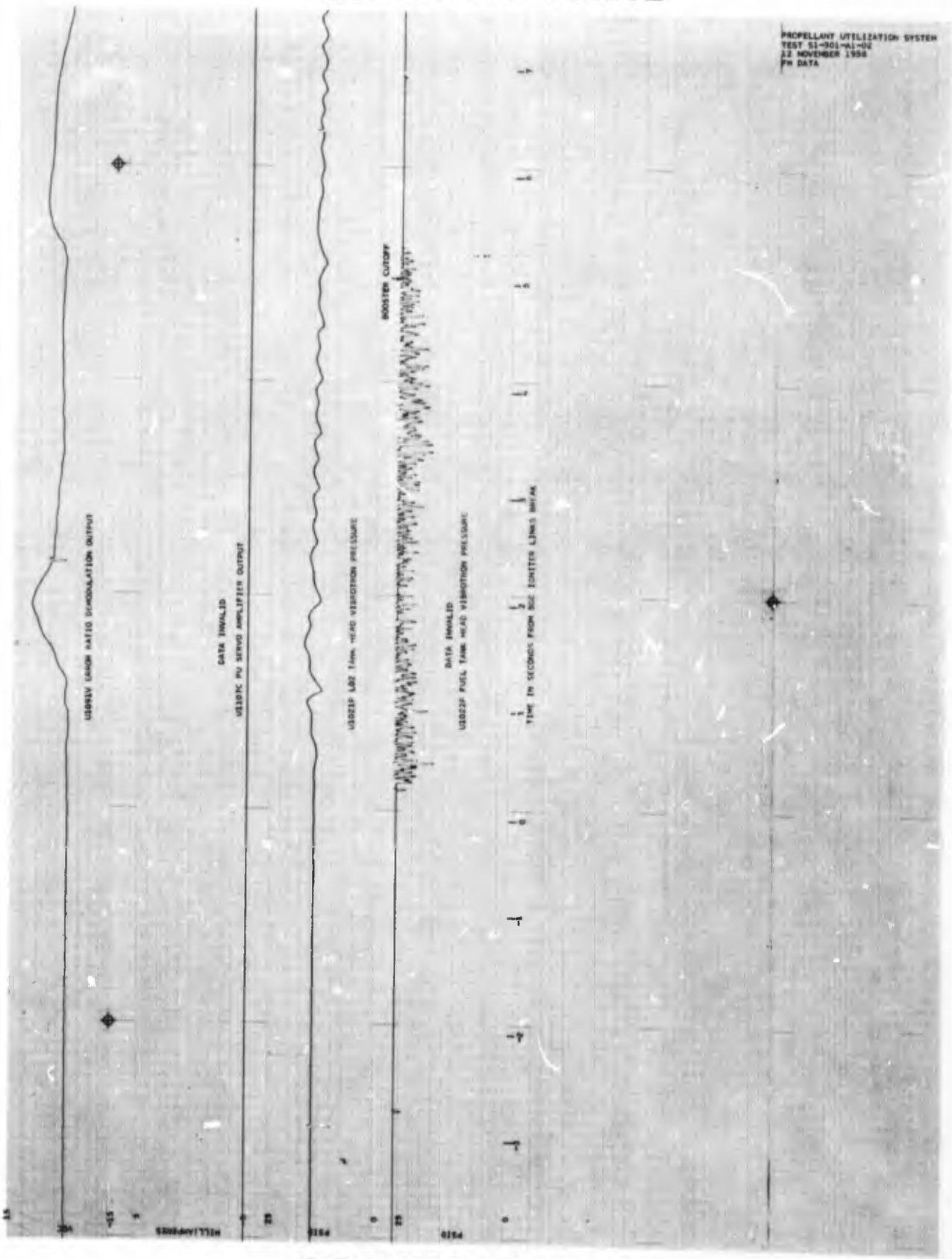


Figure 5.3-1

5.4 Electrical System

5.4.1 The electrical system test objective was to determine the compatibility of the missile facility-electrical control and power distribution system (EB21).

5.4.2 Electrical power for the various missile sub-systems was supplied by the ground source throughout the test. Although no electrical measurements were recorded, panel meter readings indicated satisfactory ground power operation.

5.4.3 Compatibility of the missile-facility electrical control and power distribution system was determined.

5.5 Pneumatics System

5.5.1 Test Objectives

5.5.1.1 FH70 - Determine the capability of the airborne pneumatic system to control tank pressures during engine start while utilizing missile ullage volumes as follows:

LO_2 Tank 239 cu ft.
Fuel Tank 150 cu ft.

5.5.1.2 To achieve the proper ullage volume the fuel tank was first filled to capacity using the load cells to monitor weight. The neptune flow totalizer was then used to drain back fuel to a weight of 70,791 lbs, resulting in an ullage volume of approximately 150 cu ft. Since the PU null meter was not functioning, the weight of LO_2 necessary to give a null indication was calculated and the LO_2 tank filled in accordance with the calculation to give an ullage of approximately 239 cu ft. (Refer to section 5.3 for detailed tanking procedure).

5.5.1.2 This run was the first in a series of three to fulfil test objective FH70. Successive runs will utilize decreased ullage volumes as specified in the test directives.

5.5.1.3 The airborne pneumatic system performed satisfactorily in maintaining tank pressurization throughout the run as evidenced by the following data. Changeover to the airborne pnaumtic system occurred at approximately X-60 seconds as scheduled for the booster tank supply.

		RL	0	X+1	X+3	X+5
F1001P	LO_2 Tank Helium	18-28.5	26.4	26.1	25.9	25.9
F1003P	Fuel Tank Helium	53-62.5	59.8	59.1	59.2	59.2

For complete graph of these measurements see Fig. 5.5-2.

5.5.2 Overall performance.

5.5.2.1 Changeover to airborne pneumatics was accomplished at approximately X-60 seconds for booster tank supply. Normal engine control switchover was verified by light indication on the pressurization consoles. This switchover is scheduled to start at vernier complete. Helium bottle pressures are listed below:

		X-0s	X+5s	Remarks
F1145P	S Ctl He Btl Disch	2985	2950	Prestart value 3010; decay of 60 psi/sec.
F1246P	B Tank He Btl Hi	(X+.75) 3005	2870	Decay rate 32 psig/sec.
F1248P	S Tnk He Btl Hi	3020	3020	
F1121P	B Ctl He Btl Dis	2965	2925	Prestart valve 3150 psig; X+6 valve 2895

For complete graph of control helium bottles pressures & temperature see Fig. 5.5-1.
For complete graph of tank helium bottles pressure and temperature see Fig. 5.5-2.

5.5.2.2 Booster control regulator discharge pressure was indicated to be low at the end of the run as evidenced by the data below. However, no adverse effects were noted on performance due to this factor.

		X-0s	X+1s	X+3s	X+5s	Spec. Value
F1125P	B Ctl Pneu Reg	730	730	730	725	750 ± 20
F1142P	S Ctl Pneu Reg	735	735	730	730	750 ± 20

For complete graph of these measurements see Fig. 5.5-1.

5.5.3 Conclusions

Pneumatic system performance was satisfactory in maintaining both tank pressures and engine control pressures within the specified test conditions.

5.6 Hydraulics

5.6.1 Both booster and sustainer hydraulic systems operation appeared satisfactory. Booster transition occurred at approximately 0.4 seconds when the pressure rose from the ground system level of 2055 psig to an airborne peak of 3440 psig at 1.1 seconds (See Figure 5.6-1). Steady state level of 3130 psig was attained by 2.5 seconds and continued so until cutoff. At cutoff, a 1 second damped oscillation with a peak to peak amplitude of 120 psig occurred. Booster hydraulic pressure was maintained for 7.25 seconds after cutoff before decay to ground level.

5.6.2 Sustainer ground hydraulic pressure was 2050 psig. A transient drop to 1830 psig was recorded between -0.7 and-0.1 sec. coincident with head suppression valve opening. At transition to airborne, hydraulic pressure rose from 2035 psig to a peak of 3220 psig whereupon it dropped to a mean value of 2960 psig where it exhibited damped oscillation until cutoff. (see Fig. 5.6-1). Following cutoff, the pressure surged to 3030 psig at six seconds and then decayed to the ground level of 2035 psig at 10.5 seconds. The effects of these oscillations on system operation may be subsequent runs of longer duration with the system subjected to full load demands by engine gimbaling.

5.7 Flame Deflector

5.7.1 The objective for this system was to evaluate the effects of the MA-1 cluster engine on the flame deflector and make modifications to the hole pattern as necessary.

5.7.2 This objective was not totally accomplished due to the short run duration and disturbed water flow pattern. Damage to the flame deflector in the form of large cracks was sustained when booster and vernier LO_2 start tanks vented onto the flame deflector prior to flame deflector water on. Recorded data indicates vernier and booster LO_2 start tank vent temperatures oscillated between -310 and -315 DEGF for approximately three minutes before BGG links break indicating that the start tanks were venting subcooled LO_2 during this period. The crack in the flame deflector extends from the radius at the lower right hand side, as viewed from the exhaust end, to a point twelve feet toward the center. Small radial crack extend from the main crack. The total damage is contained between the second and fifth water manifolds.

