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LAUNCH VEHICLE FLIGHT REPORT

NASA PROJECT APOLLO
LITTLE JOE II QUALIFICATION TEST VEHICLE 12-50-1 [U]

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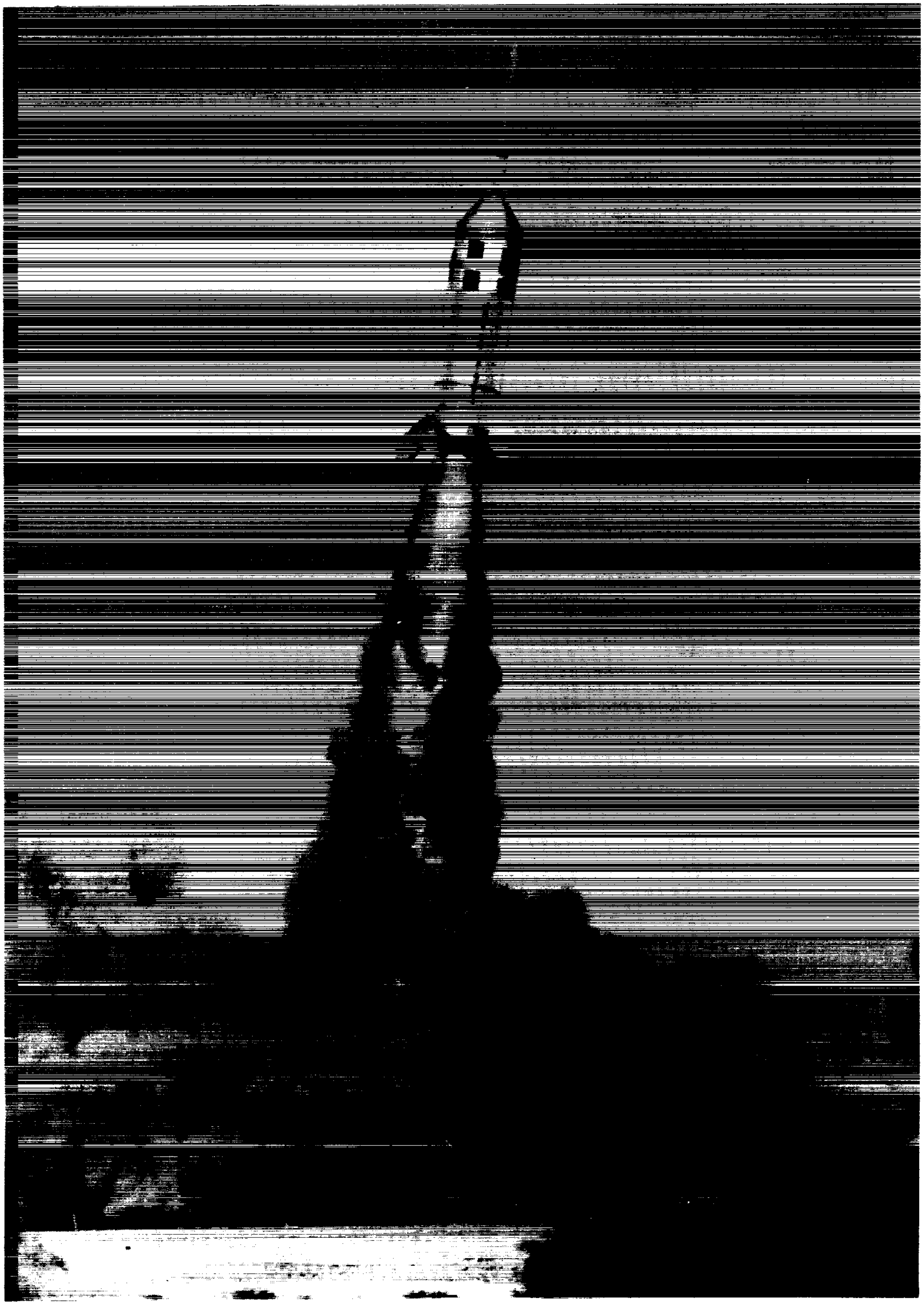


Launch of Little Joe II QTV No. 1 at WSMR, 28 August 1963

1 | INTRODUCTION

The Little Joe II Qualification Test Vehicle, Model 12-50-1, was launched from Army Launch Area 3 (ALA-3) at White Sands Missile Range, New Mexico, on 28 August 1963. This was the first launch of this class of boosters.

The Little Joe II Launch Vehicle was designed as a test vehicle for boosting payloads into flight. For the Apollo Program, its mission is to serve as a launch vehicle for flight testing of the Apollo spacecraft. Accomplishment of this mission requires that the vehicle be capable of boosting the Apollo payload to parameters ranging from high dynamic pressures at low altitude to very high altitude flight. The fixed-fin 12-50 version was designed to accomplish the low-altitude parameter. The 12-51 version incorporates an attitude control system to accomplish the high altitude mission.

This launch was designed to demonstrate the Little Joe II capability of meeting the high dynamic pressure parameter for the Apollo Program. For this test, a boiler-plate version of the Apollo capsule, service module and escape tower were attached to the launch vehicle to simulate weight, center of gravity and aerodynamic shape of the Apollo configuration. No attempt was made to separate the payload in flight. The test was conducted in compliance with Project Apollo Flight Mission Directive for QTV-1, NASA-MSC, dated 3 June 1963, under authority of NASA Contract NAS 9-492.

2 | SUMMARY OF LAUNCH OPERATIONS

2.1 GENERAL

Figure 2-1 indicates the significant vehicle/launcher milestones accomplished during the period from factory assembly and checkout through to the date of launching the Little Joe II QTV-1 at WSMR. (Photos of major events in the program are presented in Figures 2-2 through 2-13.) The following time spans required to accomplish tasks in the program schedule should also be noted.

a.	From contract go-ahead on 14 May 1963 through launch date	— 15-1/2 months
b.	From initiation of vehicle assembly on launcher in San Diego to delivery of vehicle to WSMR	— 15 weeks
c.	From arrival of vehicle at WSMR through launch	— 6 weeks
d.	From initiation of vehicle assembly on launcher through NASA acceptance (launching accomplished one day later)	— 3 weeks
e.	Time required to accomplish vehicle/payload OCIs (total of 32)	— 15 days
f.	Time required to accomplish dry run (only one necessary)	— 1 day
g.	Launch countdown time (no holds required)	— 6 hours 10 minutes

2.1.1 PREPARATION OF TEST SITE FACILITIES — On 31 July 1962, the first of a series of periodic meetings at WSMR was held to initiate the coordination of facilities requirements — particularly, the design criteria to adapt the ALA-3

Army Launching Area for the overall and/or joint requirements for the Apollo Spacecraft and Little Joe II Test Program. NASA, North American, General Dynamics/Convair, WSMR Post Engineers, and the Albuquerque District of the Corps of Engineers were the major participants in the meetings. Facility re-requirements reports submitted by contractors for the Apollo payload and Little Joe II QTV were also utilized to finalize the facility criteria, which was to be government furnished. On 10 April 1963, the new pad built on the ALA-3 complex was available to permit initiation of the Convair task associated with launcher rail installation. On this same date, the Convair field organization was activated when a portion of Building 1540 in the WSMR administrative area was allocated for offices, storage, and shop work area. (See Section 11 of this report for additional information.)

2.1.2 SAN DIEGO FACILITY OPERATIONS — Launcher/vehicle assembly and checkout was conducted in San Diego to simulate as much of the operations required at WSMR as feasible. This activity was conducted from March through 12 July 1963. Basic deviations to the WSMR operation included use of dummy rocket motors in lieu of live motors, and a terminal board installation which simulated the wiring continuity associated with the junction box installation in the blockhouse, cable trench, and power room at WSMR. The ground support equipment was also proof checked during this period.

2.1.3 WSMR FACILITY OPERATIONS — Facility preparations by Convair, which included installation of the launcher, J-boxes, test console, equipment rack, and interconnecting wiring installations, were accomplished from 10 April through the launch facility complex checkout on 8 August 1963. The fins, launch escape system, vehicle body and dummy payload modules arrived at WSMR on 15, 16, 17, and 18 of July, respectively.

Following the receiving inspection, the vehicle remained in standby status for storage until 26 July, when go-ahead was given by NASA for the Little Joe II QTV mission to precede the NAA Payload Abort Test Mission. On 6 August, vehicle buildup on the launch pad was initiated. NASA accepted the launch vehicle, launcher and associated facility wiring installations three weeks later, on 27 August 1963, and the test vehicle was successfully launched the following day. NASA provided overall program control, including final approval of the individual tasks accomplished.

The facilities and services provided by WSMR are discussed in Reference 1. WSMR support items included calibration services; vehicle components and installations provided for the command destruct and radar beacon tracking subsystems, plus the checkout equipment and services for these subsystems; and logistics support of the vehicle and rocket motors on the base.

2.2 FLIGHT TEST RESULTS

The Little Joe II Qualification Test Vehicle was launched from Army Launching Area 3 at the White Sands Missile Range, New Mexico, at 0900 hours MST on 28 August 1963.

All rocket motors lit off according to design. Vehicle stability was excellent at lift-off and throughout the flight trajectory. The flight path presented a slightly lower trajectory than planned; however, flight conditions adequately demonstrated the Little Joe II capability of meeting the Apollo Mission A-001 test point and the flutter-free characteristics of the fixed fin in the transonic region. The only test objective not achieved was the Algol motor thrust termination. The test vehicle impacted approximately 9 miles north of the launch site. Recovery teams moved in immediately to secure the area for evaluation of the abort failure.

A summary of test results indicates the following:

a. Launch trajectory attained the A-001 Apollo mission test conditions of approximately 0.90 Mach and 600 psf dynamic pressure for the period of 26.1 to 29.3 seconds following lift-off. Preliminary data indicates a slight roll during flight, reaching approximately 90 degrees at test point.

b. Algol and Recruit rocket motors operated satisfactorily. Average Algol thrust during web burning time was 105,100 pounds, with a total impulse of 4,123,000 pounds-seconds.

c. Base pressures were consistent with experimental data for similar bodies, and indicated a base drag of 35,800 pounds at maximum dynamic pressure. All pickups gave notably identical pressure readings, regardless of their varied locations along the surface of the vehicle base.

d. Analysis of flutter characteristics of the launch vehicle showed that the fixed fin was flutter-free throughout the flight regime tested, and that body bending modes were of relatively small amplitude. Vibration was characteristically low level.

e. Stresses due to thrust were approximately as predicted. A base temperature rise of only 31° F (calculated from calorimeter data) during flight to point of thrust termination signal indicates that base insulation was not necessary. Internal pressures and temperatures were well below critical environmental conditions.

All range data had not been received and telemetry data was not completely reduced at the time of publication of this report. Final analysis will be provided in a revision to be published when complete data is available.

Table 2-1 summarizes significant test results. All times are referenced to missile 4-inch lift-off as zero time — occurring at 0900:2.348 MST.

2.3 TEST OBJECTIVES

The purpose of this test was to demonstrate the capability of the launch vehicle to perform adequately the launch phase of Apollo Mission A-001 with its particular rocket combination. Achievement of this and supporting objectives is indicated in Table 2-2.

Table 2-1. Flight Test Results

	Units	Planned	Actual
Time:			
Date	---	28 Aug. 1963	28 Aug. 1963
First blast	Sec.	----	-0.08
Zero-range time (4 in.)	Sec.	57,600	57,602.348
Zero-WWV time (4 in.) MST	Hr./Min./Sec.	0900:00	0900:02.348
Apollo Mission A-001 test point	Sec.	28.3	26.1/29.3
Recruit burnout	Sec.	---	2.21
Algol burnout	Sec.	---	42.39
Thrust termination command received at vehicle	Sec.	32.5	32.4
Impact	Sec.	104	99.07
Launcher Geometry:			
Launcher azimuth	Noted	04° 57'	04° 56' 30"
Launcher elevation	Noted	82° 48'	82° 48'
Flight Parameters:			
A-001 test point			
Altitude	Ft., MSL	18,400	16,240/18,390
Mach No.	Mach	0.90	0.85/0.93
q	$Lb./Ft.^2$	600	595/650
Flight path angle	Deg.	51	42/46.1
Range	Ft.	6,600	7,060/9,270
Thrust termination command			
Altitude	Ft., MSL	22,000	20,440
Mach No.	Mach	1.02	0.98
q	$Lb./Ft.^2$	650	675
Flight path angle	Deg.	---	37.5
Range	Ft.	---	11,750

Table 2-1. **Flight Test Results (Continued)**

	Units	Planned	Actual
Flight Parameters: (cont.)			
Algol burnout			
Altitude	Ft., MSL	---	25,860
Mach	Mach	---	0.88
q	Lb./Ft.^{2}	---	437
Impact, Relative to Launcher -			
X	Ft.	---	48,350.67
Y	Ft.	---	2,743.13
Z	Ft.	---	-108.71
Environment:			
Algol grain temperature - 0515 MST			
Inner grain	° F	70	70
Outer grain	° F	70	70
Surface wind			
Velocity	Knots	---	2
Direction	Deg.	---	70
Instrumentation Performance: (After Launch)			
Telemetry, mandatory	%	100	100
Telemetry, highly desirable	%	100	100
Telemetry, desirable	%	100	100

Table 2-2. Test Objectives

Objective (Ref. 2)	Order*	Achieved Yes	Achieved No	Notes
Demonstrate capability of the launch vehicle to clear the launcher at lift-off successfully.	1	X		
Demonstrate capability of the launch vehicle to perform adequately the launch trajectory of Mission A-001.	1	X		
Demonstrate the Algol motor thrust termination system.	1		X	1
Demonstrate the adequacy of the operational procedure of launcher elevation and azimuth setting to compensate for winds existing at time of launch.	1	X		
Determine the vehicle base pressure.	1	X		
Determine base heating.	1	X		
Demonstrate that the launch vehicle fixed fins are flutter-free in the transonic region.	1	X		
Demonstrate structural integrity of the launch vehicle to perform the Mission A-001.	1	X		
Evaluate the techniques and procedures which contribute to efficient operations involving the launch of Apollo payloads on the Little Joe II launch vehicle.	2	X		2
Demonstrate the functional performance and structural adequacy of the ground support equipment.	2	X		
Evaluate procedures for ground command abort to be used for Mission A-001.	2	X		2
Determine the overall vehicle flexible body response.	2	X		

* 1 - First order objective (mandatory).
2 - Second order objective (required).

Notes:

1. Refer to Section 15.
2. Defer to NASA.

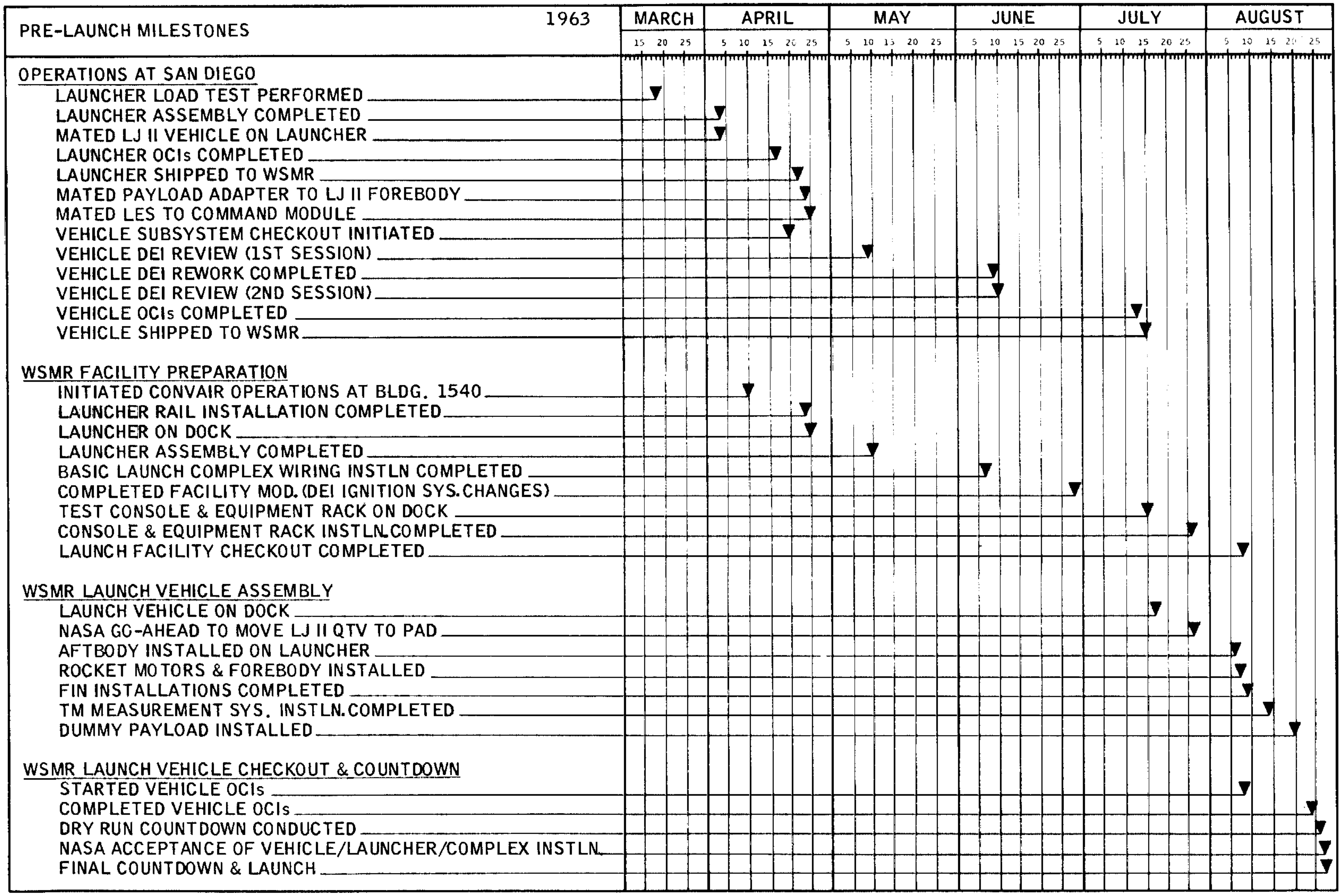


Figure 2-1. Little Joe II QTV No. 1 Pre-Launch Milestones

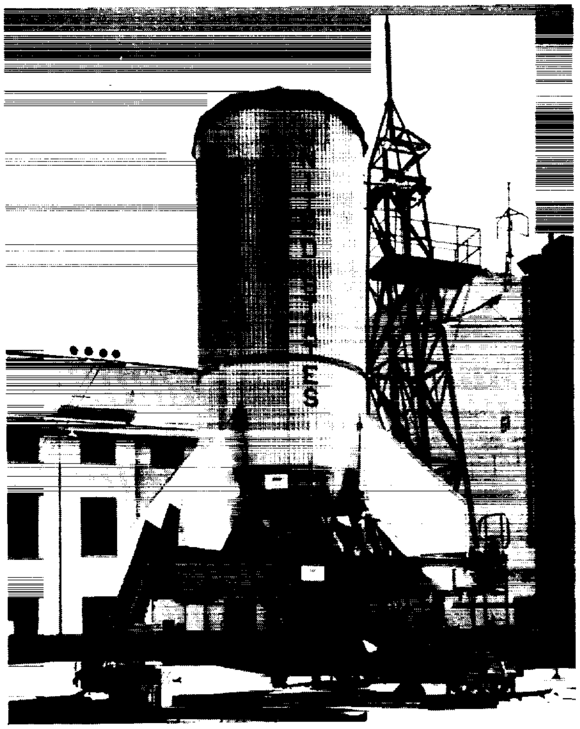


Figure 2-2. Launch Vehicle and Launcher Assembly

Figure 2-3. Launch Vehicle and Dummy Payload

Figure 2-4. Development Engineering Inspection — NASA and Convair on 9 May 1963

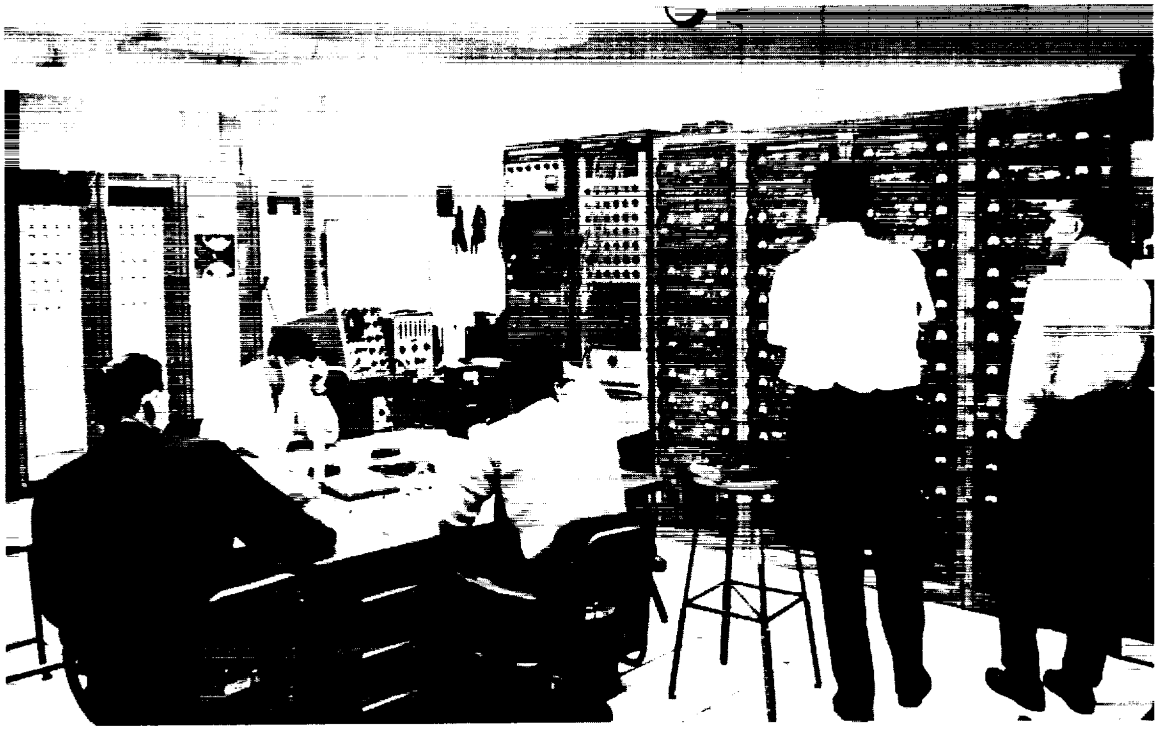


Figure 2-5. TM Data Station Operations at Convair During Little Joe II QTV No. 1 Checkout