5.7.3 There is also evidence of slight burning of paint at both lower Radii near the outlet of the flame deflector. Additional holes will be drilled to compensate for this condition prior to the next run.

5.7.4 Tests performed during X-1 day checks indicated 78 psig flame deflector manifold water pressure and 31,000 GPM water flow, without operation of the four water pumps. This was considered satisfactory for a short duration test. The water pressure during the test was 74 psig, slightly lower probably due to the crack in the deflector, which caused lower pressure drop and changed water flow patterns in the deflector. The nominal flame deflector water pressure is 70-90 psig with minimum water flow of 27,000 GPM.

5.7.5 The vernier flame deflector operation was satisfactory with both V1 and V2 coolant water pressures measured at 22 psig. Nominal pressure is 20 psig measured at the vernier flame deflector inlet manifolds. The V1 engine exhaust did not impinge on the deflector, but due to interference with the test stand in locating the V2 deflector the V2 engine exhaust impinged 4-6 inches from the exit of the V2 deflector. Both V1 and V2 engines were maintained in null position, 30 degrees from the missile longitudinal axis. No damage was sustained by either vernier flame deflector.

5.7.6 The launcher coolant system was activated automatically at booster cutoff to spray water across the bottom of the thrust section to control exhaust rollback. A small afterfire occurred on the launcher due to a slight fuel leak at the fuel fill and drain valve which was ignited at cutoff. The flames were immediately extinguished and no damage was sustained.

5.8 Flight Control System

5.8.1 There were no flight control objectives for this run. Booster, sustainer, and vernier thrust chambers were satisfactorily held at null by the autopilot servo system during the run. Maximum peak to peak mainstage transients did not exceed .25 degrees on booster or sustainer engines.

5.8.2 The "C" series gyro canister was not available for this test.

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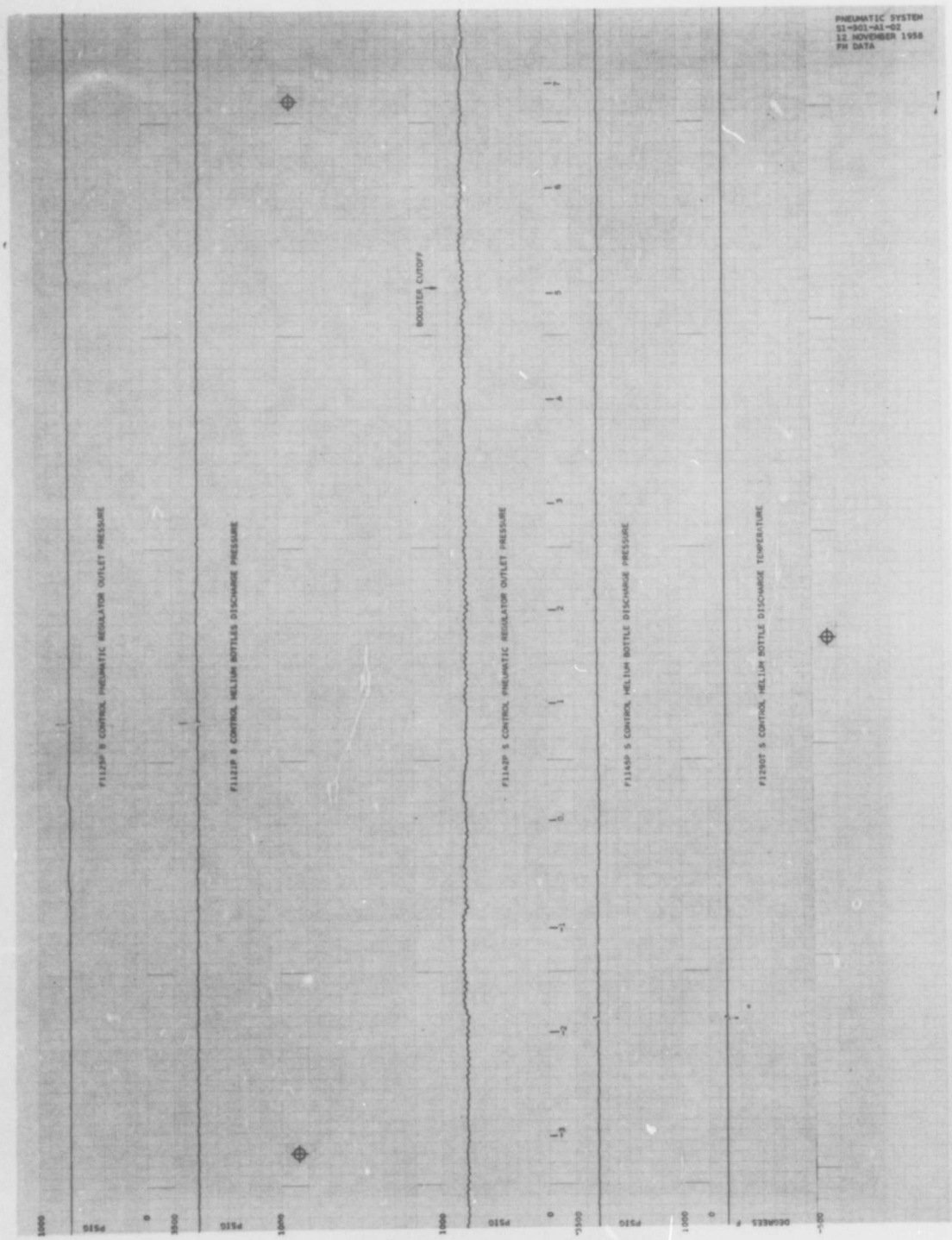