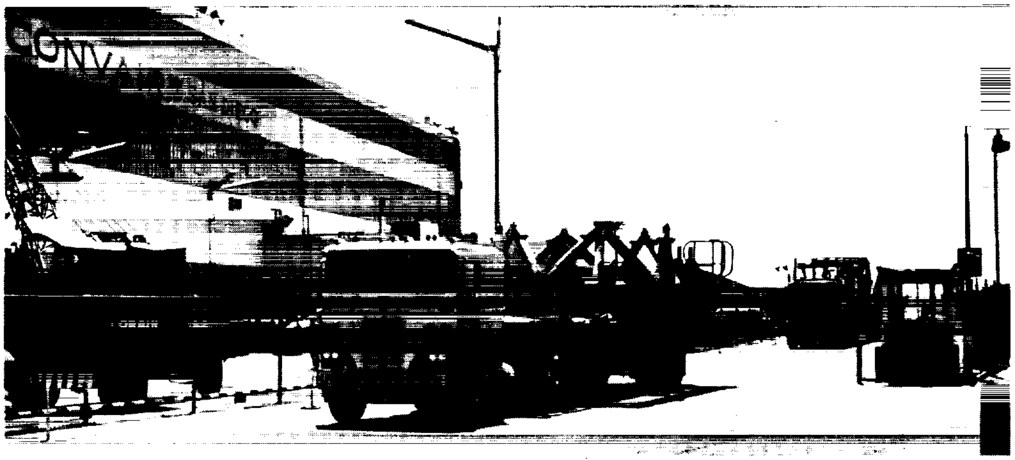


Figure 2-6. Launcher Leaving Convair for WSMR

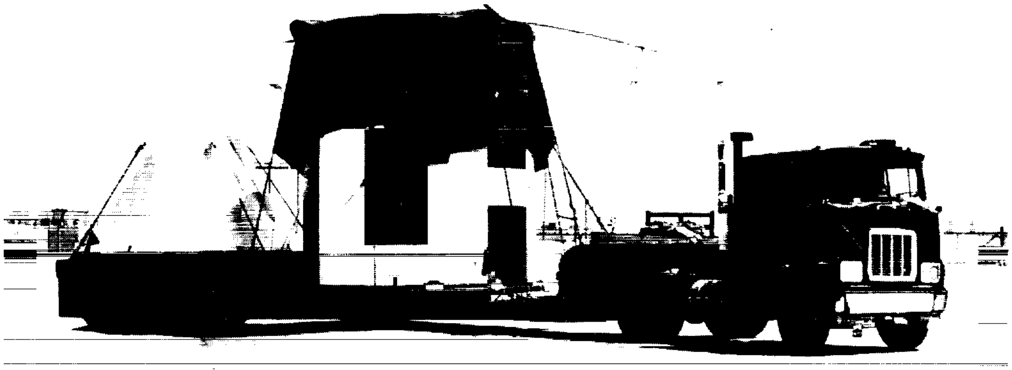


Figure 2-7. Dummy Payload Modules Ready for Transport to WSMR

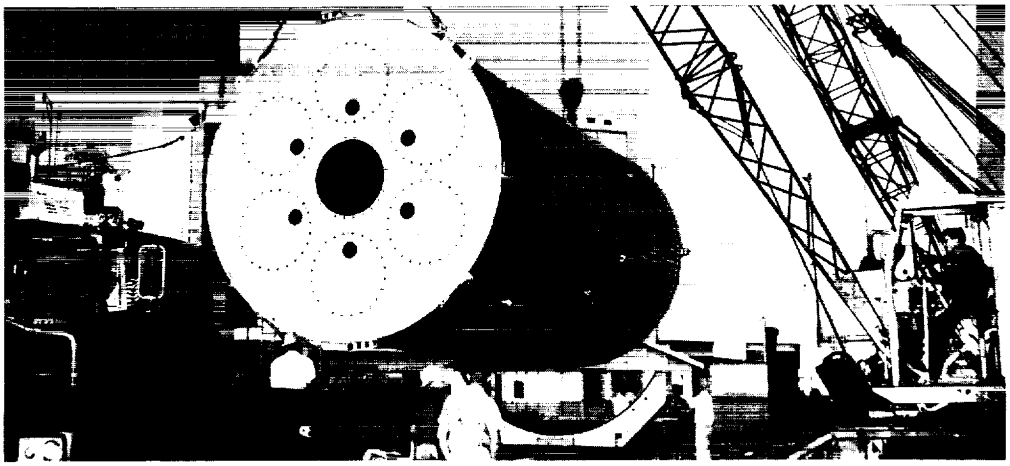


Figure 2-8. Little Joe II 12-50-1 Launch Vehicle
Being Loaded on Transportation Trailer

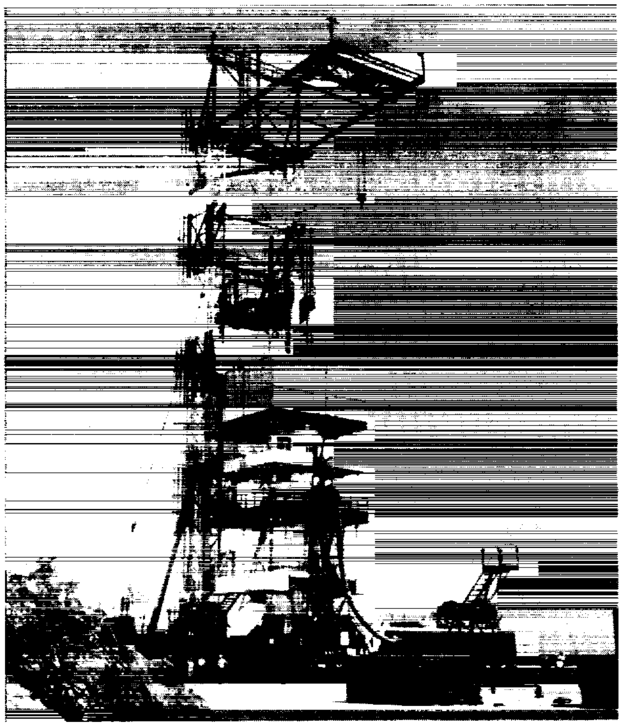


Figure 2-9. Little Joe II QTV No. 1 Enclosed by Service Tower Platforms, and Air Conditioning Trailer Connected to Vehicle

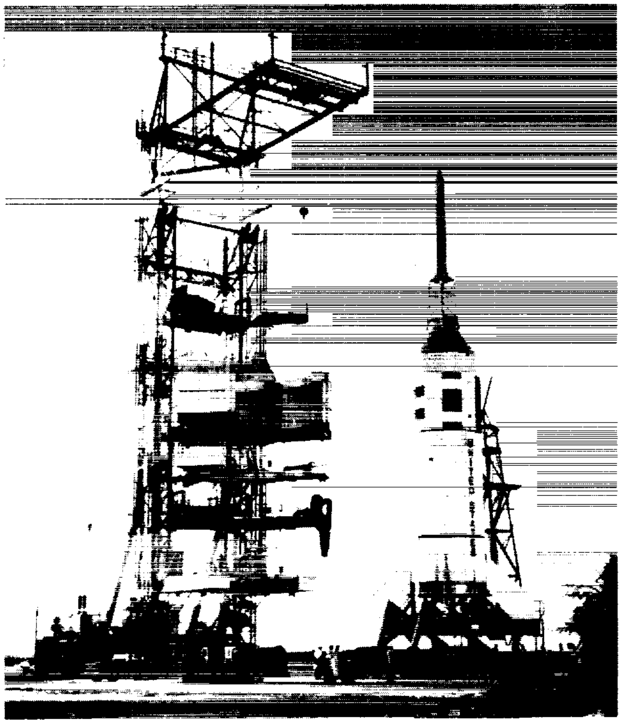
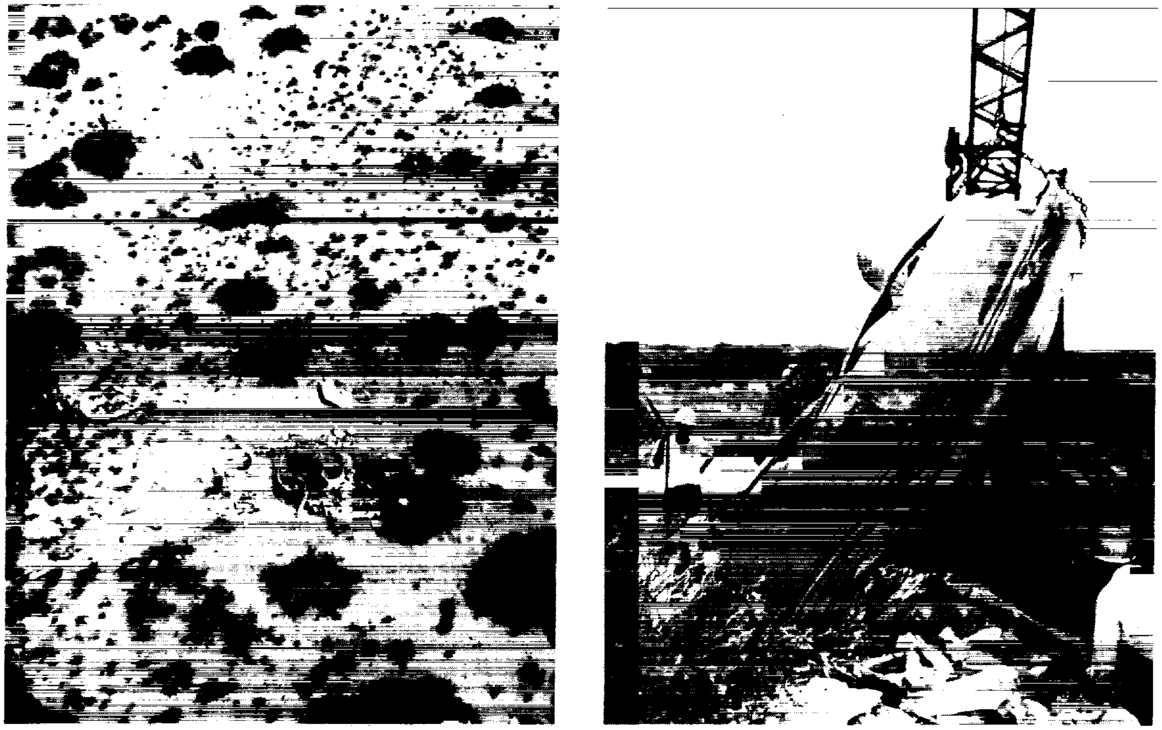


Figure 2-10. Service Tower Withdrawn and Launcher Rotated 90° in Azimuth

Figure 2-11. Little Joe II QTV No. 1 in Launch Position

Figure 2-12. Launch of Little Joe II QTV No. 1



Aerial View of Impact

Crane Lifting Debris

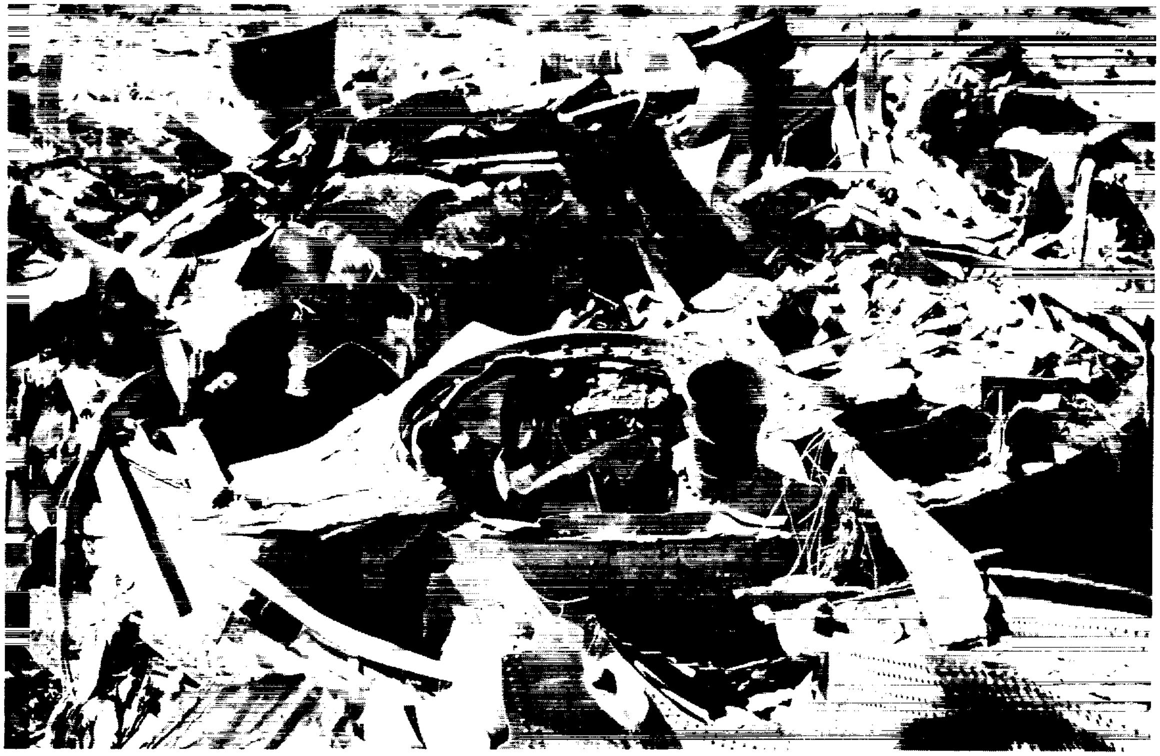


Figure 2-13. Little Joe II QTV No. 1 Impact Area at WSMR

3 | TRAJECTORY

3.1 SUMMARY

The Little Joe II QTV-1 flight essentially attained the desired test conditions of 0.9 Mach and 600 psf dynamic pressure. The flight window is considered to be from time 26.1 seconds, Mach 0.85, and dynamics pressure of 595 psf to time 29.3 seconds, Mach 0.93, and dynamic pressure of 650 psf.

Complete trajectory analysis can not be made since final WSMR range data is not available at this time. Additional data and analyses will be included in a planned revision of this report.

3.2 TRAJECTORY ANALYSIS

Flight trajectory data shown in Figures 3-1 through 3-3 can be compared with the predicted trajectory. Differences between the flight trajectory and that predicted are partially the result of major differences between actual flight conditions and those used to compute the predicted trajectory. The predicted trajectory was based upon the following:

a. ARDC (1959) standard atmosphere (see Figure 3-4).

b. Predicted Algol LJ-6 motor thrust, which is higher than the test thrust.

c. Predicted base drag which, upon preliminary analysis, differs significantly from base drag measured during the ascent to test conditions.

The launch angles (82° 48' elevation, 4° 57' azimuth) and the test drag wing data (Figure 3-5) were also used in computing the predicted trajectory.