~~CONFIDENTIAL~~

Figure 5.5-1

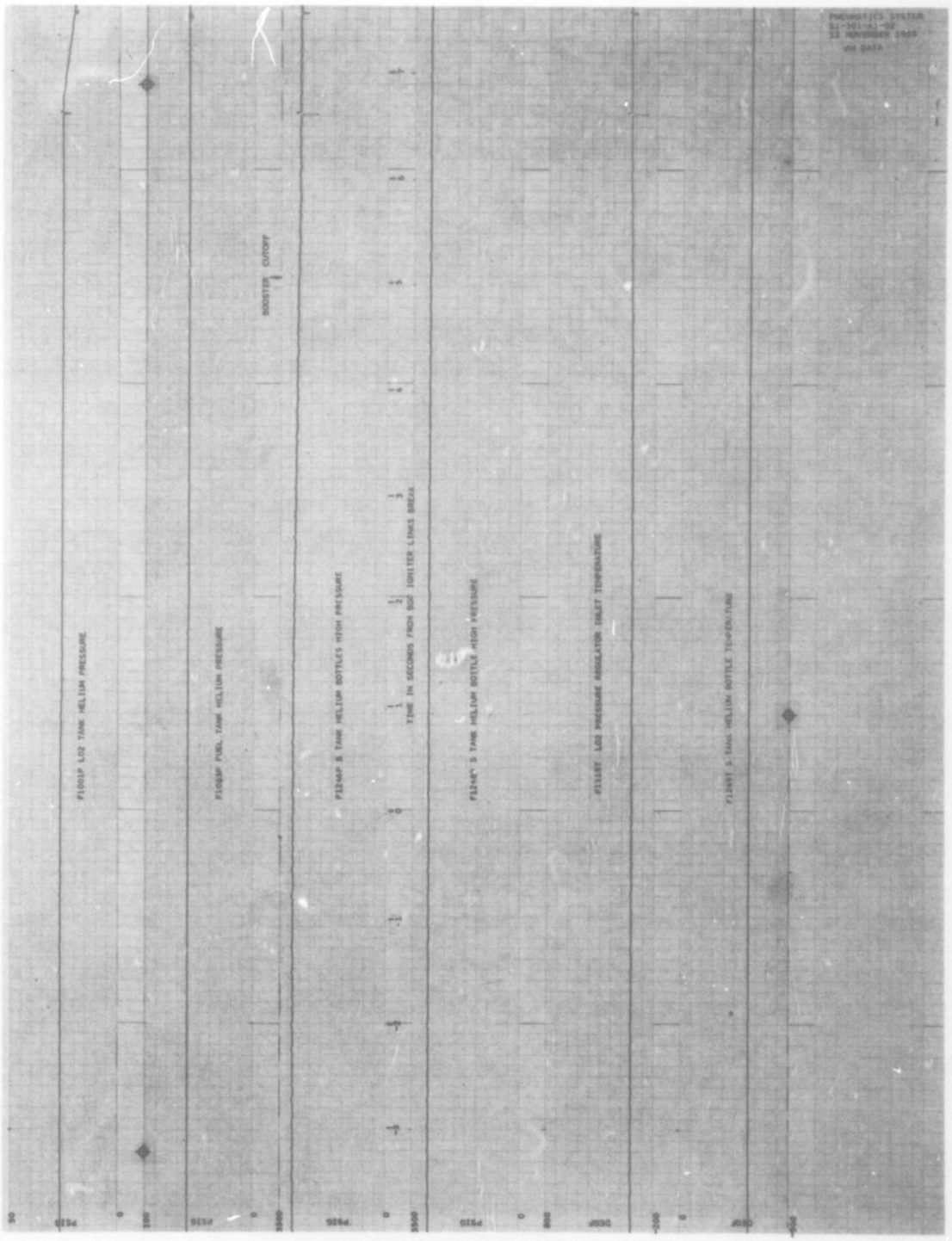


Figure 5.5-2

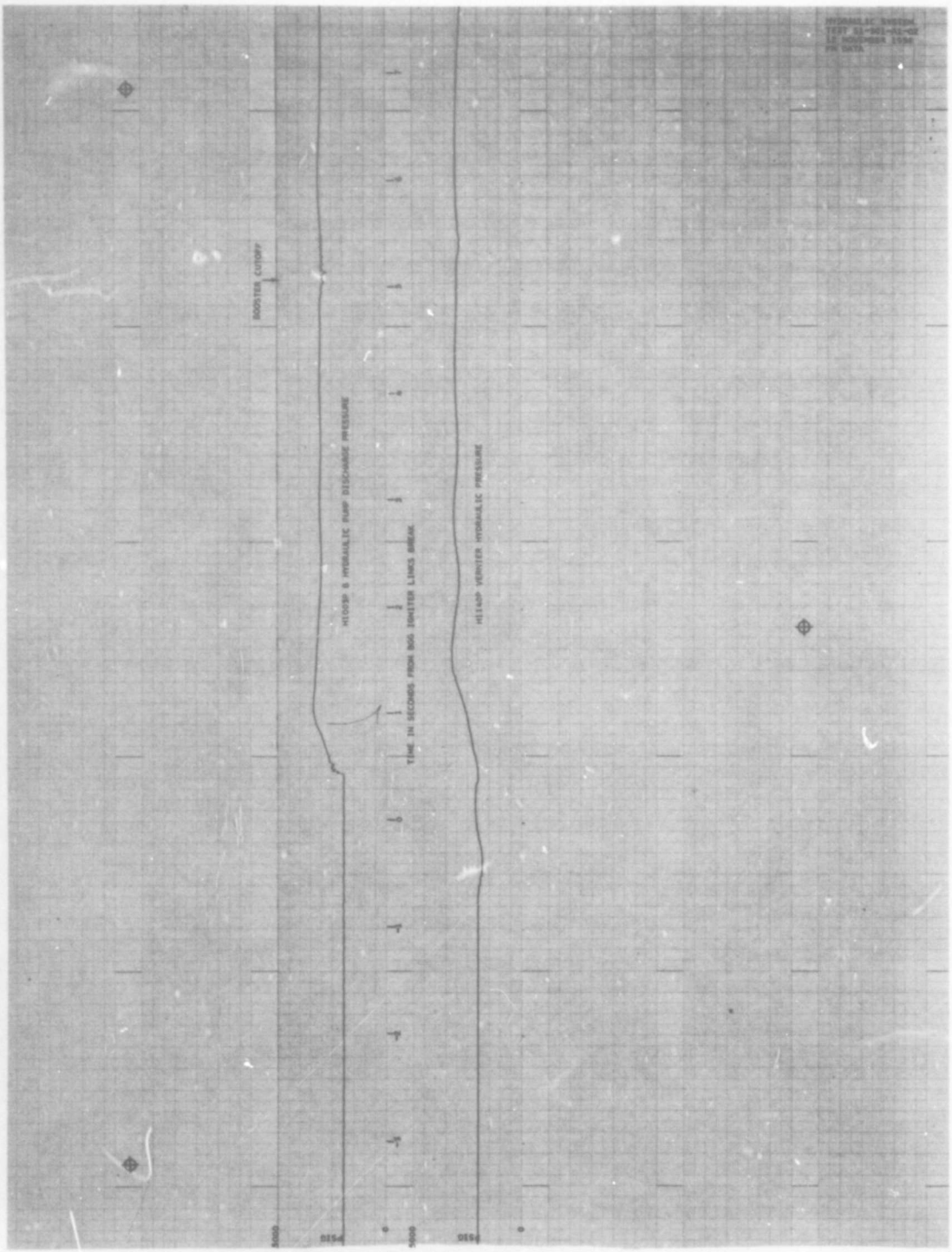


Figure 5.6-1

6.0 INSTRUMENTATION SURVEY

6.1 All records were examined indicating the following results:

Total Failures	9
Total Problem Areas	11
Total Measurements	208
Total Recordings	243

6.2 A complete "As Run" instrumentation tab is included as part of this report.

6.3 The following measurements were invalid for the reasons shown below:

Meas. No.	Description	Recorder	Failure Code
P1028P	V1 Thrust Chamber Press	FS	1f
P1029P	V2 Thrust Chamber Press	FS	1f
P1047P	V1 LO_2 Inlet Press	FS	1f
A1598S	Prop. Tk Long. Strain	F	1f
ST003T	LO_2 Heat Xchger In Temp	S	1b
P1083B	B2 Pump Speed	S	7k
P1084B	B1 Pump Speed	S	7k
P1048P	V2 LO_2 Inlet Press	S	1e
P1349B	S Pump Speed	FS	Unknown/2i

6.4 Problem areas exist in the following measurements:

Meas. No.	Description	Recorder	Failure Code
L1100P	F1. Defl. Water U Press	S	2f
P1060P	B1 Thrust Chamber Press	S	2n
P1177P	B LO_2 Start Tank Reg	S	2n
P1341P	S Lube Pump Gear Press	S	2i
P1344P	S LO_2 Reg. Reference Press	S	2f
P1187T	B2 LO_2 Pump Otbd. Brg Temp	S	2n
P1209T	B2 Turbine Bearing Temp	S	2i
Q1006P	V2 Fl. Defl.' Wtr In Press	S	2f
N1011F	Wt. & That Sys. Thrust	S	*
P1083B	B2 Pump Speed	F	Unknown
U1107C	FUSV amp out	F	4a

6.5 Failure Code

1. Transducer
   - b. damaged during test
   - f. open circuit
   - e. water in connector

* Trace Underdamped

6.5 (Cont'd)

2. Graphic Recorder

f. no timing
i. timing pen erratic
n. data pen erratic at speed change

4. Magnetic Tape Recorder

a. signal out of band

7. Instrumentation procedure

k. operational error

6.6 Recorder Code

S - Strip Chart
F - Magnetic Tape

6.7 Objective was to evaluate the adequacy of the missile facility instrumentation system to accurately sense, transmit, and record test data.

6.7.1 Examination of all the records indicates that 96.2% of the measurements were recovered.

6.7.2 Problem areas on the Brown strip chart recorders consist of timing and data pens skipping. The skipping occurred in the recorder transition from slow to fast speed.

6.7.3 All the flow measurements recorded on magnetic tape indicate a low record amplitude as it was necessary to increase playback gain in order to get readable data. Pump speeds recorded on magnetic tape also indicate a low record level. Sustainer pump speed data was not recovered due to insufficient record amplitude and P1083B booster pump speed indicates a 1000 rpm low reading.

6.7.4 The FM tape recording system was operated for the first time on this run and the results were satisfactory. From a total of 73 measurements recorded on the FM tapes a total of 6 measurements were not available for playback.

6.7.5 The scale factor method of calibration was also utilized for the first time on this run and at this time appears satisfactory. It can be expected that as personnel become accustomed to this method the amount of time required for instrumentation calibration and set-up will be considerably reduced.

AS RUN INSTRUMENTATION REQUIREMENTS LIST
SYCAMORE STAND S1 MISSILE 2C
RECORDER AND MEASUREMENT DATA
RUN-S1-301-A1-02 12 NOVEMBER 1958

RECORDER	CODE	TOTAL
AM TAPE	A	3
BROWN MULTIPOINT	B/M	3
EA	EA	101
SANBORN	D	0
FM TAPE	F	73
OSCILLOGRAPH - CEC	O	8
STRIP CHART-BROWN	S	25
TOTAL MEASUREMENTS		208
TOTAL PARALLEL MEASUREMENTS		35
TOTAL RECORDER CHANNELS		243

TAB ABBREVIATIONS

RECR	- RECORDER	RL	- REDLINE LIMIT
RSP	- RESPONSE	TR	- TEST READINESS
UNK	- UNKNOWN	LL	- LOWER LIMIT
PR	- PRIORITY	UL	- UPPER LIMIT

PRIORITY CODE

0 - SYCAMORE OPERATIONAL
1 - PRIORITY 1
2 - PRIORITY 2

~~CONFIDENTIAL~~

NUMBER	MEASUREMENT DESCRIPTION	RECR	RSP	RED LINE LIMIT	LL	UL	UNITS	OPER RANGE LOW	OPER RANGE HIGH	CALIB RANGE LOW	CALIB RANGE HIGH	PR	P
A1578S	PROP TK HOOP STRAIN	F	50				IN			0	.002	1	
A1579S	PROP TK HOOP STRAIN	F	50				IN			0	.002	1	
A1584S	PROP TK HOOP STRAIN	F	50				IN			0	.009	1	
A1585S	PROP TK HOOP STRAIN	F	50				IN			0	.009	1	
A1588S	PROP TK LONG STRAIN	F	50				IN			0	.002	1	
A1589S	PROP TK LONG STRAIN	F	50				IN			0	.002	1	
A1598S	PROP TK LONG STRAIN	F	50				IN			0	.002	1	
A1599S	PROP TK LONG STRAIN	F	50				IN			0	.002	1	
F1001P	LO2 TANK HELIUM	SF	SLO	RL	18	28.5	PIG	2.5	29			1	
F1001P				TR	23.7	28.2							
F1003P	FUEL TANK HELIUM	SF	SLO	RL	53	62.5	PIG	53	63			1	
F1003P				TR	57	62.2							
F1003P	FUEL TK HE-2ND STAGE			RL	40		PIG					1	
F1121P	B CTL HE BTL DISCH	SF	SLO	TR	3000		PIG	15	3000			1	
F1125P	B CTL PNEU REG OUT	SF	SLO	TR	730	770	PIG	200	800			1	
F1142P	S CTL PNEU REG OUT	SF	SLO	TR	730	770	PIG	735	985			1	
F1145P	S CTL HE BTL DISCH	SF	SLO	TR	3000		PIG	735	3250			1	
F1246P	B TANK HE BOTTLES HI	SF	SLO	TR	3000		PIG	0	3000			1	
F1248P	S TANK HE BOTTLE HI	SF	SLO	TR	3000		PIG	0	3000			1	
F1260P	B TANK HE BOTTLES LO	F	SLO				PIG	0	385			2	
F1261P	S TANK HE BOTTLE LO	F	SLO				PIG	0	385			2	
F1115T	LO2 PRESS REG IN	F	SLO				DGF	M100	500			2	

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE		CALIB RANGE		PR	P-T
F1247T	B TK HE BOTTLES	F	SLO				DGF	M380	M80			2	
F1249T	S TK HE BOTTLE	F	SLO				DGF	M380	M80			2	
F1290T	S CTL HE BOTTLE	F	SLO				DGF	M250	M80			1	
H1003P	B HYD PUMP DISCH	F	50	TR	2000		PIG	0	3500			1	
H1140P	VERN HYD PRESS	SF	SLO	RL	2000		PIG	2500	3300			1	
H1140P				TR	2000								
L1100P	FL DEFR WATER U	S	SLO	TR	100		PIG	75	95	0	150	1	
N1011F	WT & THST SYS-THRUST	FS	10				KPS	M260	400	M300	400	1	
P1083B	B2 PUMP SPEED	FS	SLO				RPM	5900	6200	0	6790	1	
P1084B	B1 PUMP SPEED	FS	SLO				RPM	5900	6200	0	6790	1	
P1349B	S PUMP SPEED	FS	SLO				KPM	10.2	10.8	0	12.0	1	
P1528D	S MAIN FUEL VALVE	SF	SLO	RL	20	48	DEG	30	50	0	87.5	1	
P1529D	S MAIN LO2 VALVE	SF	SLO				DEG	14	90	0	90	0	
P1439O	S RD RCC ACCEL	OA	10K				CPS	600	6K	0	10K	2	
P1439O	S RD RCC ACCEL		10K				G	0	200	0	200	2	
P1452O	B1 RD RCC ACCEL	OA	10K				CPS	600	6K	0	10K	2	
P1452O	B1 RD RCC ACCEL		10K				G	0	200	0	200	2	
P1453O	B2 RD RCC ACCEL	OA	10K				CPS	600	6K	0	10K	2	

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE		CALIB RANGE		PR	P-T
P14530	B2 RD RCC ACCEL		10K				G	0	200	0	200	2	
P1003P	B2 LO2 PUMP INLET	F	1KC				PIG	55	90			1	
P1004P	B2 FUEL PUMP INLET	F	1KC				PIG	35	55			1	
P1006P	S THRUST CHAMBER	FS	150				PIG	585	685			1	
P1010P	B1 LUBE OIL MANIFOLD	S	SLO	RL	550	985	PIG	550	985			1	
P1026P	B LO2 REG REFERENCE	S	SLO	TR	510	530	PIG	515	535			1	
P1027P	VERNIER FUEL TANK	S	SLO	TR	525	545	PIG	515	570			1	
P1028P	V1 THRUST CHAMBER	FS	250				PIG	265	335			1	
P1029P	V2 THRUST CHAMBER	FS	250				PIG	265	335			1	
P1030P	VERNIER LO2 TANK	S	SLO	TR	510	530	PIG	505	545			1	
P1047P	V1 LO2 INLET	F	1KC				PIG	400	600			1	
P1048P	V2 LO2 INLET	F	1KC				PIG	400	600			1	
P1049P	V1 FUEL INLET	F	IKC				PIG	400	600			1	
P1050P	V2 FUEL INLET	F	IKC				PIG	400	600			1	
P1055P	S FUEL INLET	F	IKC				PIG	15	75			1	
P1056P	S LO2 PUMP INLET	F	IKC				PIG	25	105			1	
P1059P	B2 THRUST CHAMBER	FS	250				PIG	520	560			1	
P1060P	B1 THRUST CHAMBER	FS	250				PIG	520	560			1	
P1075P	GND FUEL ST TK PRESS	S	SLO	TR	760	840	PIG	750	850			1	
P1093P	B1 FUEL INJ MAN	O	IKC				PIG	625	675			0	
P1094P	B2 FUEL INJ MAN	O	IKC				PIG	625	675			0	
P1100P	B GG COMBUSTION CHM	FS	250				PIG	285	585			1	
P1177P	B LO2 START TANK REG	S	1	TR	480	520	PIG	490	510			1	

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE		CALIB RANGE		PR	P-T
P1178P	GND FUEL ST TK REG	S	SLO	TR	760	840	PIG	760	840			1	
P1235P	VERN LO2 TK REG OUT	S	SLO	TR	505	535	PIG	510	540			1	
P1236P	VERN FUEL TK REG OUT	S	SLO	TR	520	550	PIG	525	545			1	
P1247P	LO2 TK PRESS	F	50				PSI					1	
P1248P	LO2 TK PRESS	F	50				PSI					1	
P1249P	FUEL TK PRESS	F	50				PSI					1	
P1250P	FUEL TK PRESS	F	50				PSI					1	
P1332P	S LO2 PUMP DISCH	SF	SLO	RL		1050	PIG	685	1185			1	
P1339P	S GG DISCHARGE	FS	SLO				PIG	485	685			1	
P1341P	S LUBE PUMP GEAR	SF	SLO	RL	400		PIG	485	985			1	
P1344P	S LO2 REG REFERENCE	FS	SLO	TR	735	755	PIG	700	800			1	
P1350P	S FUEL INJ MANIFOLD	F	150				PIG	585	785			1	
P1351P	S LO2 INJ MANIFOLD	F	SLO				PIG	585	885			1	
P1375P	S IGN FUEL INT MAN	F	IKC				PIG	500	950	0	985	1	
P1489P	B GAS GEN LO2 VLV IN	S	SLO	TR	480	520	PIG	480	520			1	
P1007R	SUSTAINER FUEL FLOW	F	SLO				GPM	650	750	0	980	1	
P1008R	SUSTAINER LO2 FLOW	F	SLO				GPM	1060	1220	0	1350	1	
P1037R	B GAS GEN LO2 FLOW	F	SLO				GPM	0	65	0	65	1	
P1042R	VERNIER LO2 FLOW	F	SLO				GPM	30	45	0	50	1	
P1043R	VERNIER FUEL FLOW	F	SLO				GPM	15	45	0	50	1	
P1051R	B GAS GEN & IGN FUEL	F	SLO				GPM	0	180	0	220	1	
P1244R	TSYS LO2 FT						READ	OUT					
P1246R	TSYS FUEL FT						READ	OUT					