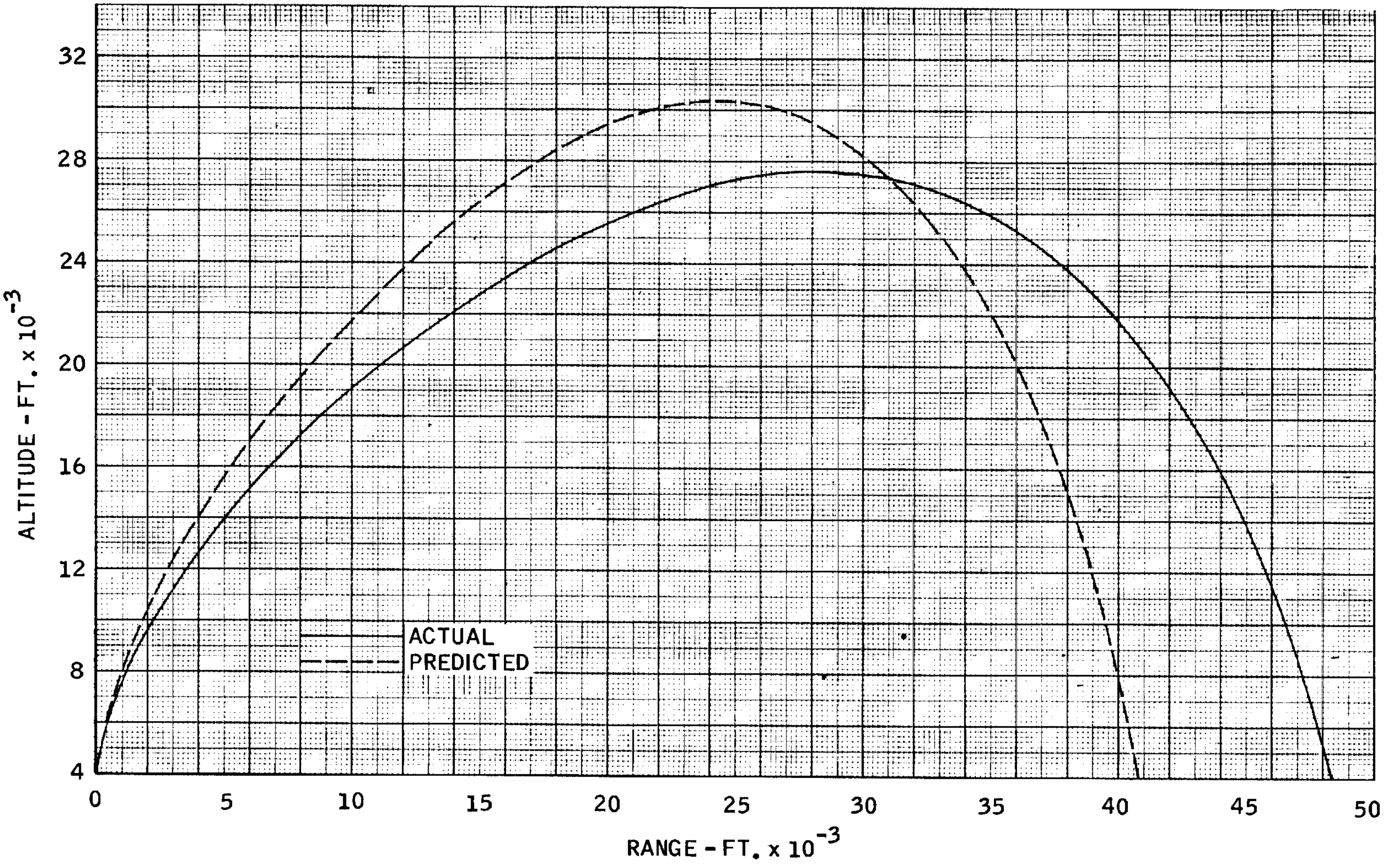


Figure 3-1. Trajectory

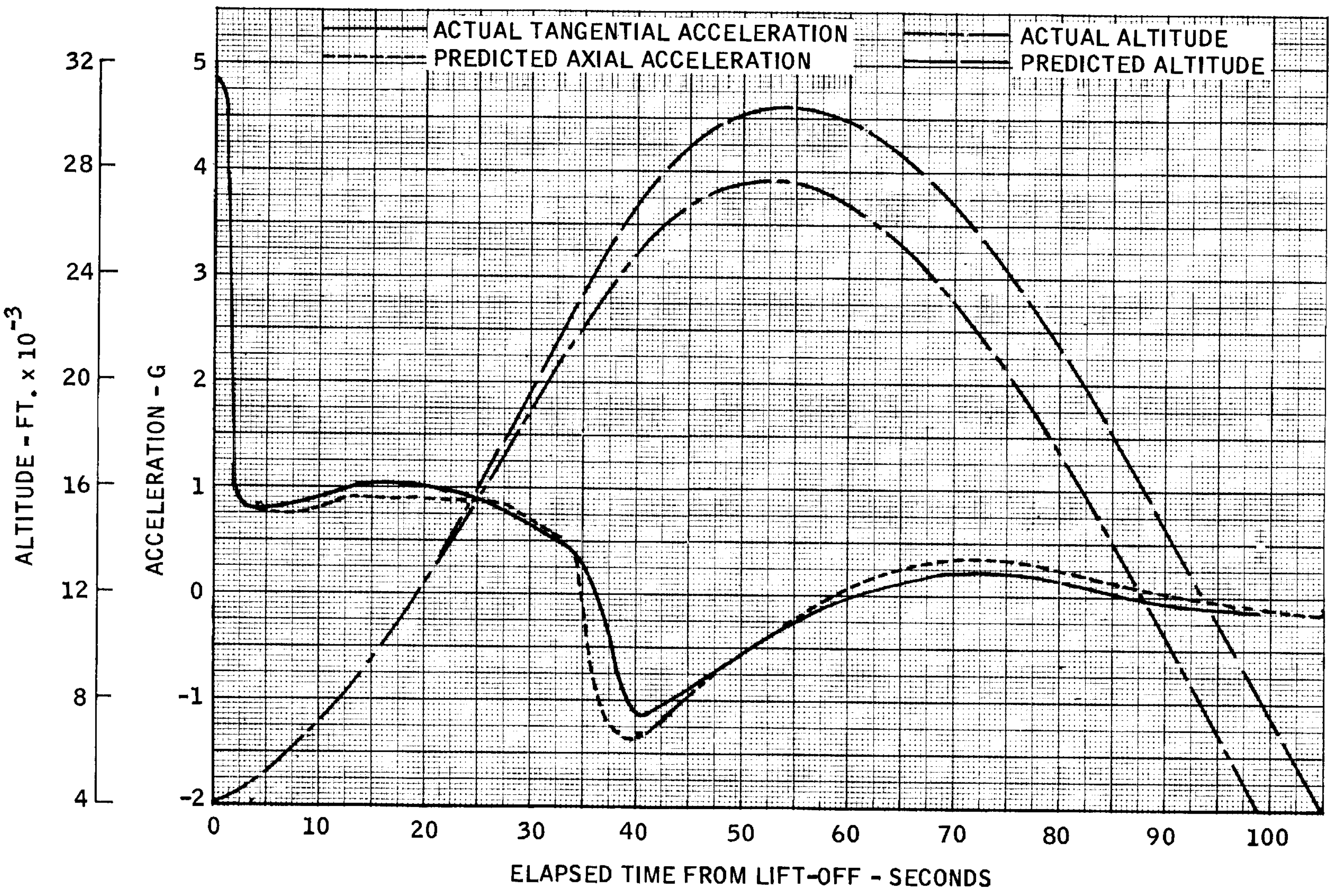


Figure 3-2. Tangential Acceleration and Altitude

During ascent, the pitch attitude was lower than predicted, being 46° upon entry into the test condition window at 26.1 seconds. Perfect fin and thrust alignment were assumed for the predicted trajectory, whereas small but acceptable fin misalignment did exist and possible minor thrust misalignment may also have existed. Final roll and attitude data are not available; however, preliminary data indicated that the vehicle had completed approximately 90° of roll at the time that the test condition was achieved.

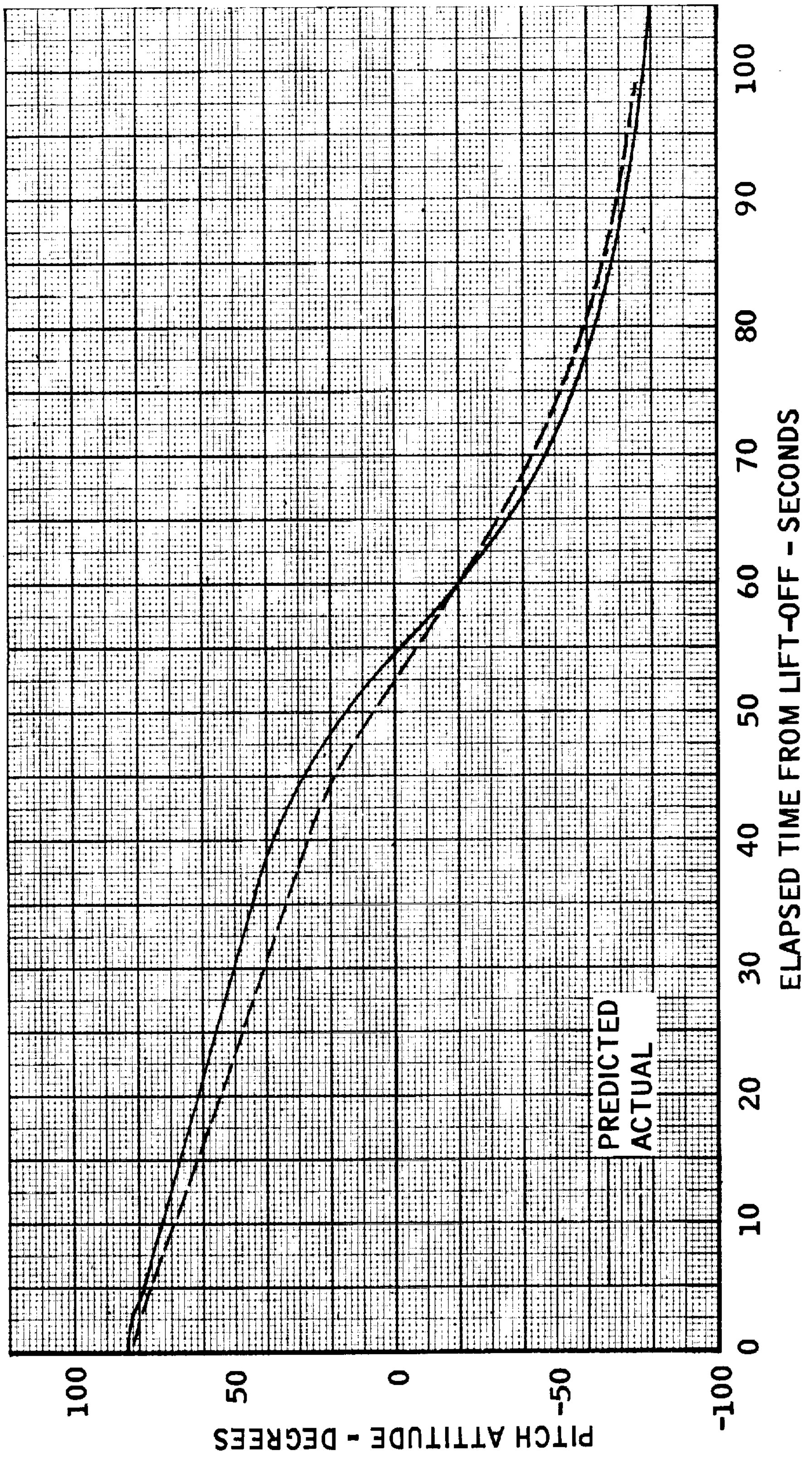


Figure 3-3. Pitch Attitude

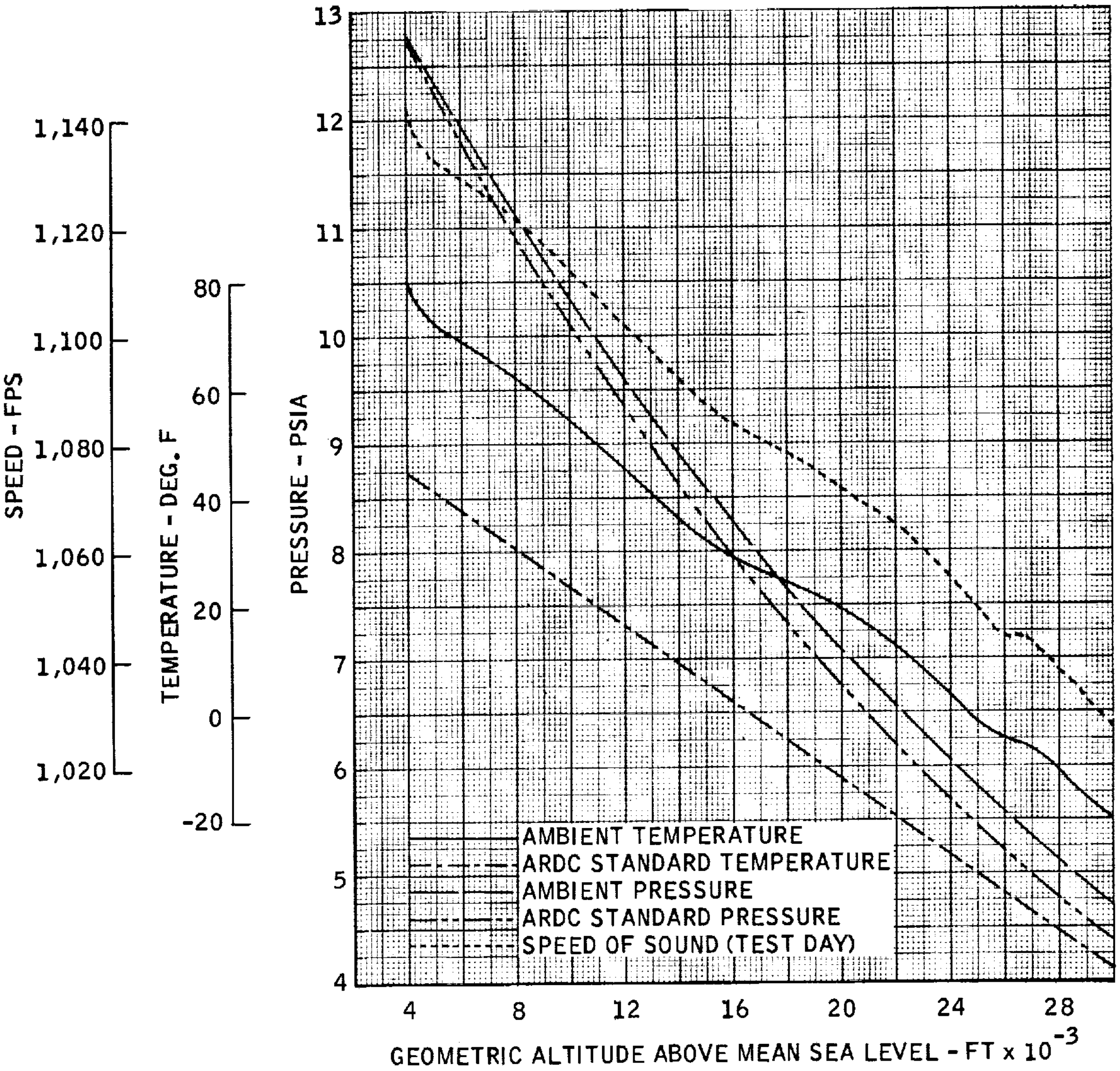


Figure 3-4. Atmospheric Pressure, Temperature and Speed of Sounds

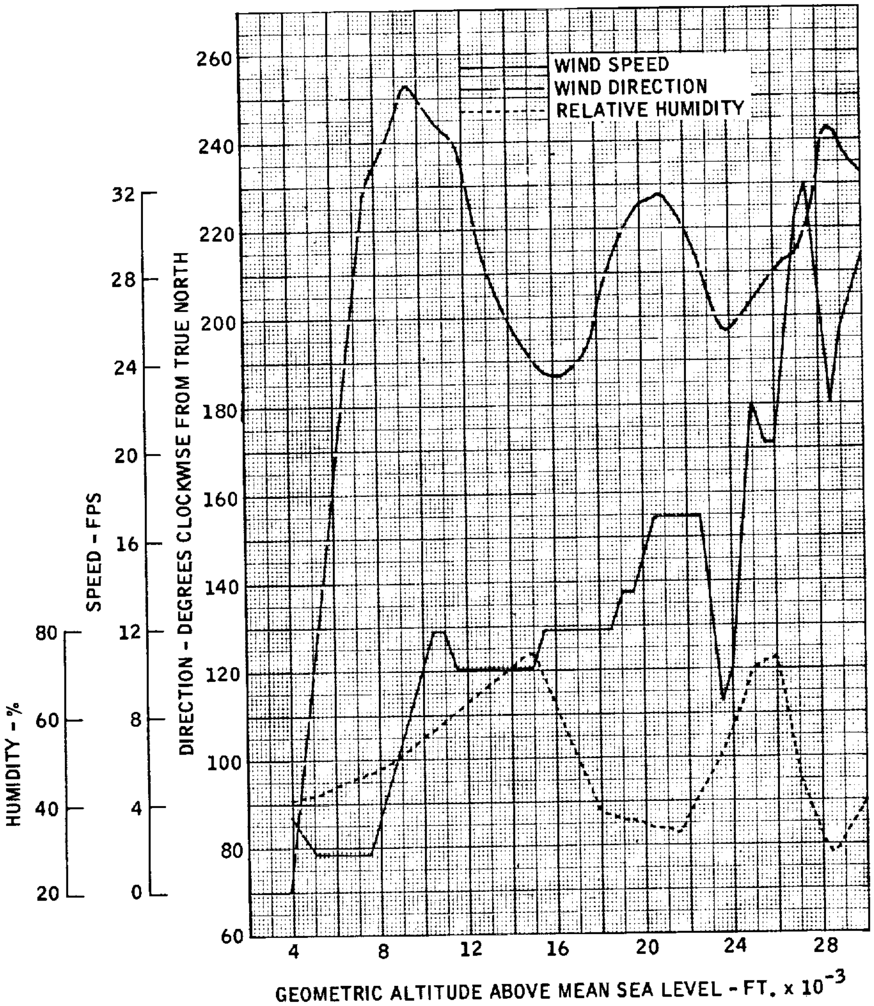


Figure 3-5. Wind Velocity and Relative Humidity

4 PROPULSION SYSTEM ANALYSIS

4.1 SUMMARY

All motors were successfully ignited and operated satisfactorily. With the exception of Algol thrust termination, all missions were successfully accomplished. Analysis of the Algol thrust termination system is presented in Section 15 of this report.

4.2 RECRUIT MOTORS

The only measurements (Figure 4-6) made of Recruit rocket performance were rocket case temperatures (Figure 4-1). These indicated generally normal operation of all Recruit motors.

4.3 ALGOL MOTOR

The Algol rocket motor operation was normal. Chamber pressure and burning time are shown in Figure 4-2. Predicted web burning time of this motor, with a propellant grain temperature of 70° F, was 33 seconds at an average chamber pressure of 465 psi. Actual web burning time was 35 seconds with an average chamber pressure of 436 psi.

4.4 THRUST COMPUTATIONS

Propellant grain temperature used for all motors was 70° F. Recruit thrust was assumed to be as predicted (Figure 4-3). Algol thrust was calculated (based on chamber pressure measurement), and predicted performance was corrected for ambient pressure (Figure 4-4). Average Algol thrust during web burning was

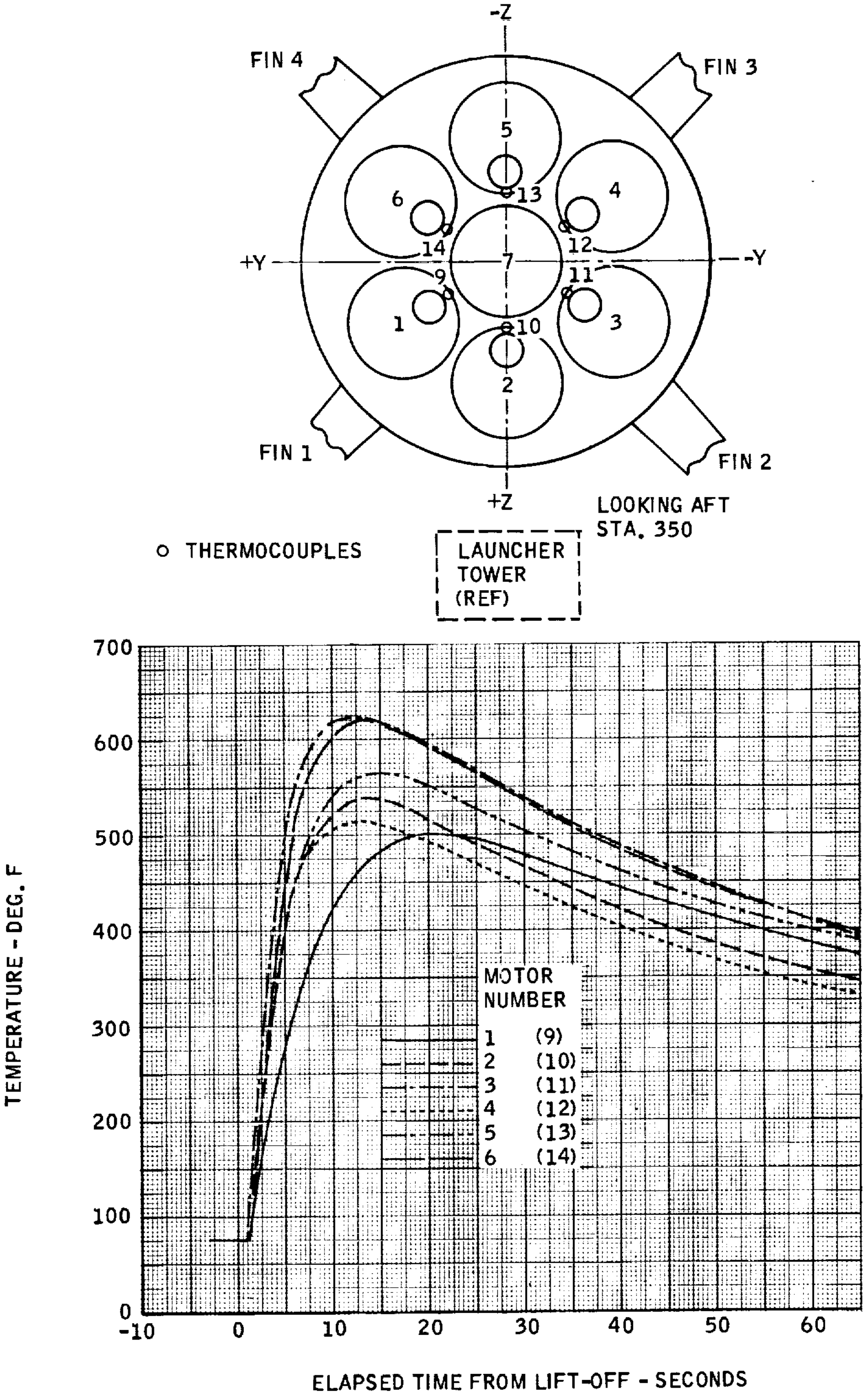
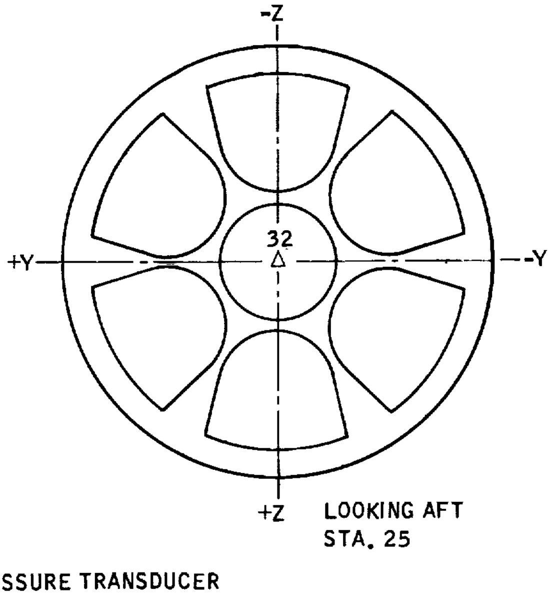