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE		CALIB RANGE		PR	P-T
P1333R	S GAS GEN LO2 FLOW	F	SLO				GPM	6	8	0	20	1	
P1334R	S GAS GEN FUEL FLOW	F	SLO				GPM	30	50	0	60	1	
P1014T	ENGINE COMP AMBIENT	S	SLO				DGF	50	100	0	165	1	
P1018T	B1 TURBINE INLET	SF	SLO	RL		1400	DGF	500	1400	0	1500	1	
P1021T	LO2 AT BRKAWAY VLV	SF	SLO	TR		M289	DGF	M297	M310	M280	M270	1	
P1126T	B1 LO2 PUMP OTBD BRG	S	SLO	TR	0		DGF	0	300	M100	400	1	
P1127T	B2 LO2 PUMP OTBD BRG	S	SLO	TR	0		DGF	0	300	M100	400	1	
P1209T	B2 TURBINE BEARING	S	SLO	RL		600	DGF	0	600	0	1000	1	
P1213T	B1 TURBINE BEARING	S	SLO	RL		600	DGF	0	600	0	1000	1	
P1323T	S TURBINE BEARING	S	SLO	RL		750	DGF	50	150	0	1000	1	
P1324T	S PUMP BEARINGS-LO2	S	SLO	RL		300	DGF	0	120	M60	300	1	
P1324T				TR	M60								
P1336T	S GAS GEN DISCH	SF	SLO	RL		1400	DGF	500	1500	500	1800	1	
P1437W	S RCC BINARY COUNTER	O	UNK				MS	0	20	0	100	2	
P1454W	B1 RCC BINARY COUNT	O	UNK				MS	0	20	0	100	2	
P1455W	B2 RCC BINARY COUNT	O	UNK				MS	0	20	0	100	2	
P1067X	B2 LOX VLV CLSD MSW	EA											
P1068X	B1 LOX VLV CLSD MSW	EA											
P1069X	B2 FUEL VLV CLSD MSW	EA											
P1070X	B1 FUEL VLV CLSD MSW	EA											
P1071X	BGG VLV CLSD MSW	EA											

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE		CALIB RANGE		PR	P-T
P1072X	B COF RELAY LOCKIN	EA											
P1078X	VERN FUL TK PRES SOL	EA											
P1079X	VERN FUL TK PRES SOL	EA											
P1096X	VERN TKS PRES RELAY	EA											
P1135X	PROP S T PRES RELAY	EA											
P1136X	B IGN DETR DELAY COF	EA											
P1137X	ETP PREP COMPLETE LT	EA											
P1139X	B LOX VLV OPEN CTL	EA											
P1142X	TCC IGN COMPLETE LT	EA											
P1143X	GAS GEN IGN LINK BK	EAF	OFF	ON			DC	0	28	0	30	1	
P1145X	BGG VLV OPEN CTL SOL	EA											
P1146X	BGG VLV CLOS CTL SOL	EA											
P1147X	BGG VLV OPEN MSW	EA											
P1148X	B FUEL VLV OPEN CTL	EA											
P1149X	B1 LOX V CLOS CTL	EA											
P1150X	B FUEL VLV CLOS CTL	EA											
P1154X	TCC B ENGINE COF SW	EA											
P1155X	OBSERVER CUTOFF	EA											
P1156X	B1 TBN OVERSPEED TRIP	EA											
P1157X	B2 TBN OVERSPEED TRIP	EA											
P1158X	PREP INCOMPLETE COF	EA											
P1161X	TCC VERN ENG STR SW	EA											
P1164X	TCC VERN ENG COF SW	EA											
P1165X	VERN ENG LOKIN RELAY	EA											

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE	CALIB RANGE	PR	P-T
P1166X	B & S FUEL INJ PRG SOL	EA									
P1167X	VERN PV OPEN CTL	EA									
P1169X	B2 LOX VLV OPEN MSW	EA									
P1170X	B1 LOX VLV OPEN MSW	EA									
P1186X	FUEL S T FULL LT	EA									
P1192X	B1 ROUGH COMB COF	EA									
P1193X	B2 ROUGH COMB COF	EA									
P1194X	B1 FUEL VLV OPEN MSW	EA									
P1195X	B2 FUEL VLV OPEN MSW	EA									
P1196X	SUSTAINER V HSV SOL B	EA									
P1197X	SUSTAINER HSV SOL A	EA									
P1198X	S LOX HSV OPEN MSW	EA									
P1199X	S LOX HSV CLSD MSW	EA									
P1200X	SUSTAINER PUV SOL F	EA									
P1201X	SUSTAINER PUV SOL E	EA									
P1202X	S FUEL PUV OPEN MSW	EA									
P1203X	S FUEL PUV CLSD MSW	EA									
P1219X	#1 OBSERVER CUTOFF	EA									
P1220X	#2 OBSERVER CUTOFF	EA									
P1221X	#3 OBSERVER CUTOFF	EA									
P1222X	#4 OBSERVER CUTOFF	EA									
P1223X	#5 OBSERVER CUTOFF	EA									
P1224X	#6 OBSERVER CUTOFF	EA									
P1225X	#7 OBSERVER CUTOFF	EA									

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE	CALIB RANGE	PR	P-T
P1226X	#8 OBSERVER CUTOFF	EA									
P1227X	#9 OBSERVER CUTOFF	EA									
P1228X	#10 OBSERVER CUTOFF	EA									
P1229X	#11 OBSERVER CUTOFF	EA									
P1230X	#12 OBSERVER CUTOFF	EA									
P1231X	OBSERVER CUTOFF	EA									
P1232X	OBSERVER CUTOFF	EA									
P1299X	B IGN DETR DELAY-PU	EA									
P1302X	B FUEL VLV OPEN TIMER	EA									
P1303X	S FUEL VLV OPEN TIMER	EA									
P1304X	FUEL VLV DYN COF	EA									
P1335X	S GG VLV CLSD MSW	EA									
P1347X	S COF RELAY LOCKIN	EA									
P1397X	GG SQUIBS TIMER	EA									
P1398X	S HYD LO PRESS COF	EA									
P1427X	VERN VENT CONT	EA									
P1438X	S ROUGH COMB COF	EA									
P1441X	B IGN STAGE TIMER	EA									
P1443X	LOX PRE VLV OPEN	EA									
P1444X	LOX VALVE CLOSED	EA									
P1445X	B FUEL PRE VLV OPEN	EA									
P1446X	B FUEL PRE VLV CLSD	EA									
P1499X	S GG VLV OPEN MSW	EA									
P1501X	IGN STAGE TIMER COF	EA									

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE		CALIB RANGE		PR	P-T
P1503X	GFST VENT CTL	EA											
P1504X	GFST F & C CTL	EA											
P1510X	TCC VERN COMPLETE LT	EA											
P1512X	B2 LOX CLOS CTL	EA											
P1515X	VERN STRT DY COF	EA											
P1516X	VERN SQUIBS FIRING	EA											
P1519X	VERN STRT DY COF TMR	EA											
P1561X	B LOX REF REG CENT	EA											
P1566X	DC GND PWR FAIL COF	EA											
P1568X	STRT TKS PRESS TIMER	EA											
P1575X	PRE START READY	EA											
P1580X	S FUEL PRE VLV CLSD	EA											
P1581X	S FUEL PRE VLV OPEN	EA											
P1582X	S LOX REG VENT V CTL	EA											
P1586X	S IGN FUEL V OPN CTL	EA											
P1587X	S GG VLV OPEN CTL	EA											
P1588X	S TBN OVERSPEED TRIP	EA											
P1591X	S HYD PRESS SW	EA											
P1592X	BOOSTER ENG CUTOFF	EAF	ON	OFF			DC	0	28	0	30	1	
P1593X	SUSTAINER ENG CUTOFF	EAF	ON	OFF			DC	0	28	0	30	1	
P1594X	TCC SUSTAINER COF SW	EA											
P1595X	S GG VLV VLOSING SOL	EA											
P1596X	HOLD ON RELEASE REL	EA											
P1598X	VERNIER ENG CUTOFF	EAF	ON	OFF			DC	0	28	0	30	1	

NUMBER	DESCRIPTION	RECR	RSP	LIMIT	LL	UL	FUNCT	OPER RANGE		CALIB RANGE		PR	P-T
Q1005P	V1 FL DEFL WTR IN P	S					PIG	0	18	0	25	0	
Q1006P	V2 FL DEFL WTR IN P	S					PIG	0	18	0	25	0	
ST003T	LO2 HEAT XGER IN TEMP	S					DEGF	M320	M280	M325	60	0	
ST004T	LO2 HEAT XGER OUT TEMP	S					DEGF	M320	M280	M325	60	0	
ST076T	B1 FUEL IGN VLV AMB	B/M	SLO				DGF	40	100	32	310	0	
ST077T	B2 FUEL IGN VLV AMB	B/M	SLO				DGF	40	100	32	310	0	
ST078T	ENG CTL PNEU MAN AMB	B/M	SLO				DGF	40	100	32	367	0	
ST126T	V LO2 ST TK VT	S					DGF	M297	AMB	M320	100	0	
ST141T	FIRE DETECTOR-EDISON	S	SLO	RL		600	DGF	0	600	0	750	0	
ST157T	B LO2 ST TK VT	S					DGF	M2971	AMB	M320	85	0	
ST158T	V1 LO2 BLEED	S					DGF	M297	AMB	M320	85	0	
ST159T	V2 LO2 BLEED	S					DGF	M297	AMB	M320	85	0	
U1107C	PUSV AMP OUT	F	I				MA	M10	10	M10	10	1	
U1021P	LO2 TK MD VIBROTRON	F	SLO				PID	15	22	0	25	1	
U1091V	ERROR RATIO DEMOD OP	F	20				VDC	M20	20	M20	20	1	

7.0 TEST PREPARATIONS

7.1 X-1 Day Operations (1st attempt)

1. X-1 Day started at 0745 on 11/6/58. LO_2 and Fuel storage tank readings were 26,600 gal. & 13,700 gal respectively. A satisfactory LO_2 system leak check was performed. Major commands 0001 to 0011 were performed during the period from start of X-1 day to approximately 1300.

2. A water systems check was performed at 1315 with satisfactory results.

3. At 1420 an engine regulator decay test was performed per section 5-21 of STP-P-003.

4. The sustainer over/under speed filter checkout commenced at approximately 1400. At 1700 the test was completed. The lower cutoff and arming frequency were within range. The upper cutoff frequency was slightly low (945 cps). Since no spurious cutoff signals were observed, this value was considered satisfactory.

5. The RCC check commenced at approximately 1700. Trouble was encountered with a coaxial connector into the cathode follower. Erroneous signal readings were indicated on the VTVM. The meter was replaced. This check was completed at approximately 2000. Accelerometer checks were accomplished by the tapping test with satisfactory results. The accelerometer check was completed at approximately 2100.

6. Checkout of the water & firex systems was initiated at 1835. Booster coolant was not operative for Run 1 due to the solenoid not being explosion proof.

7. The ignition delay timer test was initiated at approximately 2100. Upon evaluation of data it was found that timers were beyond limits by about 0.75 sec. (correct timer reading should be 1.6 ± 0.15 sec. instead of the 2 sec. indicated). A BOI was obtained to open launcher boxes so that resetting of timers could be accomplished.

8. Ignition delay timer test was performed again at 0035 (7 Nov. 1958). Results were satisfactory.

9. Fuel tanking was accomplished at 0130 with a quantity of 10,457 gal. (approx.) as indicated on the Fuel Digitizer and 10,455 gal. indicated on the Totalizer.

10. The fuel vibrotron transducer was inoperative for fuel tanking. No transducer replacement was available for the run at this time. Load cell, totalizer and digitizer readings were used to determine quantity of fuel tanked.

11. The LBU inlet control GN_2 solenoid valve at the LBU indicated a leak when it was energized (closed). The cannon connector was disconnected since the valve is used for back up purposes.

12. Operations were halted at approximately 0200, 7 November 1958.

13. X-1 day operations were continued at 0630, 7 November 1958.

14. Boosters & sustainer chambers fill & flush was completed at 0830.

15. During the flame deflector checkout the surge from the pumps caused the flex flow valve to open, releasing water into the thrust section. Shutdown was initiated and the second attempt was satisfactory at 0900. In order to dry the thrust section, the thrust section heating unit was set up per major command 043 of the precount.

16. Fuel leak check was initiated at 1033 and completed at 1049.

17. Igniter installation was commenced at 1054.

18. Due to the fuel pre-valve being left closed, the fuel leak check had to be repeated. This commenced at 1204 with sustainer hydraulic press. at 3000 psig and seq. II pressurization (32 psig). Completion time was 1220.

19. At 1115 an instability was observed with the fuel tank seq. 1 regulator and relief valve at the PCU. Resetting of the regulator was necessary. This task was completed at 1229.

20. Due to the necessity of the 2nd fuel leak check, installation of the igniters was delayed. Installation was completed at 1229.

21. The igniter squib test was performed and completed at 1250.

22. X-1 day operations were completed at 1252, 7 November 1958. Total elapsed working hours for this section was approximately 24:22 hours.

23. A countdown review and time second practice was accomplished prior to initiation of precount.

7.2 Precount Operations (1st attempt)

1. Precount operations began at 1348, 7 November 1958.

2. Action was initiated at 1406 for pressurization of the missile hydraulic accumulators. Recharge of the reservoirs and shift change delayed completion of this procedure until 1541.

3. Improper instrumentation indications for the sustainer main fuel valve P1528D were noted. Trouble shooting resulted in finding reversed leads on the transducer.

4. Other precount procedures progressed normally through to time of boot installation and removing flame deflector covers. The boot installation required approximately 1 hour and 30 minutes (completed at 1811). Removal of flame deflector covers and installation of the LN_2 flush line were completed in 13 minutes.

5. A countdown practice was held prior to preparing for Condition Red.

6. The LO_2 Heat Exchanger was topped off with LN_2 at 1858.

7. The command to clear area to proceed to Condition Red was called at 1919, at which time it was reported from the stand that the 11-inch LO_2 duct on the missile had collapsed. At 1935 it was announced that the test was called off and securing operations would be activated to place test at the point of X-1 day completion.

7.3 Time Interval Between 1st and 2nd attempts

1. During the morning of the following day (11/8/58), the 11" LO_2 duct was removed. It was replaced with a new duct that evening. The new LO_2 duct was purged for 1/2 hour by using 8-11 psig GN_2 from the PU line (Sta. 27) connected to the boss on the LO_2 low press. manifold, and purging through the Vernier start tank low press. relief valve. The duct is to be maintained at a press. of 3 psig until countdown time.

2. During the preparation for a re-run of STP-F-004 (This was necessary in order that correct setting of valves 37 and 26 in the PCU could be attained.), hydraulic oil was discovered at the tee on the fuel pressurization line at the RVU. This contamination extended from the check valve through the A/B fuel regulator (3000 psig He line) relief valve and the RVU to approximately 15 ft. downstream of the PCU. De-contamination and replacement of parts started Saturday evening (11/8/58) and was completed on the evening of 11/12/58 at 2335. Two check valves between the fuel press. duct and sustainer & booster hyd. reservoir were replaced. It was believed one of these had caused the contamination.

3. Monday night it was determined that the fuel press. relief valve setting was bad. Tuesday (11 Nov.) morning another attempt was made to correct the valve setting, with unsatisfactory results. The valve was IR'd and a relief valve from the 9C missile was installed late Tuesday afternoon.

4. At 0700 on 12 November, a PCU C/O was initiated per STP-F-004. The A/B bottles were pressurized to 2000 psig and a leak check performed. When 3000 psig pressure was applied to the A/B bottles the pressurization system was switched to Internal and a check was made on the new fuel regulator. The exhaust valves on the ullage tank were opened to simulate tank utilization of fuel and LO_2.

For approximately 7 seconds the pressure was satisfactory except for minor fluctuations. Then the fluctuation became excessive and popping of the fuel pressurization relief valve occurred. From recordings it was determined that the A/B fuel pressurization relief valve and pressurization regulator were bucking each other. The Design Group was contacted, and upon examination of the records a decision was reached (at 1230) to continue with the attempt.

5. During the accumulator charge and checkout on the evening of Nov. 10, the following problems were encountered:

   a. With A/P AC Power ON, the sustainer & verniers nulled satisfactorily and the system performed normally at 3000 psig.

   b. With A/P AC power ON, the boosters nulled satisfactorily at 3000 psig, but B-1 system vibrated excessively with an audible erratic rumble.

   c. With A/P AC power switch OFF, B-2 nulled satisfactorily at 3000 psig, but the B-1 went over hard in pitch with no vibration or rumble.

   d. Under conditions noted in (b) reservoir LP relief valve threw hydraulic oil out vent line almost constantly.

   e. A bad leak on the sustainer system was discovered on the hydraulic reservoir charge line, between the reservoir and the relief valve. The leak was fixed and checked satisfactory.

6. Investigation of the B-1 (Yaw) vibration was initiated Tuesday morning, 11 November. The B-1 actuator was replaced, but the trouble still existed. Late Tuesday evening the Autopilot canister ("B" series) was replaced with a "C" series Autopilot -933 production model canister. This eliminated the trouble. An examination of the removed canister failed to reveal the possible source of trouble. It is believed that the trouble lies in the B-1 yaw channel since connecting the B-1 yaw to the B-1 pitch did not alleviate the trouble.

7. An engine sequence check was attempted at approximately 0800, 11/12/58. Sustainer and booster regulator pressure decayed to 250 psig during this test. It was discovered that the engine control pressurization disconnect was approximately 3/4-inch low, thus preventing proper engine control pressurization. When this problem was corrected a complete engine sequence check was performed.

8. A problem with the B-2 main LO_2 valve micro switch was encountered. A closing light indicator lag of 250 milliseconds when the switch was closing, was noted. This situation disappeared when EA pens 48 and 43 were paralleled. Removing pen 43 resulted again in the time lag signal. The pens were left parallel for run.

9. X-1 day operations were continued at 1300 with the start of major command 0090.

7.4 X-1 Day (2nd Attempt, 12 November 1958)

1. All prefiring checks were completed, and X-1 day operations resumed at 1300,12 November 1958, with PCU set-up and the booster & sustainer fill and flush. Both tasks were completed at 1330 hours.

2. Pressurization of the fuel storage tank was started at 1338 followed immediately by filling of the fuel facility line. Completion of both tasks was at 1350.