Figure 4-1. Recruit Rocket Motor Case Temperature



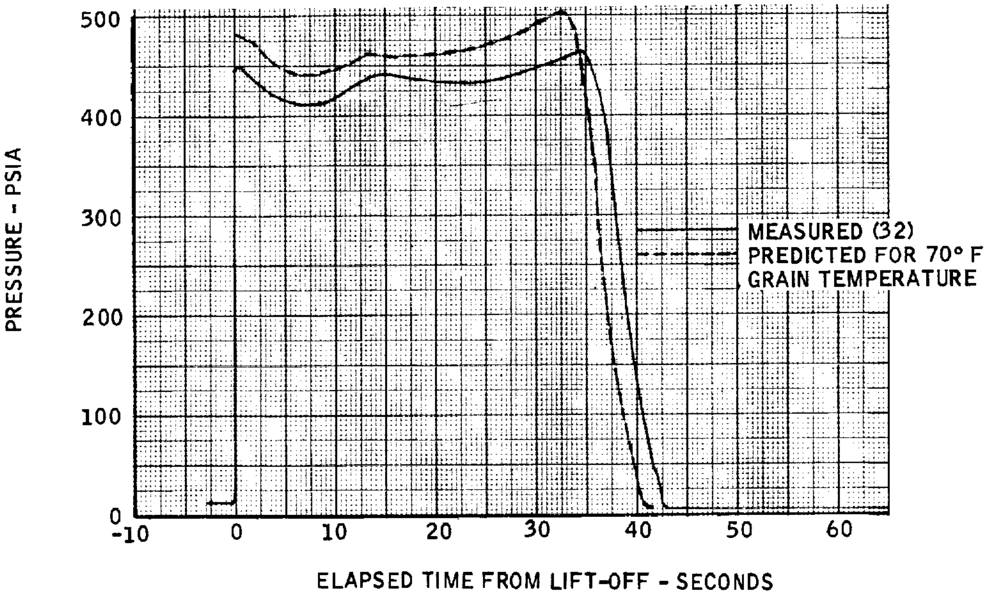


Figure 4-2. Algol 1D, Mod 2, LJ-6 Chamber Pressure

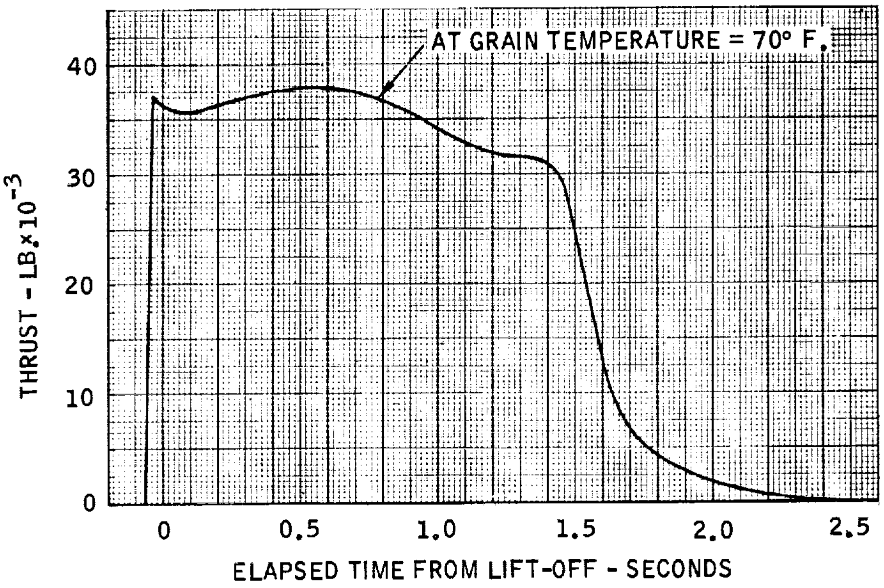


Figure 4-3. Recruit Thrust

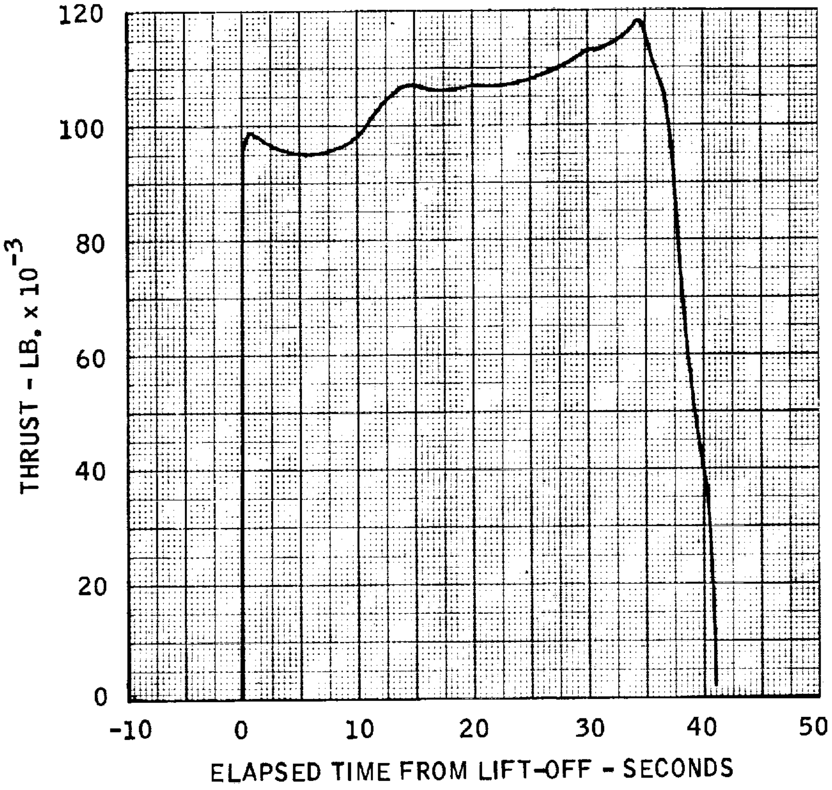


Figure 4-4. Algol Thrust

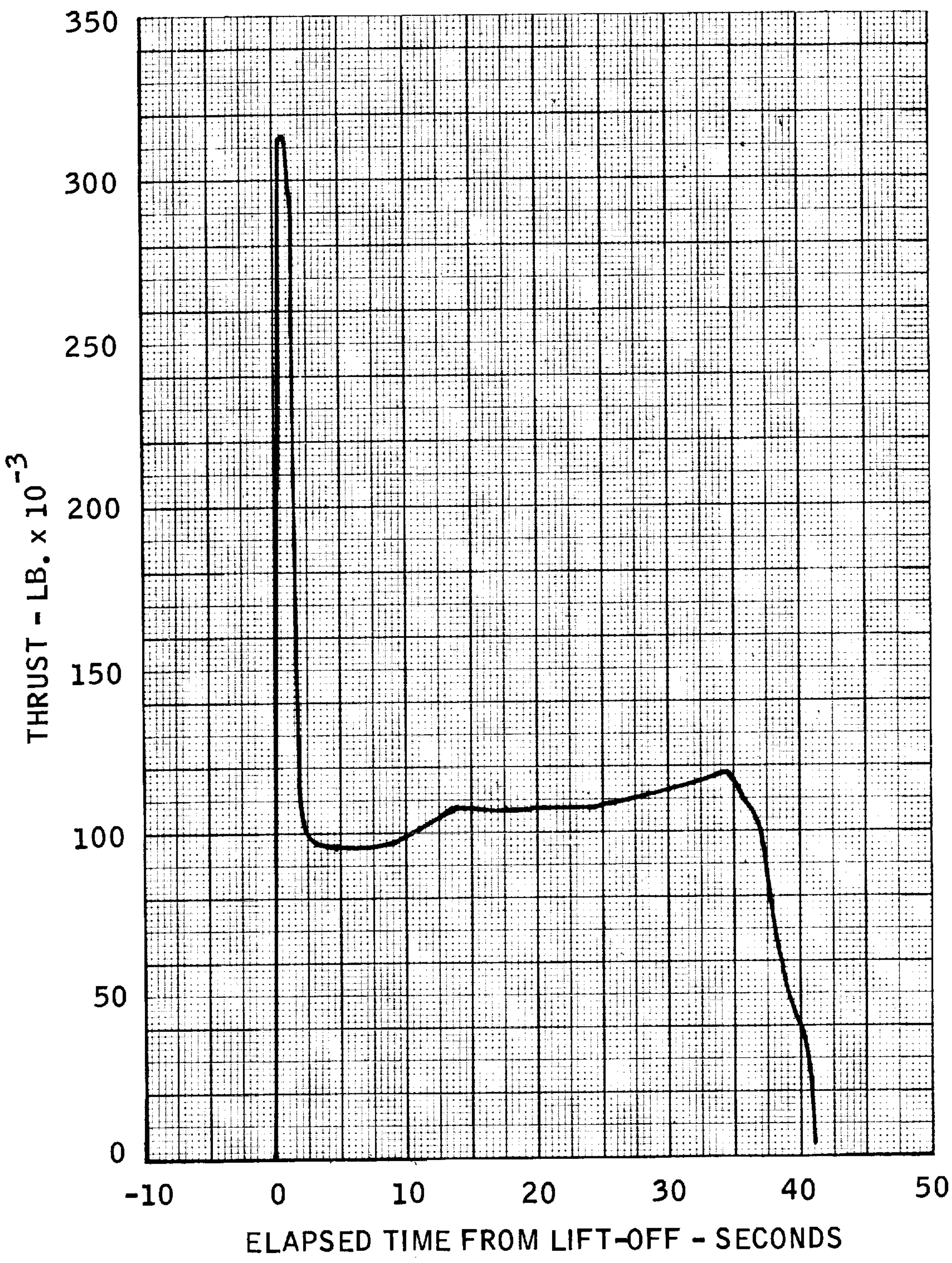


Figure 4-5. Total Thrust

105,100 lb. Total impulse for the Algol motor was 4,123,000 lb.-sec. The total thrust is shown in Figure 4-5.

A more complete analysis of propulsion system performance will be presented in a planned revision to this report.

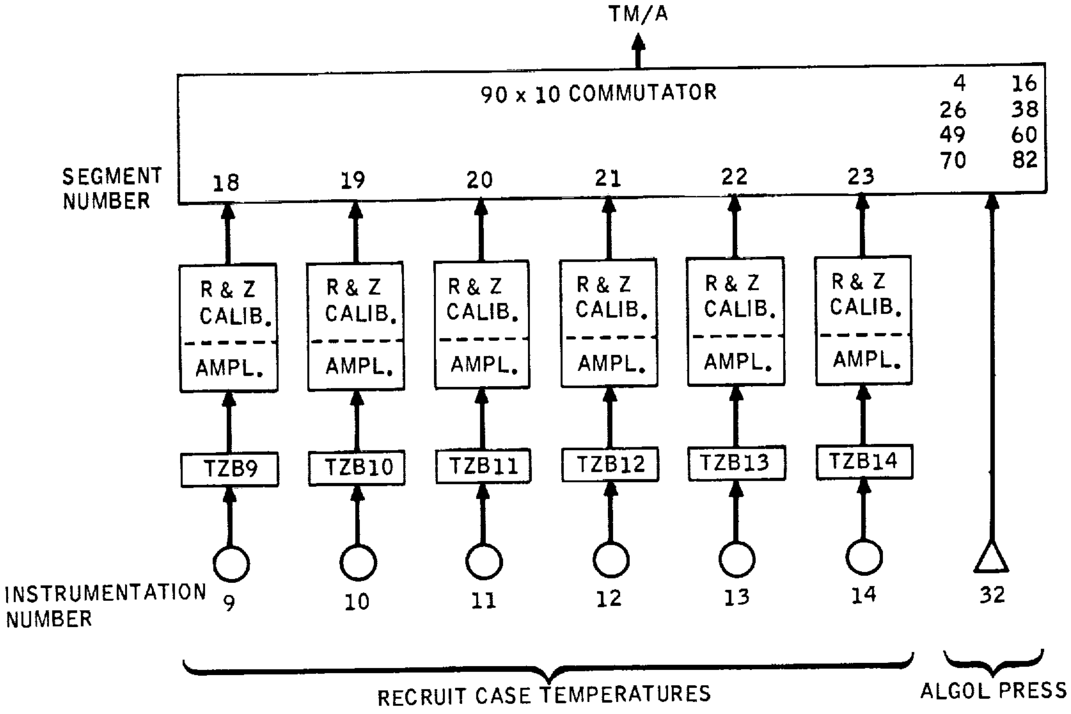


Figure 4-6. Propulsion System Instrumentation Block Diagram

5 | AERODYNAMIC ANALYSIS

5.1 SUMMARY

Complete information is not available to make a thorough analysis of aerodynamic parameters at this time. When the information is obtained, this section will be completed and submitted in a revised flight test report.

5.2 BASE DRAG

To calculate drag on the base of the launch vehicle, 12 pickups were located radially and circumferentially (Figures 5-1 and 5-3) at Station 350 to sample base pressures. Despite their various locations, all pickups gave readings which were identical within the nominal data scatter. In Figure 5-1, this data is plotted as a single line function versus flight time, and compared with ambient pressures. The differential pressure apparent from this plot are consistent with experimental data for flow conditions induced by a jet flow at the center of the base of a missile, as indicated in Section 5 of Reference 3.

Application of these differential pressures to base drag-producing areas (base area less jet areas) indicated the base drag conditions shown in Figure 5-2. As flight parameter data becomes available, base drag coefficients will be calculated, then published when this report is revised.

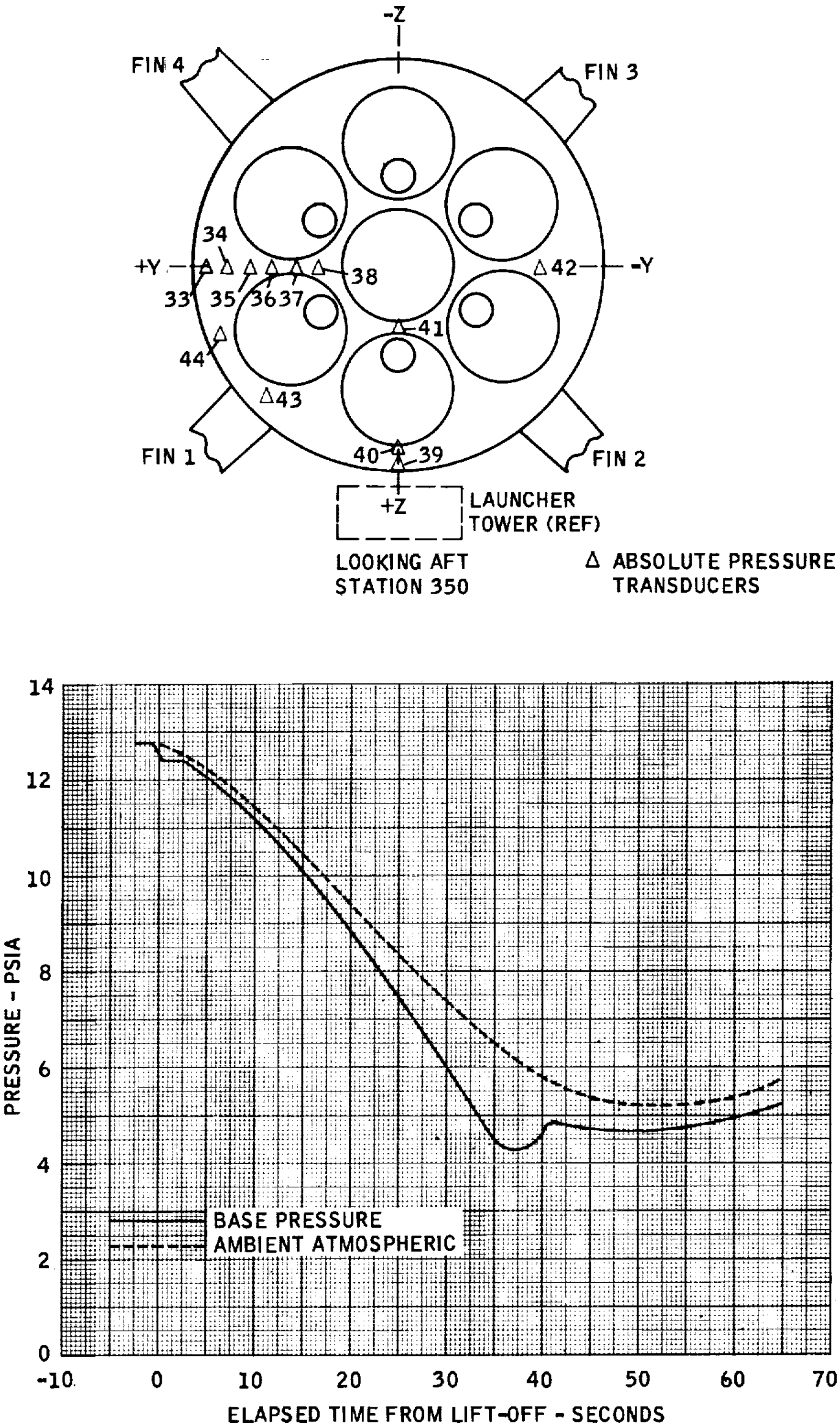


Figure 5-1. Base Pressure

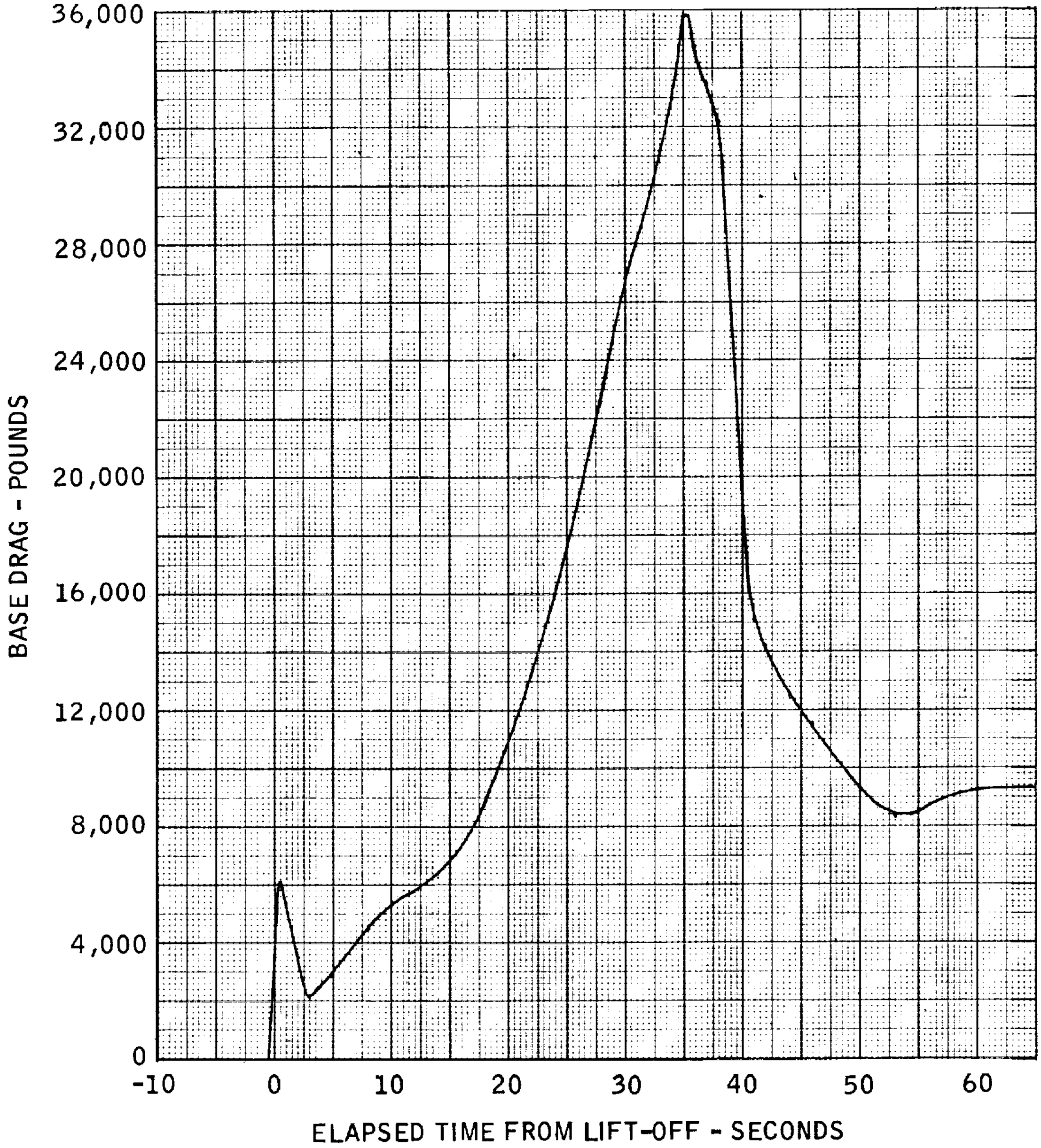


Figure 5-2. Base Drag

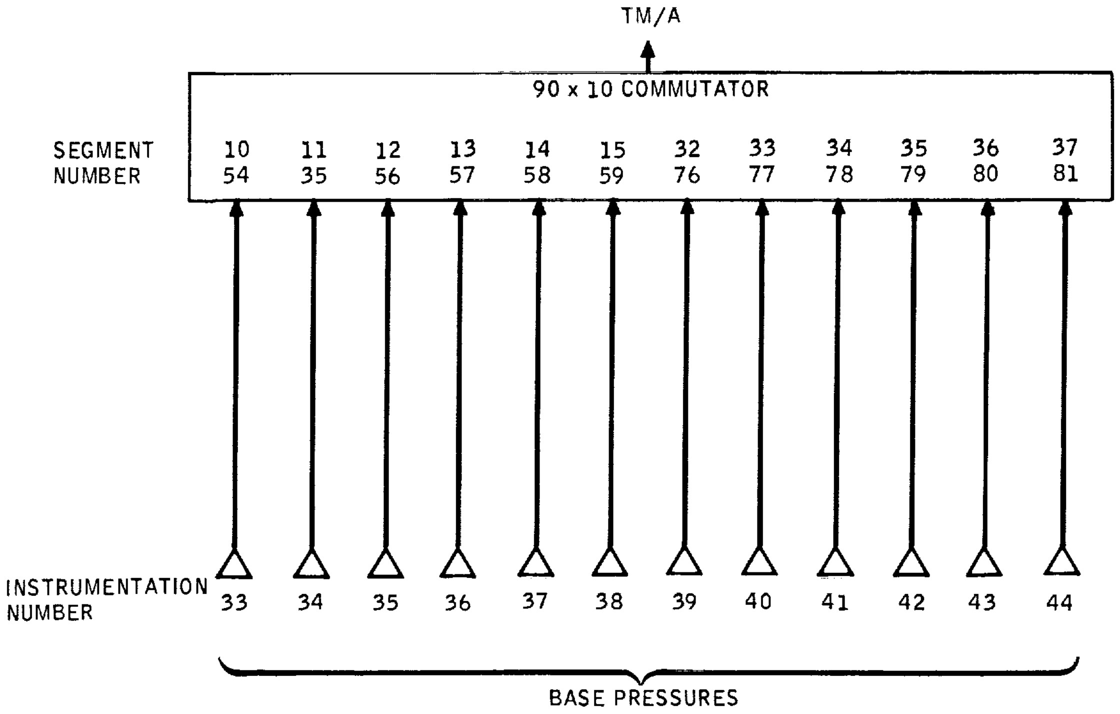


Figure 5-3. Aerodynamic Instrumentation Block Diagram

6 | FLUTTER ANALYSIS

6.1 SUMMARY

The Little Joe II QTV 12-50-1 was instrumented with 4-fin and 8-body accelerometers for fin flutter analysis and vehicle bending mode analysis (Figure 6-8). Oscillogram playbacks of these accelerometers indicate that the fins were flutter free, and that amplitudes of the body bending modes were small. Vibratory data gathered during the flight was characteristically low level. Vehicle passage through the transonic flight region was notably quiet.