3. Condition amber was called at 1410 hours.

4. Fuel tanking began at 1420. The missile fuel tank was to be filled to 100% using load cells and totalizer readings. The 90% probe lite functioned properly; the 95% lite flickered but did not come on. At this time the totalizer indicated 11,440 gallons. The 100% lite did not come on. The load cells indicated 69,000 lbs or 10,250 gallons at the approximate 100% level. Fuel was drained back by the fuel totalizer to a final reading of approximately 10,530 gallons. It was assumed that the ullage of this level was 150 cu ft. Specific gravity was .806 #/ft^3 at a temperature of 68°F. Tanking of fuel was completed at 1523.

5. Fuel leak inspection began at 1530. A leak was found at the fuel fill and drain valve. A flush hose was installed to flush away excess fuel. The leak check was completed at 1640.

6. Igniter installation was started at 1649 hours. A bushing from the igniter (installed and removed during the first attempt) was found in the silver dollar. This required a special tool to remove. The igniter installation was completed at 1822 at which time the squib test was performed.

7. X-1 day operations were completed at 1827.

7.5 Precount Operations (2nd attempt)

1. Precount operations began at 1828, 12 November 1958.

2. The thrust section heater was activated at 1832 hours to dispel the GN_2 vapors which had accumulated in the section. The unit was deactivated at 1850.

3. Pressurization of the hydraulic accumulators was completed at 1855.

4. The LO_2 storage tank was pressurized at 1848.

5. Preparation of booster & sustainer hydraulic systems for run was started at 1854. Completion was reported at 1924.

6. A practice countdown and review was accomplished at 2008 hours.

7. The LO_2 heat exchanger was filled with LN_2 at 2027.

8. Transfer of LN_2 to the missile shrouds began at 2039.

9. Precount operations were completed at 2110. Predicted duration for this section was 60 minutes, actual elapsed time was 162 minutes.

7.6 Countdown Operations

1. Countdown operations started at 2111 12 November 1958, and the area placed in Condition Red.

2. At 2124, missile helium bottles pressurization was started. The bottles were pressurized to 3000 psig at 2127.

3. LO_2 system chilldown commenced at 2127. Pump LC was started at 2128. An indication of LO_2 in the missile occurred at 2130 and pumps LA & LB were started.

4. Sustainer gas generator purges were turned on at 2143.

5. LO_2 topping was started at 2147 and maintained at approximately 80 gpm until time of initiating Sequence III.

6. Sequence III pressurization was initiated at 2200.

7. At approximately X-1 minute the LO_2 temperature at the breakaway valve rose to the test readiness limit of -289°F. LO_2 was dumped for approximately 20 seconds (X-60 to X-40 seconds), which lowered the temperature to -293°F.

8. Booster and sustainer ignition was initiated at 2209. Cutoff occurred at 5.08 seconds after engine start via engine timer cutoff.

9. LO_2 detanking started at 2211 and was completed at 2258.

10. Fuel detanking started at 2259 and was completed at 2313.

11. Missile tank pressurization sequence I was set at 2313.

12. The area was placed in condition amber at 2321.

13. Securing operations continued and the area was placed in condition green (stand in local amber) at 2358.

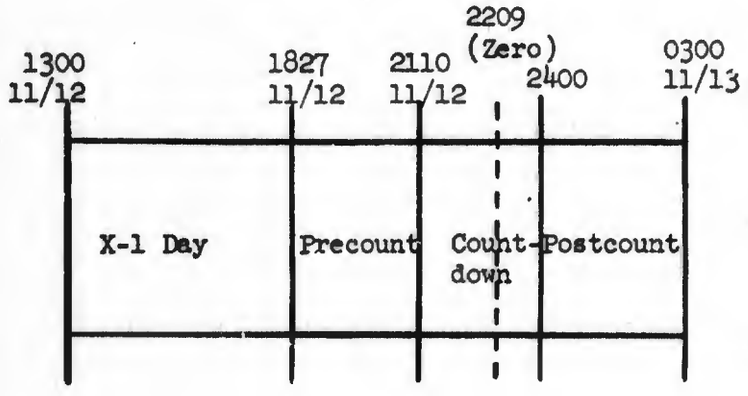
14. Countdown operations were completed at 2400.

15. Predicted duration for this section was 70 minutes. Actual elapsed time was 169 minutes.

7.7 Postcount Operations

1. Postcount operations began at 0010, 13 November 1958.
2. Fuel was drained from the missile fuel tank and engines. Hydraulic, Helium, Engine. PCU, Missile Power, Fuel, Engine Igniter, & Missile CO_2, systems were secured.
3. The missile LO_2 tank was purged. The LO_2 pre-valve leaked excessively, and it was suspected that the pre-valve seal was out of the seal groove.
4. The soft water and trichlor engine flush was accomplished.
5. The facility power console was secured and operations were halted at 0300 hours.
6. Postcount operations were resumed at 0700 hours 13 November 1958. Normal operations progressed satisfactorily with the exception of those for which demating permits more ease of operation, i.e., engine preservation and torque check.
7. Preparations were under way for demating with demating scheduled for the second shift 13 November 1958.
8. The LO_2 pre-valve was being removed for bench check.

7.8 Run Summary (2nd attempt)



Precount:	Scheduled time	60 Min.
	Actual time	163 Min.
	Holds	None
Countdown:	Scheduled time	70 Min.
	Actual time	169 Min.
	Holds	None
Countdown time to zero:		
	Scheduled time	30 Min.
	Actual time	59 Min.

APPENDIX A

History of XSM-65C Missile 2

Missile 2C arrived at Sycamore Canyon Test Site on Sept. 20, 1958 and was erected at S1 on Sept. 22, 1958.

The missile was demated on Sept. 24, 1958 to facilitate strain gage installation and systems checkout. The missile was remated on Oct. 25, 1958.

The following systems checkouts (C/O) were conducted on Missile 2C on the dates listed. Significant difficulties encountered are noted:

1. Actuator Null & Phase Test (STP-1003). 9/24/58

2. LO_2 Tanking Unit Installation Leak and Functional Test. (STP 1120) 9/24/58

3. Intermediate Bulkhead Leak Test (STP 4085). 9/24/58.

4. Engine Leak and Functional Checkout (STP-P-003) 9/30/58.

   During leak check of the BGG LO_2 blade valve, engine purges were activated with the turbine exhaust duct capped. This caused the exhaust duct to be overpressurized resulting in damage to both the exhaust duct and the booster fuel pump inlet ducting. As a result of the damage, both the exhaust duct and the fuel duct had to be replaced.

5. Thrust Chamber Alignment and Actuator Adjustement (STP 4100B). Boosters, 10/3/58; Sustainer, 10/16/58.

6. Shroud LN_2 Level Control Amplifier Calibration (STP-N-501) 10/3/58

7. Missile Power Checkout, "C" Series (STP-E-801). 10/3/58.

8. LO_2 Boil-off Valve Operations Check (STP-F-006). 10/14/58.

9. Missile LN_2 Shroud Leak and Functional Check (STP-F-005). 10/16/58.

10. Interim Propellant Utilization Checkout (STP-U-005). 10/21/58.

11. Sustainer Overspeed Filter Checkout (STP-P-006). 11/6/58.

    During the first attempt to accomplish this C/O, Oct. 11, 1958, the upper cutoff frequency was found low and the unit was replaced. An electrical fire in the Ground Box made it necessary to replace the unit. The new unit gave cutoff at 950 cycles, however, a spurious cutoff signal was generated at engine reset. The unit was IRed and sent to Rocketdyne for rework. When re-installed, as a prototype unit, it gave cutoff at 945 cycles.

12. Missile Hydraulic System Fill and Bleed - 1st Stage (STP 4186 & ZE-7-124). 10/21/58

13. Engine CO_2, Booster and Launcher Coolant Checkout (STP-M-003). 10/22/58

14. Rough Combustion Cutoff System Readiness Test (STP-C-001). 10/23/58

15. Ground and Airborne Pneumatic Systems Readiness Test (STP-F-004). 10/22/58

16. Propulsion Staging Disconnects Leak Check (STP-P-003 Addendum). 10/27/58

17. Igniter Squib Test, Series "C" Missile (STP-P-004). 10/30/58

An integrated systems test (S1-3CM-01-02) was initiated on Oct. 29, 1958 and concluded Nov. 1, 1958. This test concluded the missile systems checkout. During Post-countdown operations while changing over from ground to tower pressurization, the flexible diaphram in the A/B LO_2 tank relief valve was ruptured. The diaphram was ruptured by overpressurization of the LO_2 tank pressurization duct with the duct manual shut-off valve closed. The relief valve was replaced.

The first attempt to static test missile 2C (Run S1-301-A1-02) on November 7, 1958 was aborted while final preparations were being made prior to entering the 30 minute countdown. The reason for aborting the run was the collapse of the 11 in. LO_2 duct approximately 5 feet below the LO_2 prevalve. The cause of the collapse appeared to be the cooling and subsequent contraction of helium gas sealed in the duct between the booster and sustainer main LO_2 valves and the LO_2 prevalve. Apparently LN_2, which had been in the missile shrouds for approximately three hours, greatly aided the temperature change which lead to collapse of the duct. The LO_2 duct was replaced on the following day.