To aid in the identification of the low-level body modes, spectral analysis of accelerometer output was performed over the duration of the flight (Figures 6-2 through 6-7). These plots show both the average relative amplitude of the modes at each accelerometer location and the modal frequencies.

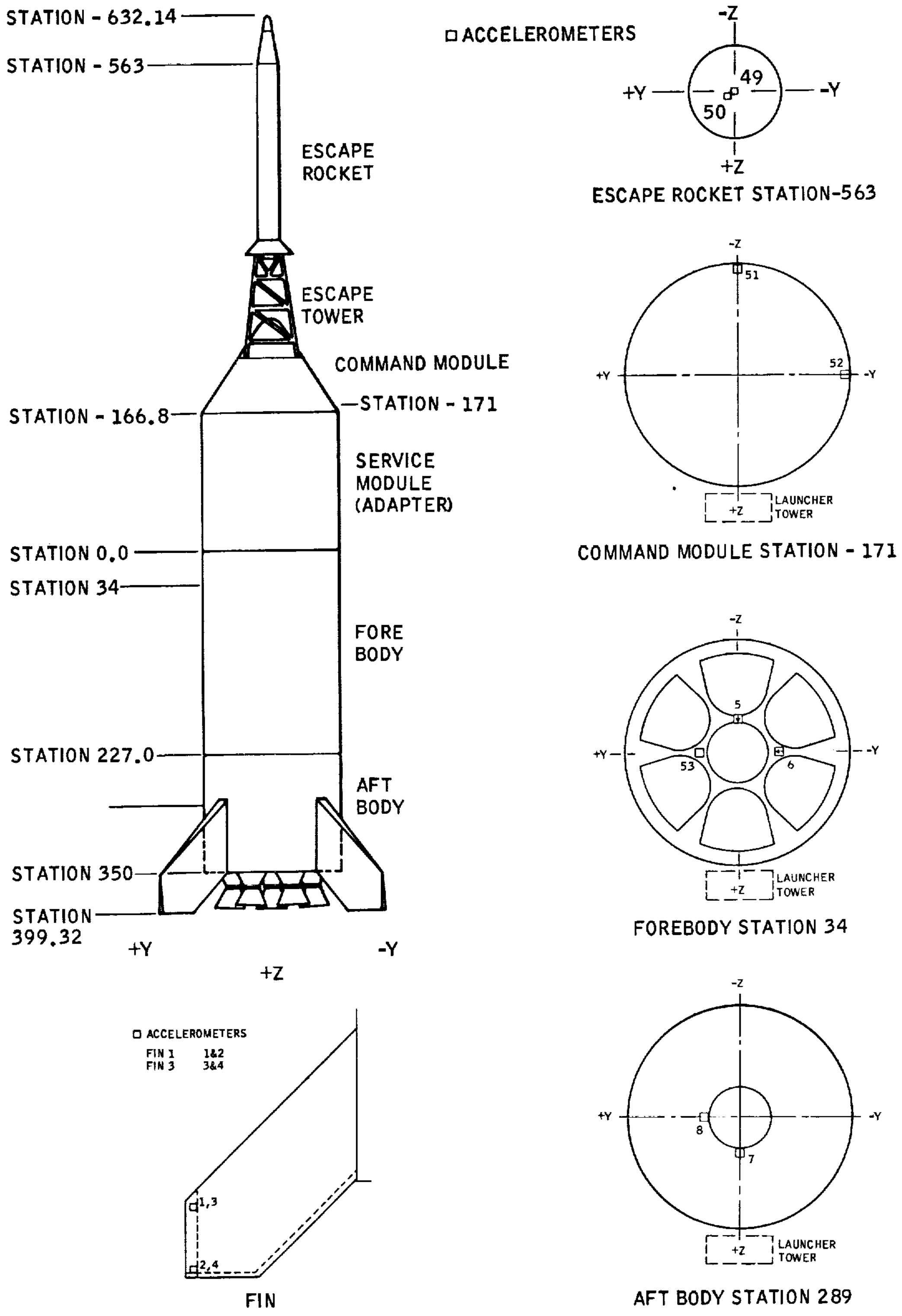


Figure 6-1. Accelerometer Locations

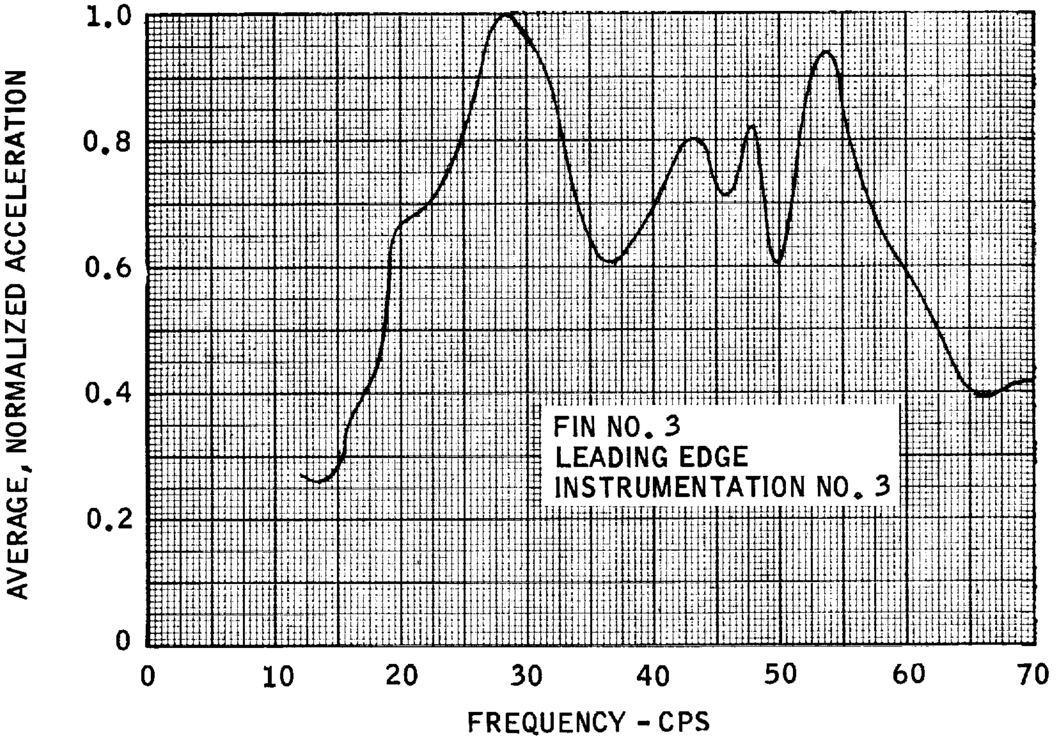
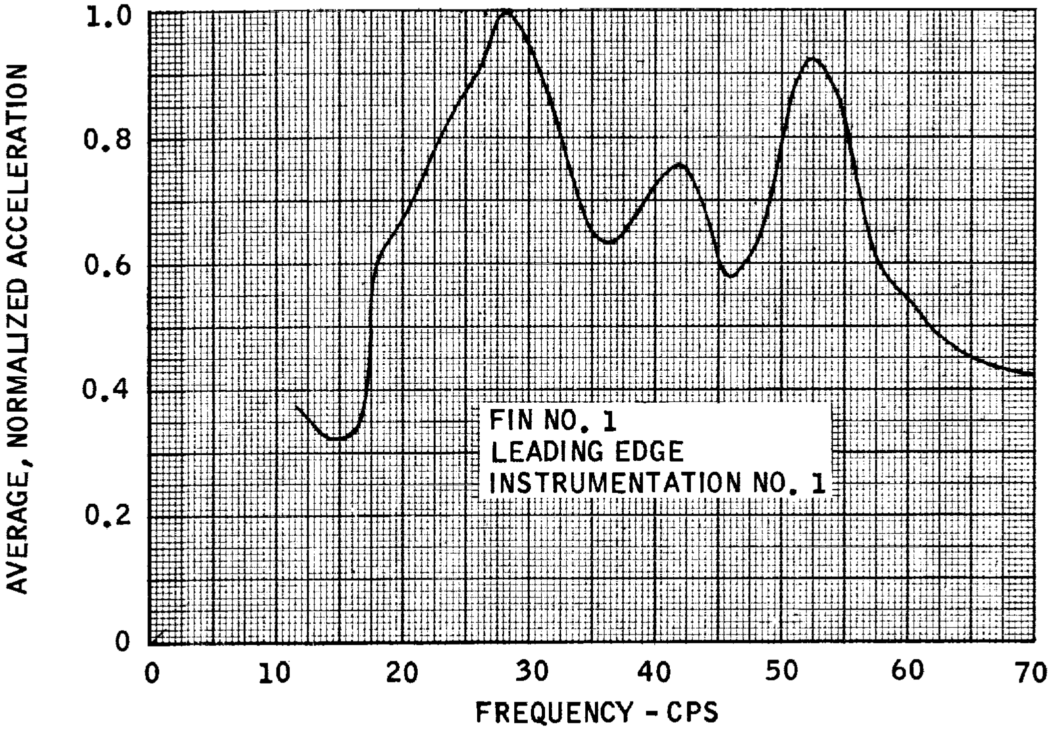


Figure 6-2. Average, Normalized Acceleration — Fin No. 3



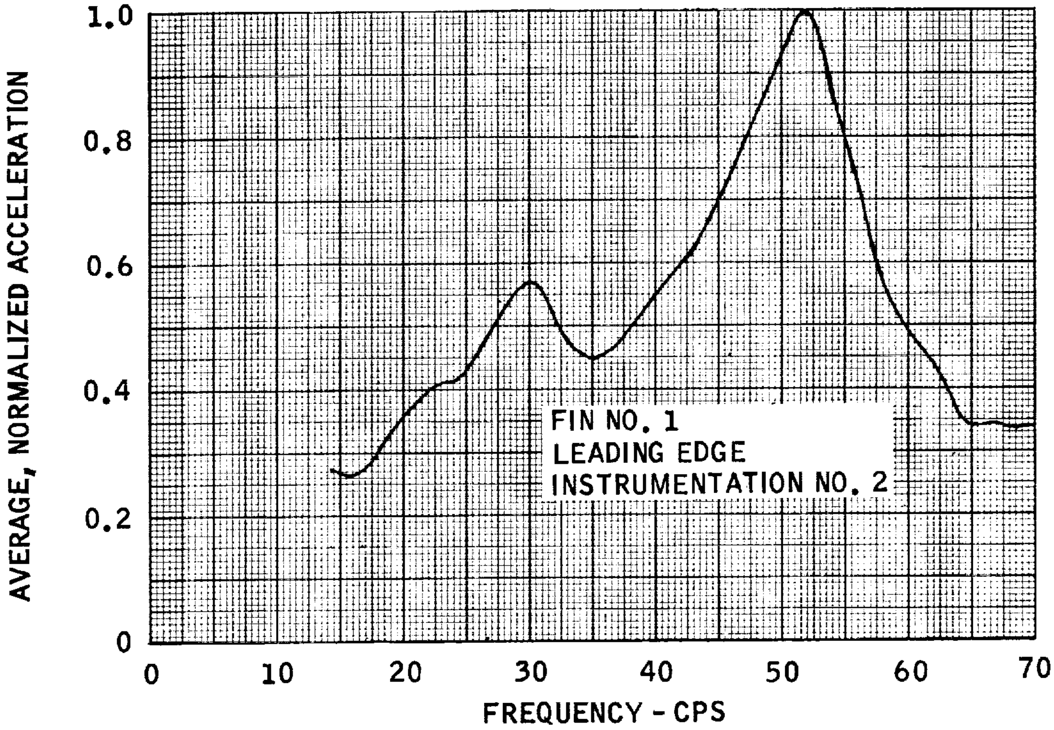
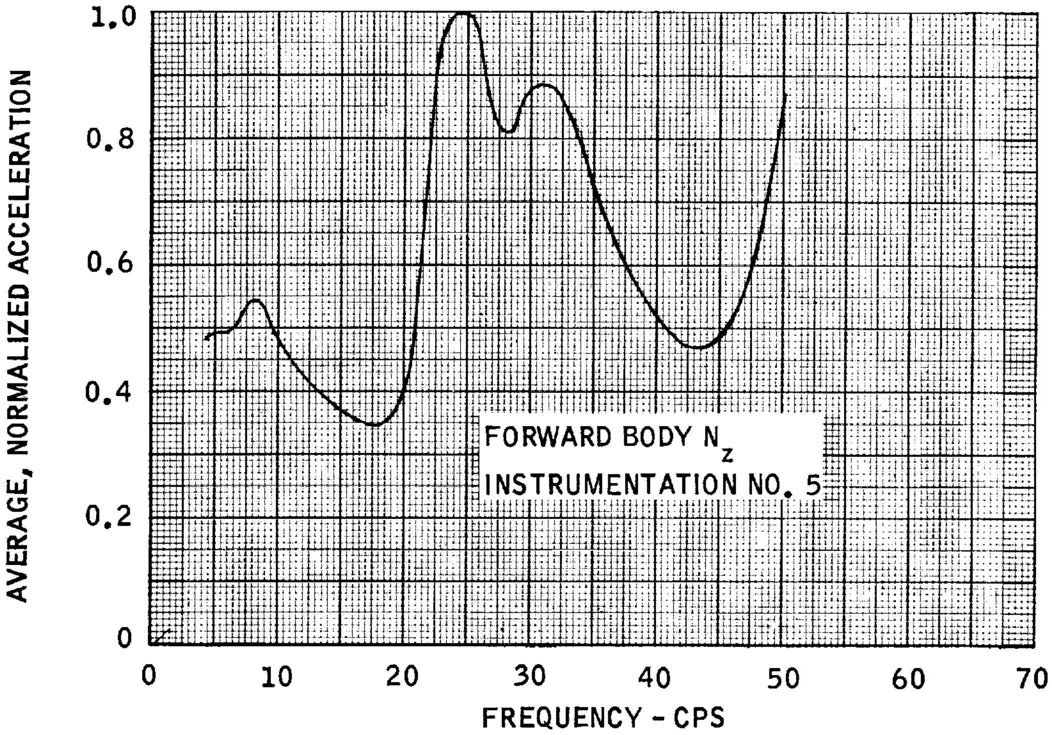


Figure 6-3. Average, Normalized Acceleration — Fin No. 1



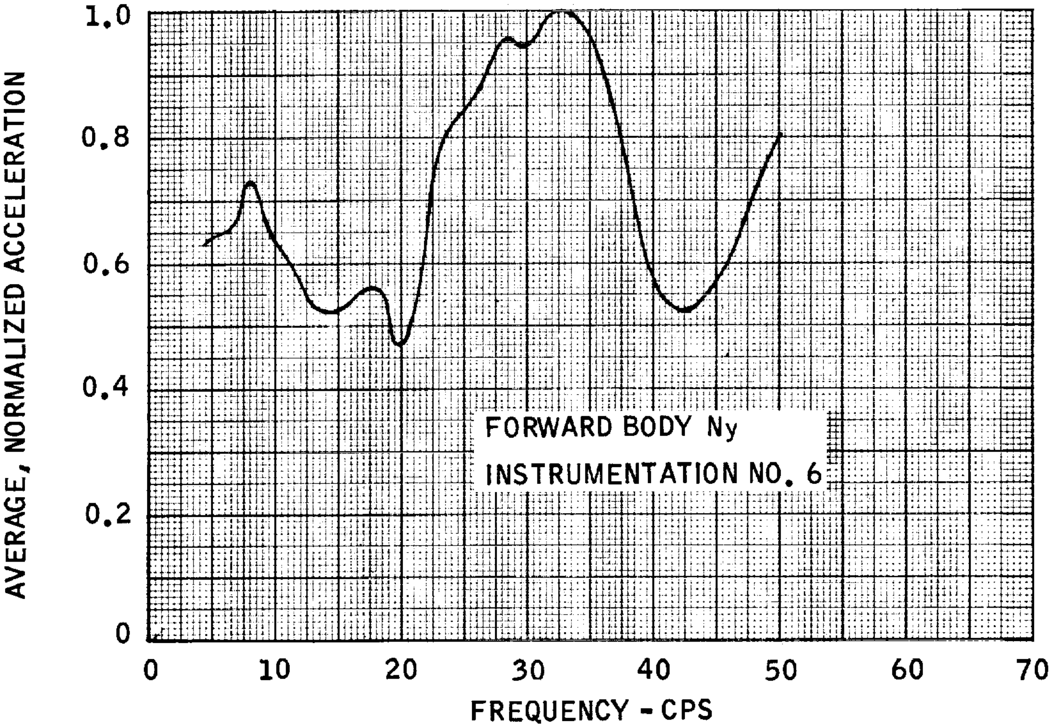
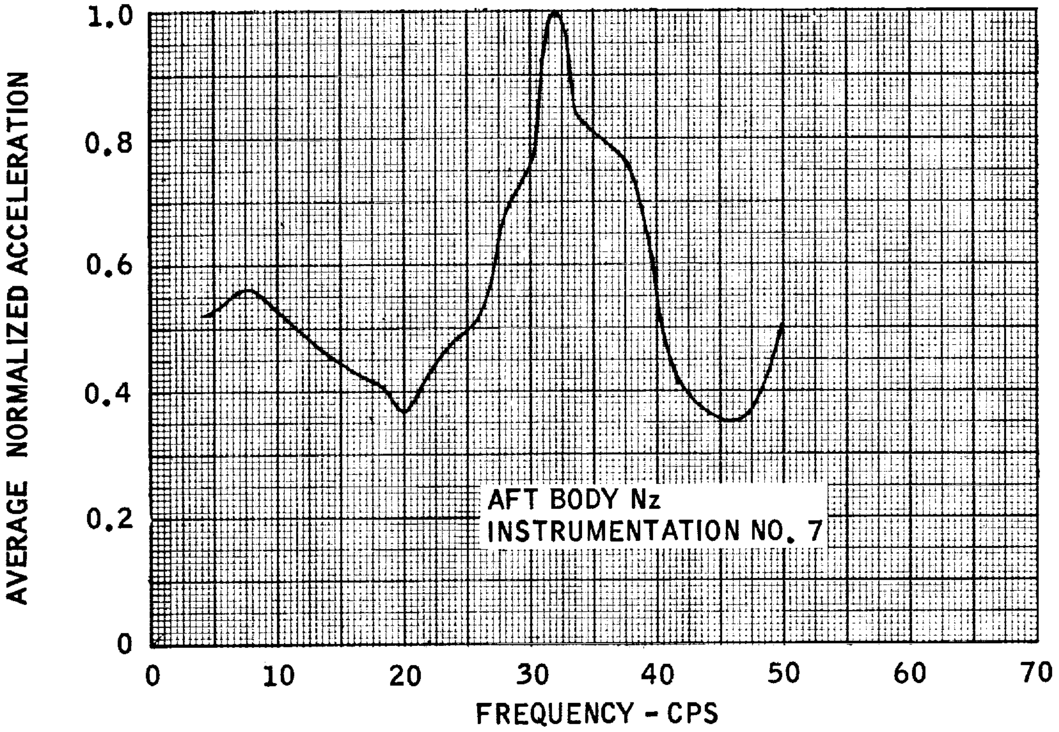


Figure 6-4. Average, Normalized Acceleration — Forward Body



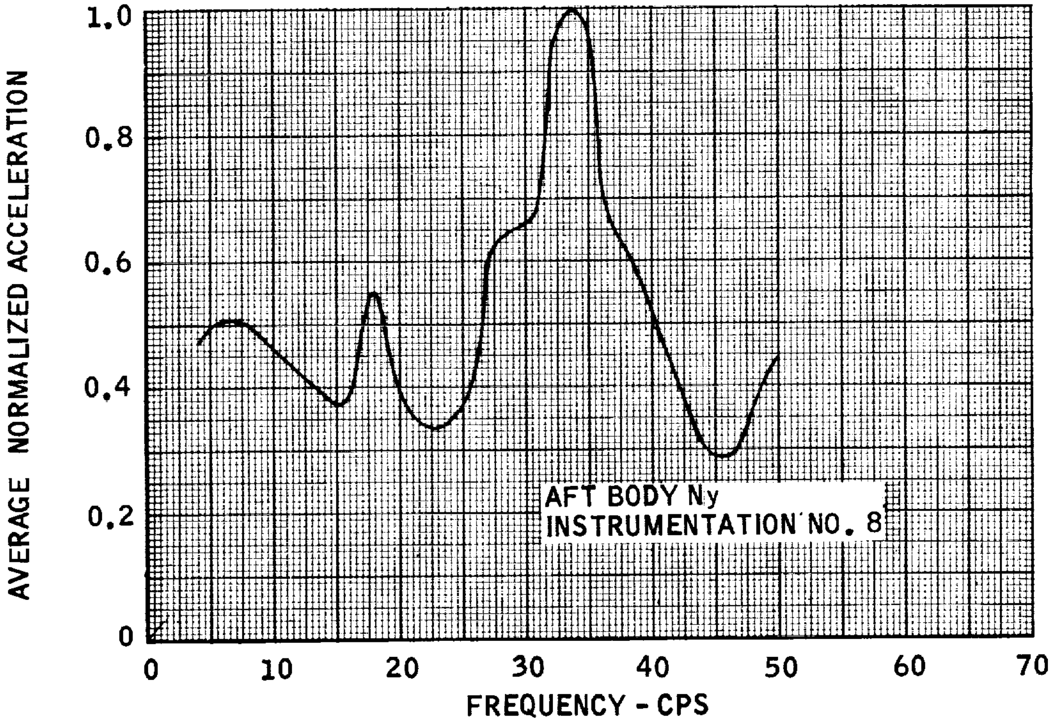
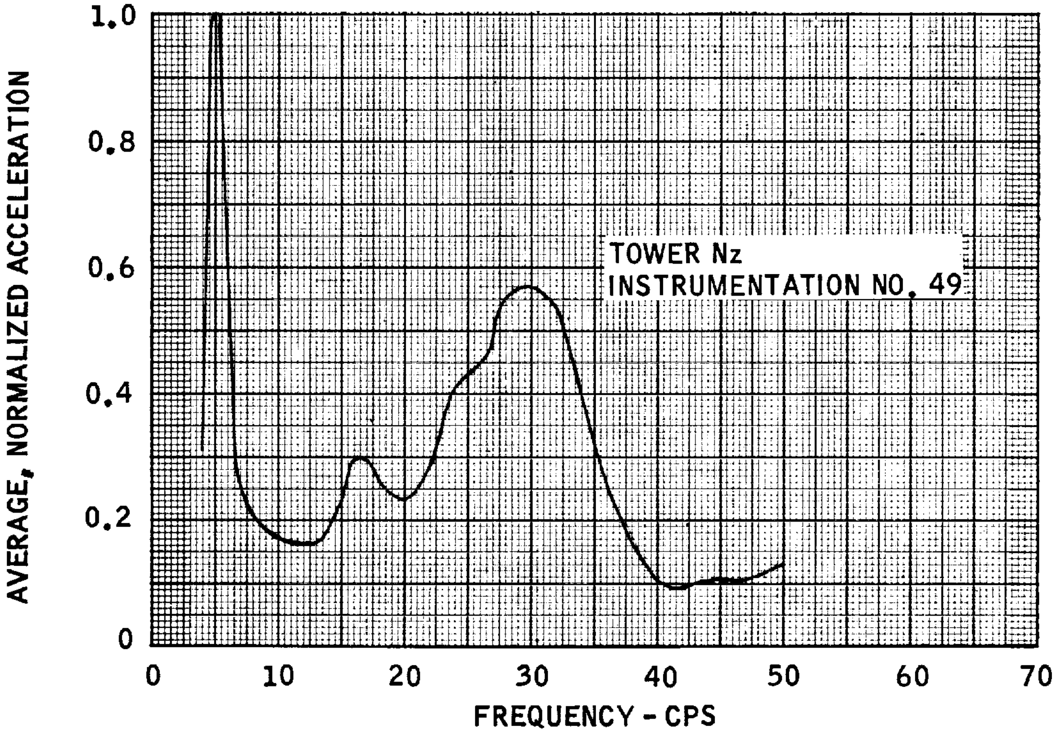


Figure 6-5. Average, Normalized Acceleration — Aft Body



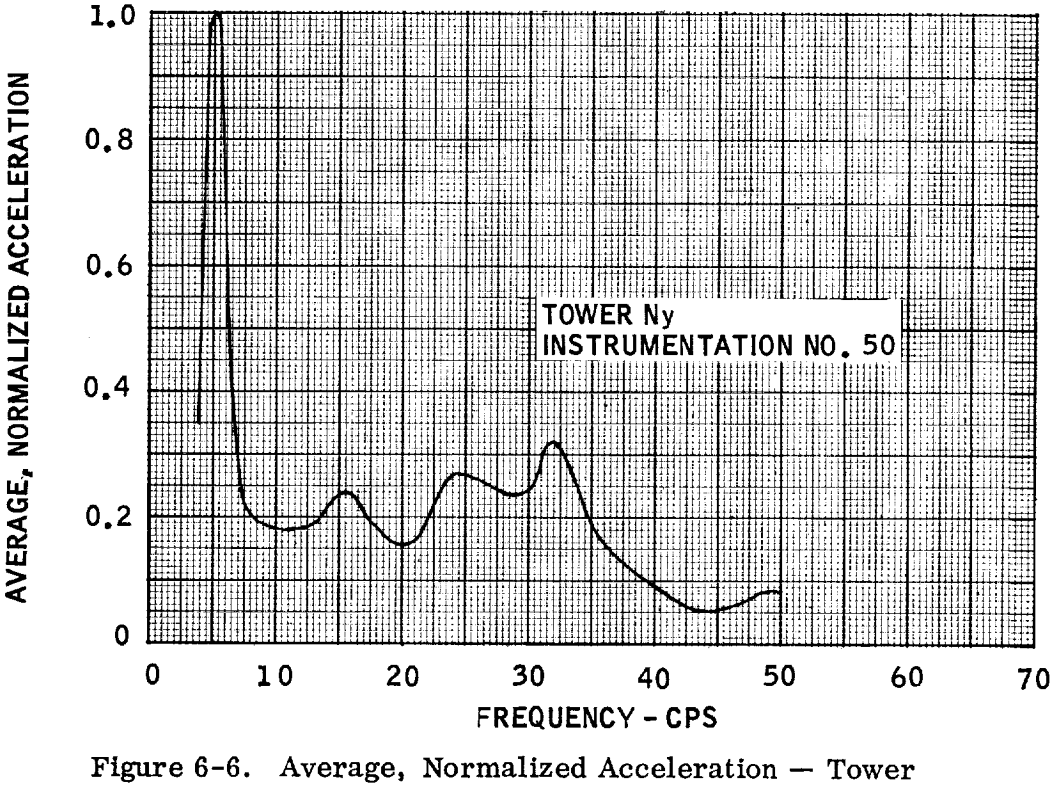
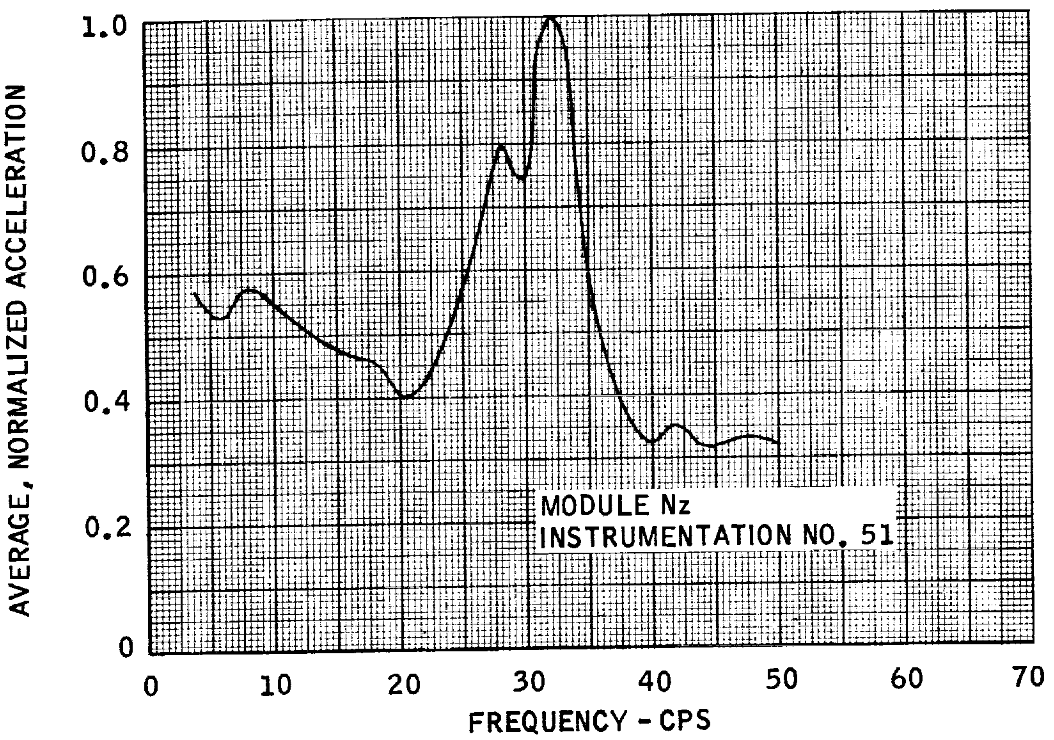


Figure 6-6. Average, Normalized Acceleration — Tower



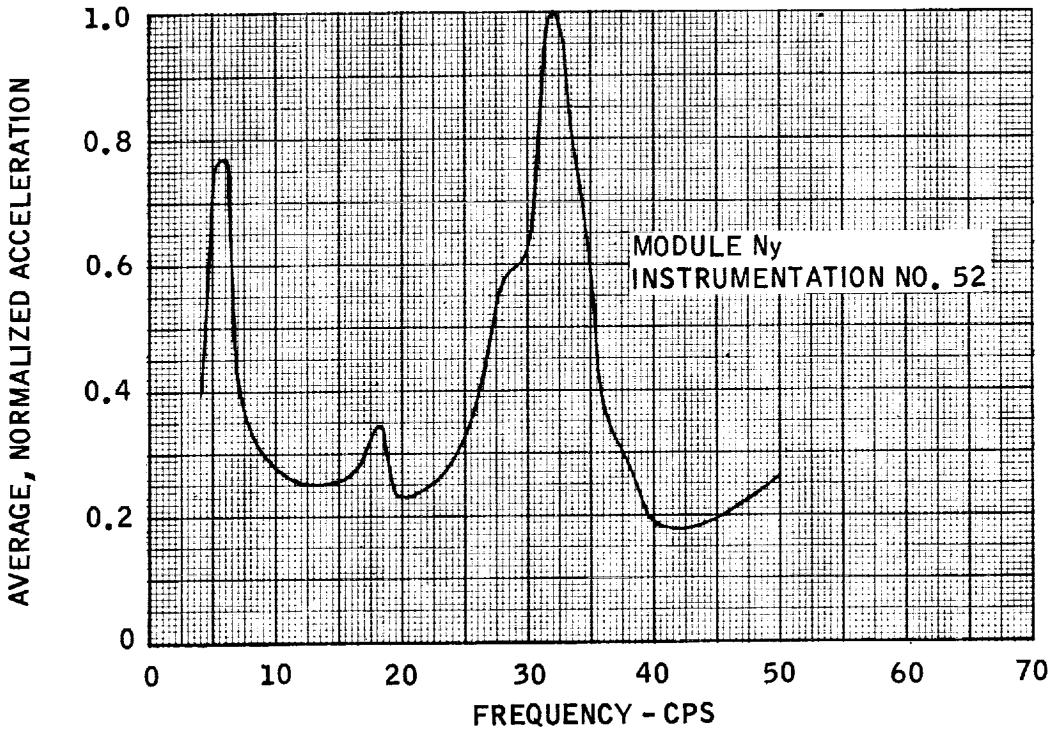


Figure 6-7. Average, Normalized Acceleration — Module

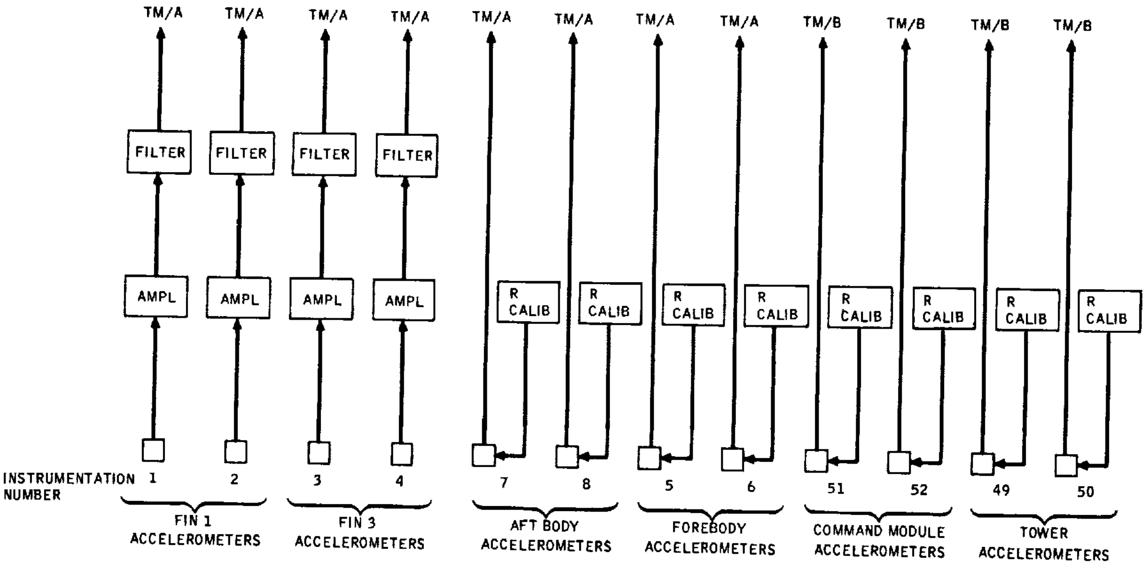


Figure 6-8. Flutter Instrumentation Block Diagram

7 | STRUCTURAL AND ENVIRONMENTAL ANALYSIS

7.1 SUMMARY

Operation of structural and environmental instrumentation was satisfactory. Thrust structure stresses were approximately as predicted. Internal pressures were essentially the same as ambient pressure. Internal temperatures indicated an essentially constant temperature environment, except in the equipment compartment, where the various heat sources did not match the adiabatic cooling and a 30-degree temperature drop occurred in the first minute.

Fin temperature measurements indicated that the fin trailing edge insulation kept the fin temperature rise to acceptable levels. Base temperature and calorimeter measurements showed that: 1) Base insulation was highly effective, and 2) Base heating rates with 1 Algol and 6 Recruits were low enough so that base insulation would not have been required.

7.2 STRESS MEASUREMENTS

Preliminary evaluation of stress measurements on the base bulkhead diagonal structure indicates induced stresses were within 13 percent of design stress for Algol thrust at 34.5 seconds after lift-off. Location of the strain gage bridges for these measurements is shown in Figure 7-1, together with the time development of stresses. Prior to 0.6 second after lift-off, the strain measurement between Motors 2 and 3 followed the trend of the other strain measurements, then became inoperative. Because the measurement substantially agreed with the other strain measurements during the first 0.6 second (the more highly stressed flight condition), the stress measurement between Motors 2 and 3 is

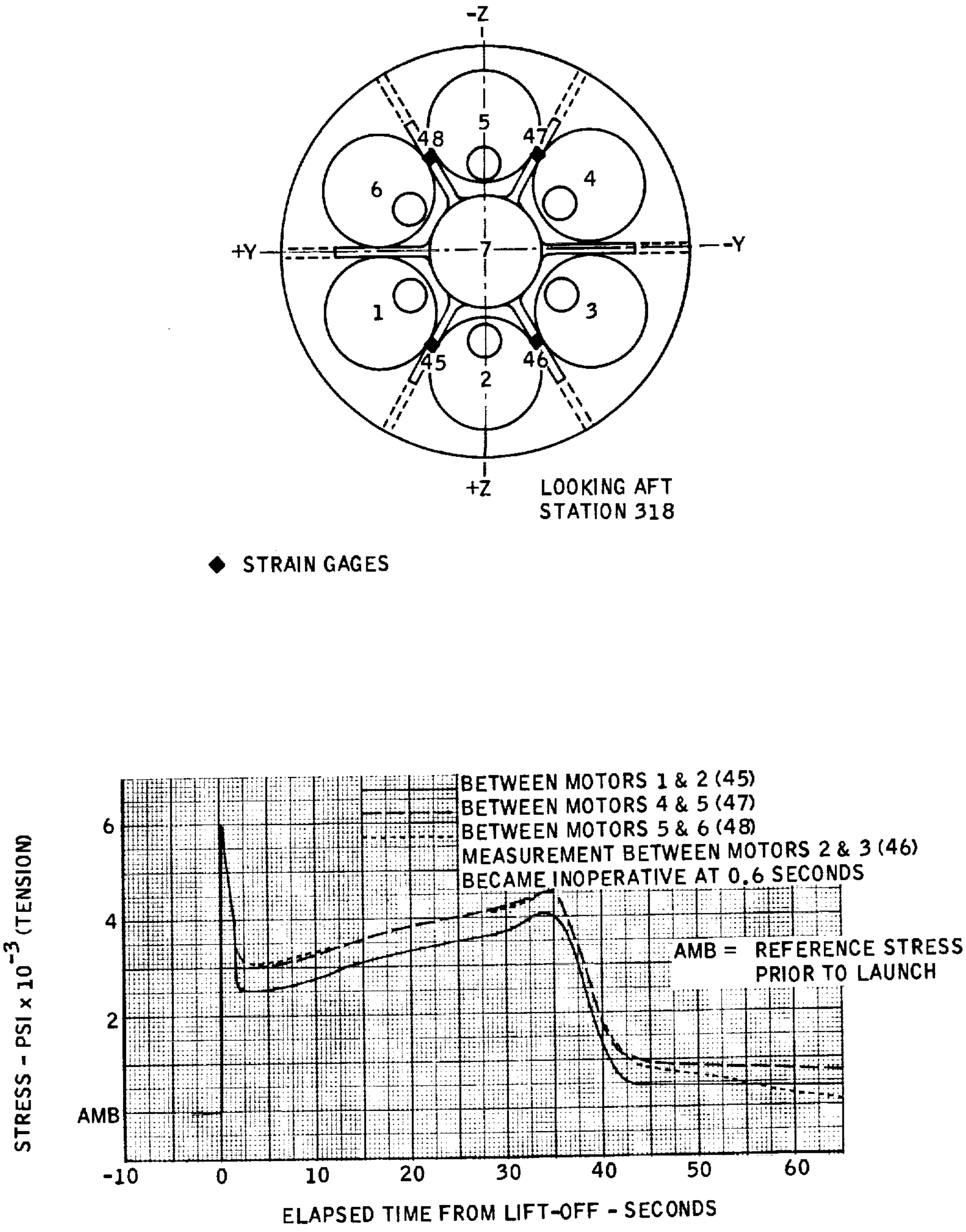


Figure 7-1. Stress Vs. Time

considered successful. Additional information from the stress measurement analysis will be reported in a planned revision of this report.

7.3 INTERNAL PRESSURES

Pressure measurements in the Service Module and the Little Joe II QTV show that within the instrumentation accuracy the same pressure exists in both compartments. Time development of these pressures is shown in Figure 7-2, together with the ambient pressure. The open area represents the envelope which encloses the four pressure measurements in the Service Module. Since both compartments are vented to ambient, the internal pressures should be above ambient during ascent and below ambient during descent — again, within the accuracy of measurements, this is shown in Figure 7-2. (Figure 7-7 is an instrumentation block diagram for these pressure measurements.)

7.4 ENVIRONMENTAL TEMPERATURES

Measurements were made of ambient air temperature in the aft body and in the equipment compartment, and of command destruct receiver base temperature (Figure 7-3).