Also, during post-countdown activities, while attempting to check the A/B regulator and relief valve settings, contamination of the fuel pressurization system by hydraulic oil was discovered. At this time, the actual cause of the contamination has not been determined, however, it is suspected that the booster or sustainer hydraulic reservoir pressurization check valve malfunctioned. Examination disclosed that the contamination extended from the check valve through the A/B fuel regulator and relief valve, the RVU to approximately 15 feet downstream of the PCU. The contaminated plumbing was cleaned and the following items were replaced.

1. Fuel Tank Press. A/B relief valve.
2. Fuel Tank Press. A/B regulator.
3. Fuel Tank Press. system flex hose in Q III of the test stand at plates above RVU.

4. RVU M/O gate valve - 72A.
5. RVU M/O gate valve - 72B.
6. RVU M/O gate valve - 72C.
7. RVU differential press. switch - #78.
8. Booster hydraulic reservoir pressurization check valve.
9. Sustainer hydraulic reservoir pressurization check valve.
10. Fuel press system flexline - launcher to disconnect plate.

To prevent a recurrence of contamination, the hydraulic reservoir pressurization lines were disconnected from the fuel pressurization duct and capped off at the duct. Pressure for the hydraulic reservoir was supplied by a K-bottle connected to the hydraulic reservoir pressurization line. These changes were interim for Run 1 only. The reservoir charge lines will be remocked prior to Run 2.

On Nov. 10, 1958, while conducting X-1 day activities in preparation for the second attempt to accomplish Run S1-301-A1-02, a noise was detected in the missile hydraulic system at the time the hydraulic checkout cart was set up. This condition was eliminated when the "B" series servo-amplifier canister (7-41011-895) was replaced with a "C" series S/A canister (7-41011-933, S/N 33).

The second attempt to conduct run S1-301-A1-02 was successfully accomplished on November 13, 1958. The primary objectives were attained.

APPENDIX B

Test Directive Summary

1.0 The following Test Directive summary lists the missile systems and test conditions applicable to test S1-301-A1-02. For more detailed information, refer to TD S1-2C-Block One. In any case where information given in the Test Directive conflicts with that listed in the summary, the values given below are correct.

1.1 Airframe

1.1.1 Main body assembly (7-00009) complete with ground handling and erection nose fixture, sustainer section, jettisonable booster section, dummy retarding rocket assemblies, and separation systems for the sustainer and nose sections.

1.1.2 The missile ground handling and erection nose fixture is modified by the addition of 2600 lbs of lead ballast. A nose adapter (7-78001) connects the nose fixture and body assembly.

1.2 Propulsion System

1.2.1 North American Aviation MA-1 propulsion system consisting of an XLR-89-NA-1 booster engine, S/N NA-112017, an XLR-105-NA-1 sustainer engine, S/N 222017, and an XLR-101-NA-1 vernier engine, (V-1 S/N 332041 & V-2 S/N 332032) installed in accordance with Convair drawing 7-20003.

1.2.2 Regulator Settings

1) Vernier LO_2 tank 520 $\pm$ 15 psig.
2) Vernier fuel tank 535 $\pm$ 15 psig.
3) Booster & sustainer LO_2 start tank reg. 500 $\pm$ 20 psig.
4) Ground fuel start tank reg. 800 $\pm$ 40 psig.
5) Booster GG LO_2 reference reg. 525 $\pm$ 10 psig.
6) Sustainer GG LO_2 reference reg. 745 $\pm$ 10 psig.
7) Booster control pneumatic reg. 750 $\pm$ 20 psig.
8) Sustainer control pneumatic reg. 750 $\pm$ 20 psig.

1.2.3 Timer Settings

1) Start delay cutoff timer (K49C) 60 sec.
2) Vernier tanks pressurizing timer (K46C) 10 sec.
3) Take-off simulator (K82C) 1.6 sec.
4) Ignition delay cutoff (K55C) 5 sec.
5) Ignition detector timer (K56C) 1.2 sec.

1.2.4 Overspeed Trip

The sustainer overspeed trip filter unit was set to initiate cutoff if output exceeded 946 cps, or 11,352 rpm.

1.2.5 RCC Setting

The RCC was set to initiate cutoff as follows:

Sustainer -- 100 g's -- 40 milliseconds
Booster -- 60 g's -- 40 milliseconds

1.3 Propellant Tanking

1.3.1 The fuel tank was filled to a level corresponding to 150 cubic foot ullage volume.

1.3.2 The missile LO_2 tank was filled to a calculated 2.25 mass ratio based on load cell readings.

1.4 Pneumatic System

Missile propellant tank pressurization and engine control pressurization were supplied by the airborne pneumatic system (7-81100 and 7-81101). The system was continuously replenished by the facility helium system at a maximum rate of 30 lbs/min.

1.4.1 PCU LO_2 & Fuel Tank Regulator and Relief Valve Settings

	LO_2 Tank (PSIG)		Fuel Tank (PSIG)	
Sequence	Reg.	Rel. Vlv.	Reg.	Rel. Vlv
I	2.1 + .1-0	3.5	6.9	8.0
II	2.1 + .1-0	3.5	32.0 $\pm$ .1	32.5 $\pm$ .2
III	25.7 $\pm$ .1		59.5 $\pm$ 2	

1.4.2 Missile Airborne Regulator and Relief Valve Settings

	Reg.	Rel. Vlv
LO_2 Tank	23.7 to 28.2	28.1 $\pm$ .1
Fuel Tank	57.0 to 62.2	62.1 $\pm$ .1

1.4.3 LO_2 Boil-off Valve setting: Relieve 3.1 psig Reset: 2.25 psig

1.5 Hydraulic System

1.5.1 Missile hydraulic requirements were supplied by the airborne hydraulic systems (7-84124).

1.6 Electrical System

1.6.1 Electrical power required for missile operation was supplied from the ground system.

1.7 Flight Control System

1.7.1 Main components of the Autopilot system consisted of a servo-amplifier canister (7-41011-933), 4 booster actuator assemblies (7-84200), 2 sustainer actuator assemblies (7-84501), and 4 vernier actuator assemblies.

1.7.2 A harness adapter has been installed by TVA 90010 to provide continuity of pitch and yaw servo signals, since the gyro canister is not provided for Block One testing.

1.7.3 The thrust chambers were held in the null position.

1.8 Propellant Utilization (PU) Systems

1.8.1 Both the PU Manometer system (7-43009) and the Vibrotron Monitor Unit were used to sense missile proprellant tank head pressures.

1.8.2 The PU valve was held at the null position of 30.4 degrees.

APPENDIX C

RED LINE VALUES VS RECORDED DATA

MEASUREMENT		UNITS	REDLINE		RECORDED	
NUMBER	DESCRIPTION		LL	UL	Min	Max
F1001P	LO_2 Tank Helium	PSIG	18	28.5	26	27
F1003P	Fuel Tank Helium	PSIG	53	62.5	59	60
F1003P	Fuel Tk He -2nd Stage	PSIG	40	--	--	--
H1140P	Vern Hyd Press	PSIG	2000	--	2859	3203
P1010P	B1 Lube Oil Man	PSIG	550	985	890	900
P1332P	S LO_2 Pump Disch	PSIG	--	1050	835	909
P1341P	S Lube Pump Gear	PSIG	400	--	757	757
P1018T	B1 Turbine Inlet	DGF	--	1400	78	1262
P1209T	B2 Turbine Brg	DGF	--	600	70	72
P1213T	B1 Turbine Brg	DGF	--	600	67	80
P1323T	S Turbine Brg	DGF	--	750	60	70
P1324T	S Pump Brg - LO_2	DGF	--	300	48	52
P1336T	S Gas Gen Disch	DGF	--	1400		1400 C/O
ST141T	Fire Detector-Edison	DGF	--	600		200
P1528D	S Main Fuel Valve	DEG	20	48	34.5	

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APPENDIX D

TEST CONSTANTS

Barometric Pressure	29.575	In. Hg
Temperature	55	dgf
Relative Humidity	73	percent
Dew Point	48	dgf
Wind	SSE at 2	MPH
Fuel Density	50.31	lbs/ft^3
LO_2 Density	70.4	lbs/ft^3
B1 Thrust Chamber Throat Area	206.43	In^2
B2 Thrust Chamber Throat Area	205.13	In^2
Sustainer Chamber Throat Area	67.041	In^2
Vernier Squibs Firing	2209 Hrs 46.14 sec.	PST
BGG Links Break	2209 Hrs 48.71 sec.	PST
BGG Links Break to Booster Cutoff	5.05	Seconds
BGG Links Break to Vernier Cutoff	5.06	Seconds
BGG Links Break to Sustainer Cutoff	5.07	Seconds

Surface weather data were secured from the Miramar Weather Office for 2200 PST. Test time was referenced to BGG igniter links break. This was Sycamore Test Number S1-301-A1-02.

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