Initially, the equipment compartment temperature was 11° F warmer than the aft body temperature. This is attributed to convective heating and electronic equipment operation. As the internal pressure decreased during the flight, adiabatic cooling caused a 30° F decrease in temperature in the equipment compartment. This decrease was not matched in the lower body, apparently as a result of radiant heating from the rocket motor cases. The command destruct receiver base was cooled from 88° to approximately 85° F in a minute, as a result of the cooling of its environment.

7.5 FIN TEMPERATURES

A study of Little Joe II QTV 12-50-1 base heating had indicated the necessity of increasing the fin base thickness or employing a thermal insulator on the fin

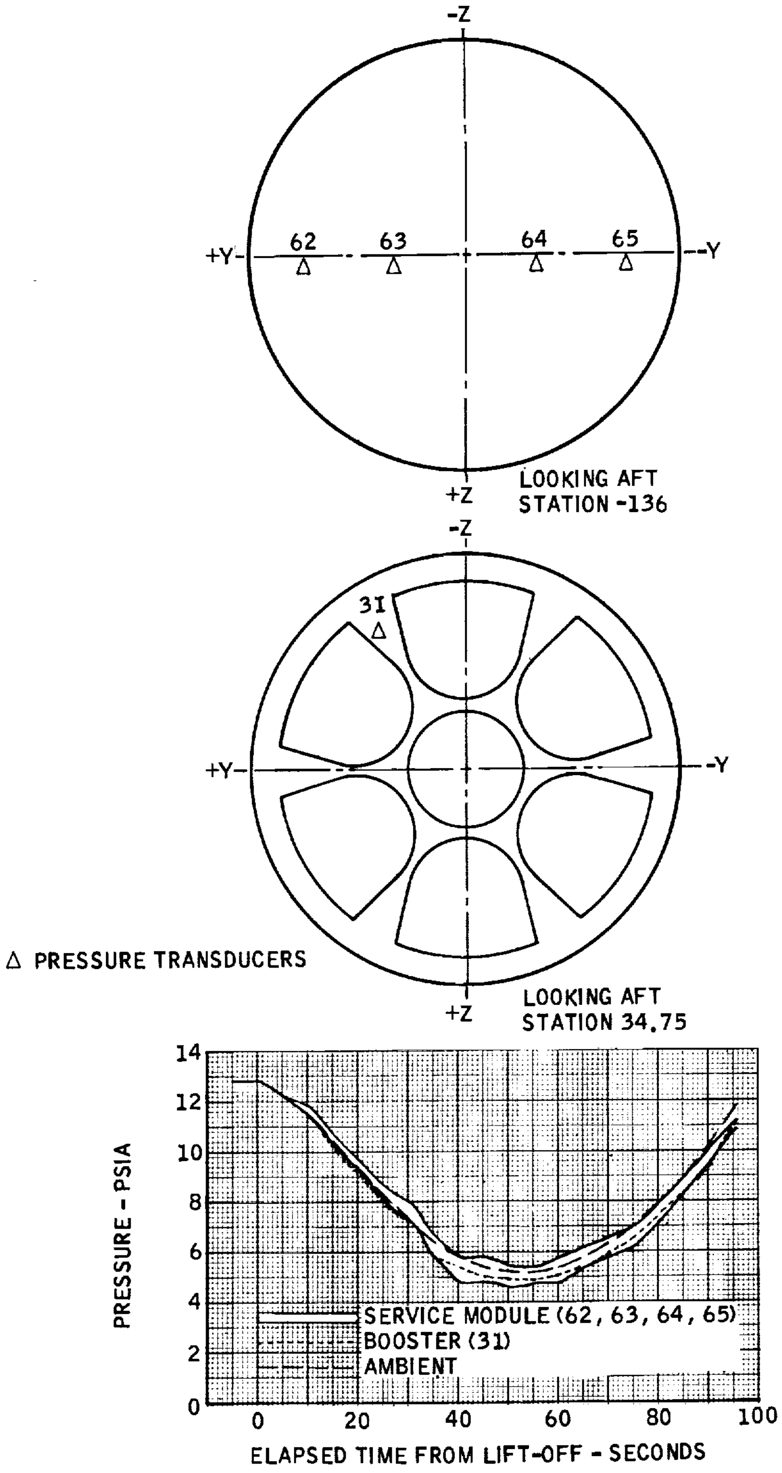


Figure 7-2. Internal Pressures

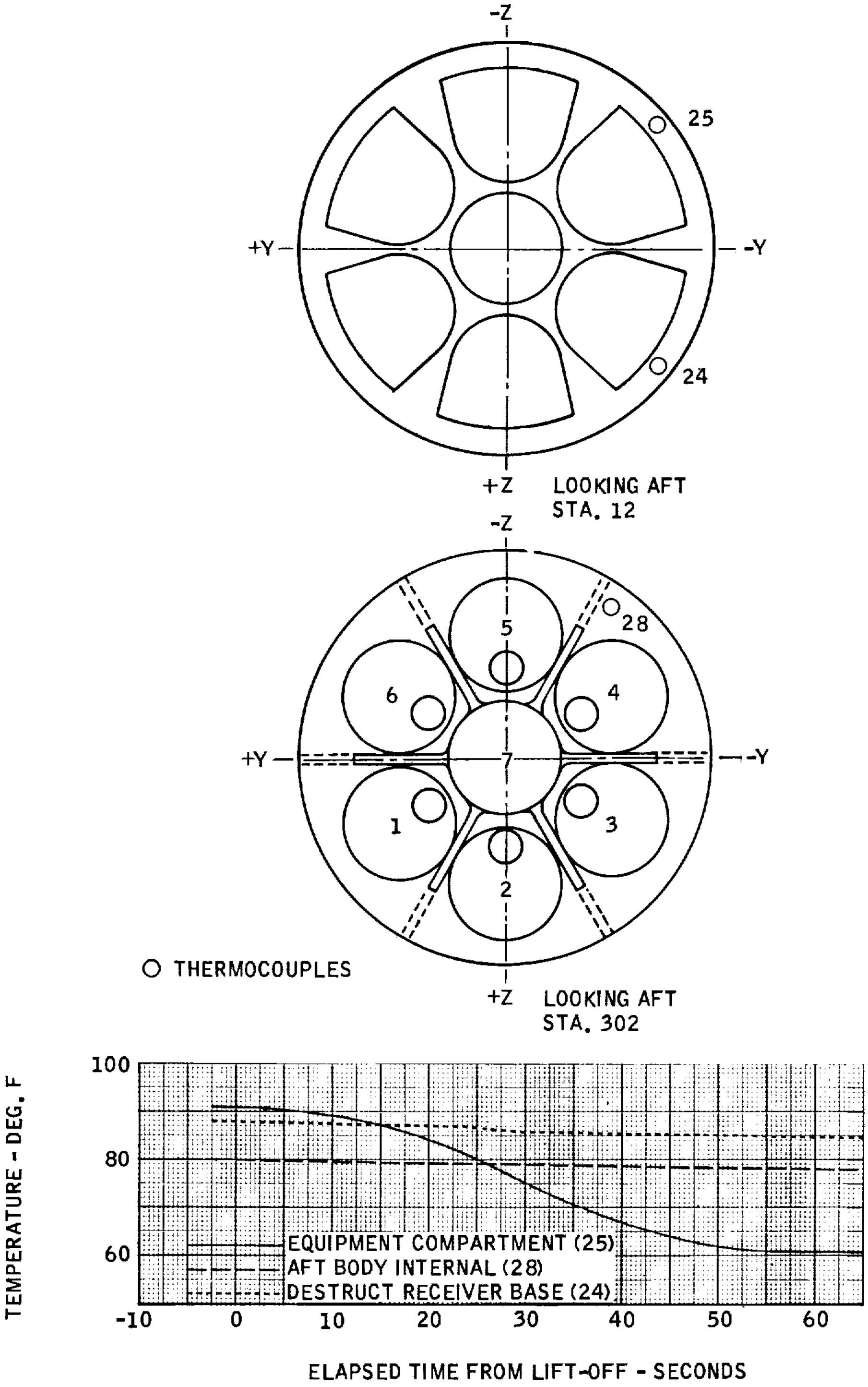


Figure 7-3. Booster Internal Temperatures

base to maintain an acceptable temperature for the aluminum structural member. For the QTV 12-50-1 flight, a thermal insulator was employed.

Fin base temperature beneath the insulation was monitored during flight by four thermocouples (Figure 7-7). A time history of these temperatures is shown in Figure 7-4. All four thermocouples indicated that the thermal insulation was highly effective in maintaining an acceptable fin base structural temperature. The maximum temperature rise from ignition to the abort point was 11° F.

An interesting sidelight of the temperature time history is the initial difference between temperatures of Fins 2 and 4, and Fins 2 and 3. The probable cause of the temperature differential is believed to result from Fins 2 and 3 receiving direct solar heating while Fins 1 and 4 were partially shaded.

7.6 BASE HEATING

Results of the calorimeter measurements on the base of the vehicle show that the temperature of the base without insulation would not exceed the design temperature limit of 250° F. This is based upon an expected temperature rise of 31° F at destruct time (approximately 32.5 sec.) for a conservative 0.375-in.-thick base, and using equal absorptivities for the base material and the copper calorimeter.

Time development of calorimeter and base temperatures are shown in Figure 7-5. The base temperature thermocouple was located on the base material under the insulation, and shows negligible temperature changes during the flight. Base heating rates for both calorimeters are shown in Figure 7-6.

The significant maximum heating rate of 5,800 BTU/Ft.^{2}/Hr. compares favorably with the predicted 5,100 BTU/Ft.^{2}/Hr. maximum heating rate. The peak heating rates at 42 seconds occur during final tail-off of the Algol motor, and it is suspected that the negative base incremental pressure (Figure 5-1)

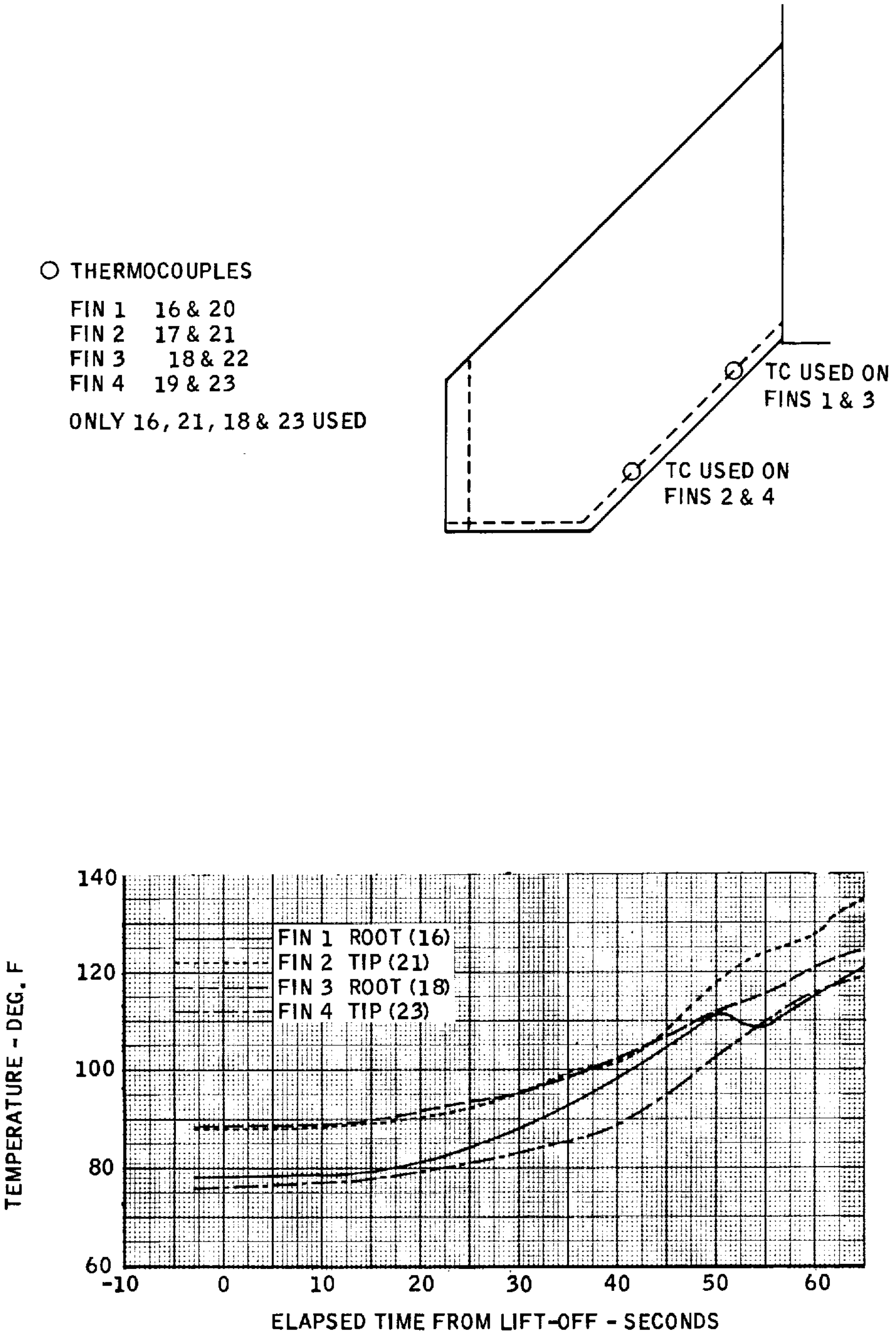


Figure 7-4. Fin Trailing Edge Temperature

draws part of the hot gases into contact with the base. This tail-off base heating rate is short lived (approximately one second) and is not considered significant. With Algol motor destruct, this condition would not exist.

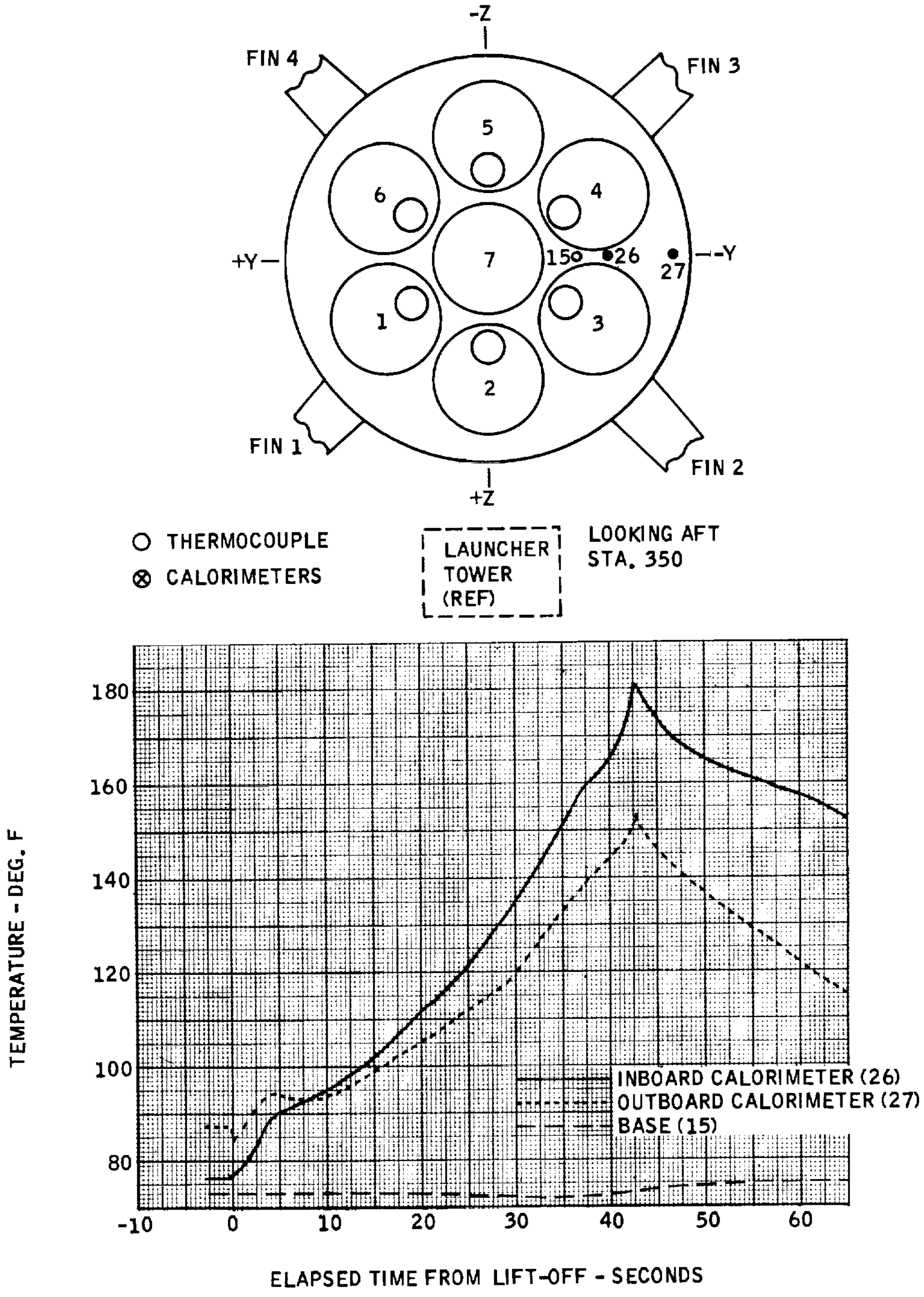
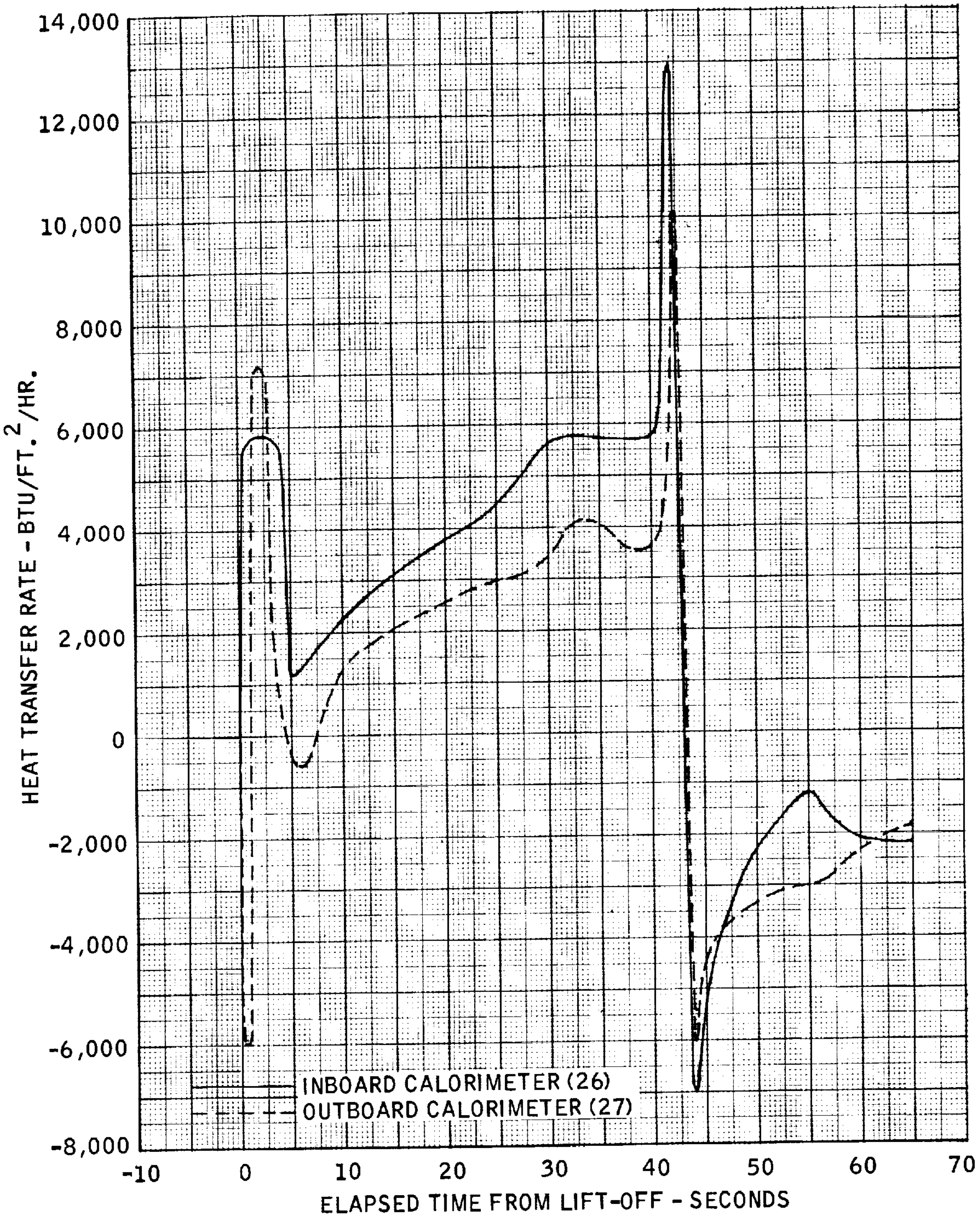


Figure 7-5. Calorimeter and Base Temperatures


14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-2,000
-4,000
-6,000
-8,000
HEAT TRANSFER RATE - BTU/FT.^{2}/HR.
-10
0
10
20
30
40
50
60
70
ELAPSED TIME FROM LIFT-OFF - SECONDS
INBOARD CALORIMETER (26)
OUTBOARD CALORIMETER (27)

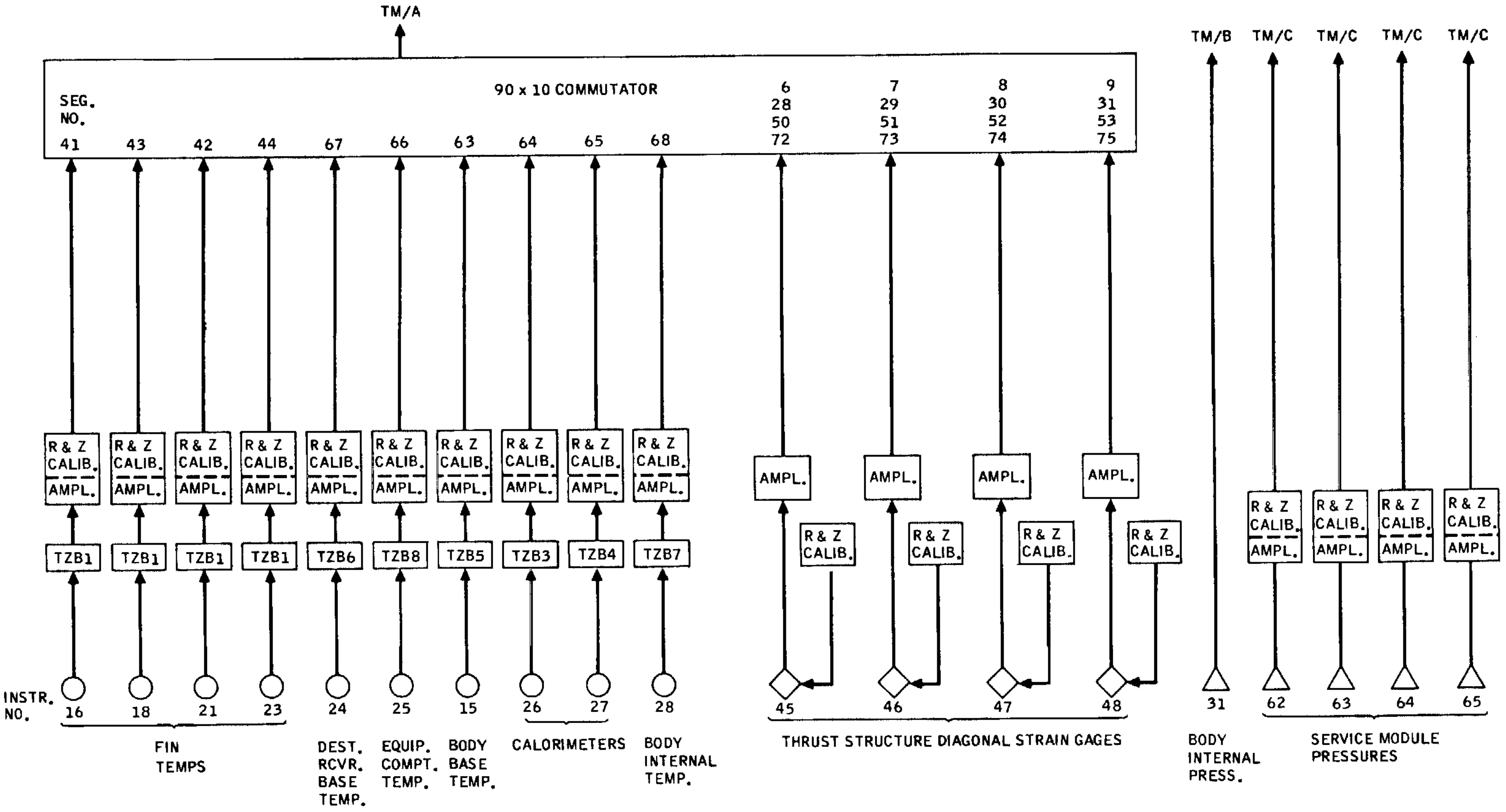


Figure 7-7. Vehicle Structural Instrumentation Block Diagram

8 | VEHICLE INSTRUMENTATION SYSTEM*

8.1 SUMMARY

All of the 52 on-board measurements operating at vehicle lift-off yielded satisfactory and reducible data. One hundred percent in-flight instrumentation measuring efficiency was obtained.

8.2 DESCRIPTION OF SYSTEM

Figure 8-1 shows the location of end instruments, Figure 8-2 is the block diagram of the system and Table 8-1 is the measurement list.

8.2.1 POWER – The primary power for the vehicle system was a silver zinc battery (manufactured by Eagle-Picher Co.) of nominally 30 volts. The voltage used by the end instruments and SCO packages was furnished by a DC to DC converter that had a regulated output of 28 ± 0.1 volts.

8.2.2 END INSTRUMENTS

8.2.2.1 Pressure Transducers — The pressure transducers used in the system were all manufactured by Wiancko, except for the Algol chamber pressure which was a Statham. In each application, the power input was 28 volts, and the output was 0 to 5 volts for the expected range. In the case of the internal body pressure and the Algol chamber pressure, the transducer involved was calibrated to approximately 140 percent of its range, and the output then had a maximum of approximately 7 volts. The SCO in these cases was set to accept 0 to 7 volts and remained linear and in a usable bandwidth (±8%). All transducers were of the integral solid-state carrier-demodular type.

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* Vehicle instrumentation is designated as "Package A" and "Package B".

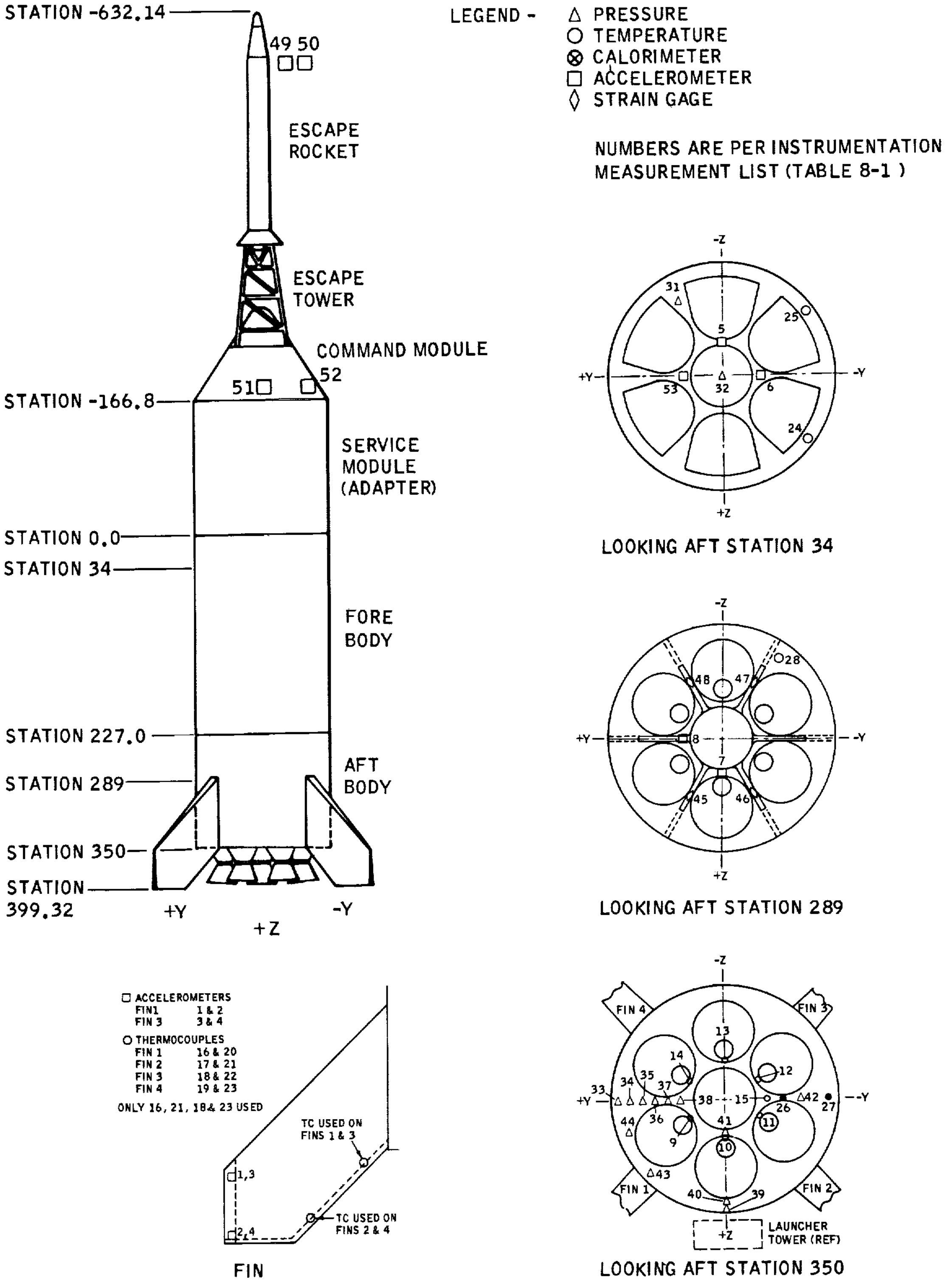


Figure 8-1. Vehicle Instrumentation Location

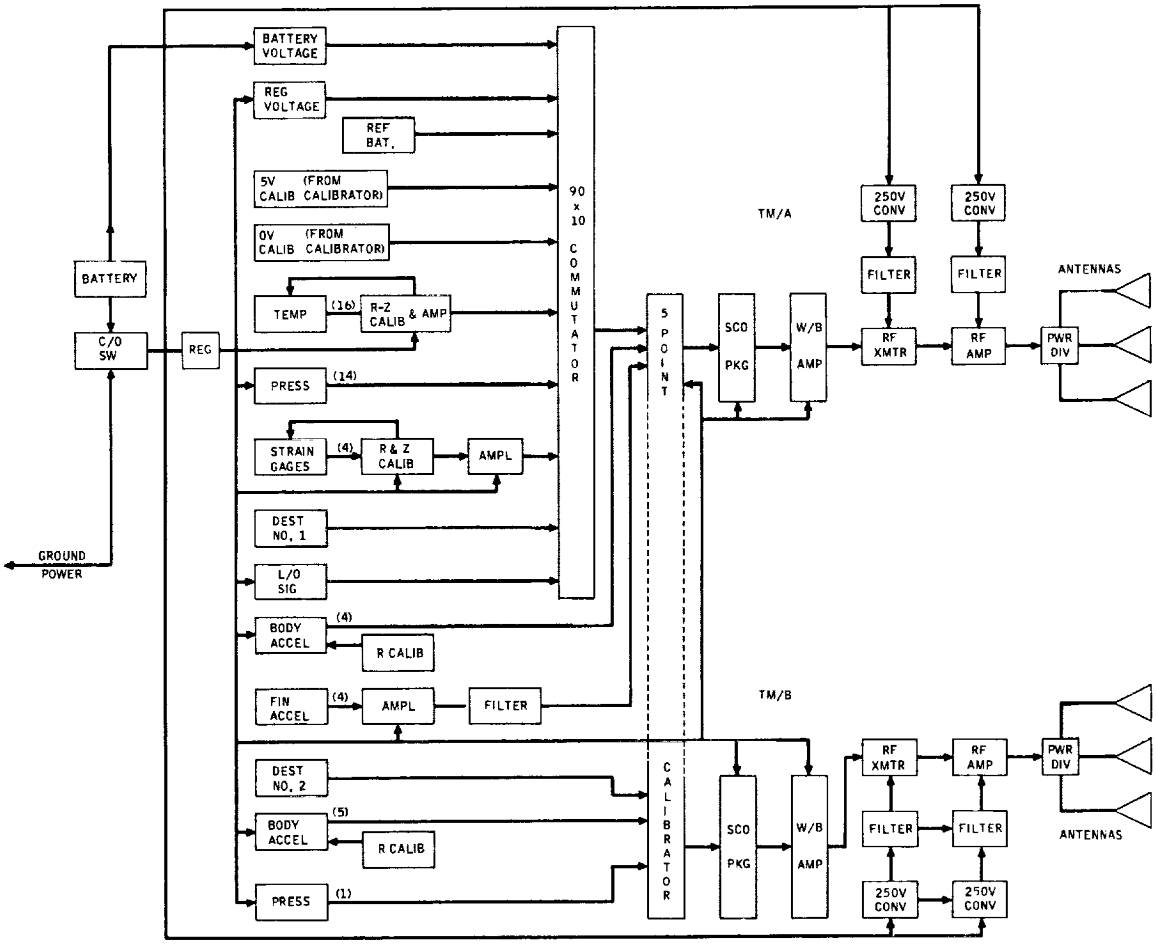


Figure 8-2. Vehicle Instrumentation System Block Diagram

Table 8-1. Vehicle Instrumentation Measurement List

Instrument No.	Type	Name	Location X In.	Location Y In.	Location Z In.	TM System	TM Band IRIG	TM Band Freq. ~KC	Commutator Segment	R Calib.	Z Calib.	Comments
1	Accel.	Fin flutter, ⊥ to chord plane	367.3	120.0	120.0	A	13	14.5				
2	Accel.	Fin flutter, ⊥ to chord plane	398.3	120.0	120.0	A	16	40.0				
3	Accel.	Fin flutter, ⊥ to chord plane	367.3	-120.0	-120.0	A	15	30.0				
4	Accel.	Fin flutter, ⊥ to chord plane	398.3	-120.0	-120.0	A	14	22.0				
5	Accel.	Body NZ, forward	32.8	0.0	- 22.0	A	9	3.9		X		
6	Accel.	Body NY, forward	32.8	- 26.5	0.0	A	11	7.35		X		
7	Accel.	Body NZ, aft	289.0	0.0	23.2	A	12	10.5		X		
8	Accel.	Body NY, aft	289.0	23.2	0.0	A	10	5.4		X		
9	Temp.	Rocket body temp., Recruit No.1				A	E	70.0	18	X	X	
10	Temp.	Rocket body temp., Recruit No.2				A	E	70.0	19	X	X	
11	Temp.	Rocket body temp., Recruit No.3				A	E	70.0	20	X	X	
12	Temp.	Rocket body temp., Recruit No.4				A	E	70.0	21	X	X	
13	Temp.	Rocket body temp., Recruit No.5				A	E	70.0	22	X	X	
14	Temp.	Rocket body temp., Recruit No.6				A	E	70.0	23	X	X	
15	Temp.	Body base structure temp.	348.0	- 36.3	0.0	A	E	70.0	63	X	X	
16	Temp.	Fin T. E. chord temp. at root	368.0	69.0	69.0	A	E	70.0	41	X	X	
17	Temp.	Fin T. E. chord temp. at root	368.0	- 69.0	69.0							Not Connected
18	Temp.	Fin T. E. chord temp. at root	368.0	- 69.0	- 69.0	A	E	70.0	43	X	X	
19	Temp.	Fin T. E. chord temp. at root	368.0	69.0	- 69.0							Not Connected
20	Temp.	Fin T. E. chord temp. at tip	391.0	86.0	86.0							Not Connected
21	Temp.	Fin T. E. chord temp. at tip	391.0	- 86.0	86.0	A	E	70.0	42	X	X	
22	Temp.	Fin T. E. chord temp. at tip	391.0	- 86.0	86.0							Not Connected
23	Temp.	Fin T. E. chord temp. at tip	391.0	86.0	- 86.0	A	E	70.0	44	X	X	
24	Temp.	Destruct receiver base temp.	29.0	- 60.0	43.0	A	E	70.0	67	X	X	
25	Temp.	Equipment compartment temp.	12.5	- 43.0	- 64.0	A	E	70.0	66	X	X	
26	Temp.	Heat quantity	348.0	- 39.3	0.0	A	E	70.0	64	X	X	
27	Temp.	Heat quantity	348.0	- 66.3	0.0	A	E	70.0	65	X	X	
28	Temp.	Body internal temp.	302.6	- 37.5	- 58.5	A	E	70.0	68	X	X	
29	E. M. F.	Instrumentation battery voltage				A	E	70.0	46			
30	E. M. F.	Inst. regulated voltage				A	E	70.0	3			
31	Press.	Body internal pressure	32.0	44.0	- 49.0	B	14	22.0				
32	Press.	Algol chamber pressure				A	E	70.0	4, 16, 26, 38, 49, 60, 70, 82			

Table 8-1. Vehicle Instrumentation Measurement List (Continued)

Instrument No.	Type	Name	Location X In.	Location Y In.	Location Z In.	TM System	TM Band IRIG	TM Band Freq. ~KC	Commutator Segment	R Calib.	Z Calib.	Comments
33	Press.	Body base press. No. 1	348.0	75.5	6.0	A	E	70.0	10, 54			
34	Press.	Body base press. No. 2	348.0	64.9	0.0	A	E	70.0	11, 55			
35	Press.	Body base press. No. 3	348.0	54.1	0.0	A	E	70.0	12, 56			
36	Press.	Body base press. No. 4	348.0	43.5	0.0	A	E	70.0	13, 57			
37	Press.	Body base press. No. 5	348.0	32.8	0.0	A	E	70.0	14, 58			
38	Press.	Body base press. No. 6	348.0	22.4	- 2.5	A	E	70.0	15, 59			
39	Press.	Body base press. No. 7	348.0	2.0	75.4	A	E	70.0	32, 76			
40	Press.	Body base press. No. 8	348.0	2.0	67.8	A	E	70.0	33, 77			
41	Press.	Body base press. No. 9	348.0	2.0	22.9	A	E	70.0	34, 78			
42	Press.	Body base press. No. 10	348.0	- 53.9	0.0	A	E	70.0	35, 79			
43	Press.	Body base press. No. 11	348.0	49.5	44.8	A	E	70.0	36, 80			
44	Press.	Body base press. No. 12	348.0	61.5	25.5	A	E	70.0	37, 81			
45	Stress	Thrust structure diagonal stress	318.5	22.0	39.0	A	E	70.0	6, 28, 50, 72			
46	Stress	Thrust structure diagonal stress	318.5	- 22.0	39.0	A	E	70.0	7, 29, 51, 73			
47	Stress	Thrust structure diagonal stress	318.5	- 22.0	- 39.0	A	E	70.0	8, 30, 52, 74			
48	Stress	Thrust structure diagonal stress	318.5	22.0	- 39.0	A	E	70.0	9, 31, 53, 75			
49	Accel.	Tower NZ	-563.0	0.0	- 2.3	B	9	3.9		X		
50	Accel.	Tower NY	-563.0	2.3	0.0	B	E	70.0		X		
51	Accel.	Command module NZ	-170.8	0.0	- 71.3	B	12	10.5		X		
52	Accel.	Command module NY	-170.8	- 71.3	0.0	B	10	5.4		X		
53	Accel.	Body module NX, forward	32.8	24.8	0.0	B	13	14.5		X		
54	Event	Missile lift-off				A	7	2.3				
						A	E	70.0	71			
55	E. M. F.	Reference voltage				A	E	70.0	5, 49			
56	Event	Abort signal No. 1				A	8	3.0				
57	Event	Abort signal No. 2				B	8	3.0				

8.2.2.2 Accelerometers — Two types of accelerometers were used. The body accelerometers were Donner with solid-state electronics, which operated on 28-volt input and had an output of 0 to 5 volts. These accelerometers incorporated a torque motor type of synthetic calibration which was used in one direction.

The accelerometers used for the fin flutter data were of the Piezo-Electric type, and the system incorporated charge-type amplifiers and a low-pass filter to adapt to the specific range of frequencies required. Because of the tailoring involved, the output range was 1.75 ± 2.5V DC output.

8.2.2.3 Temperatures — All temperatures were sensed by thermocouples through a Microdot amplifier and reference system. This system had a 0 to 5-volt output for each of three discrete ranges. Also employed in the system was a synthetic calibration of each amplifier.

8.2.2.4 Voltages — All voltages were conditioned to be 0 to 5 volts through voltage-divider networks, except the output of the 28-volt converter. In this case, the voltage was made to be 0 to 5 volts for 25 to 30 volts, which gave an extended range accuracy and resolution.

8.2.3 TELEMETERING SYSTEM — The system is broken up into four parts for convenience: commutator, calibrator, sub-carrier oscillator package, and RF link.

8.2.3.1 Commutator — The commutator used was a 90 x 10 solid-state unit. The input was 0 to 5 volts DC, and the output was 0 to 5 volts with 1 to 5 volts being data. This was used to modulate the 70 KC oscillator of Package A. Typical commutator waveforms are shown in Figure 8-3.

8.2.3.2 Calibrator — The calibrator had two functions: 1) To supply voltages for use in 5-point calibration of the SCOs and reference 5 volts for the commutator, and 2) To supply control voltages for relays to disconnect the end instruments during calibration. The calibration voltages were supplied by voltage divider

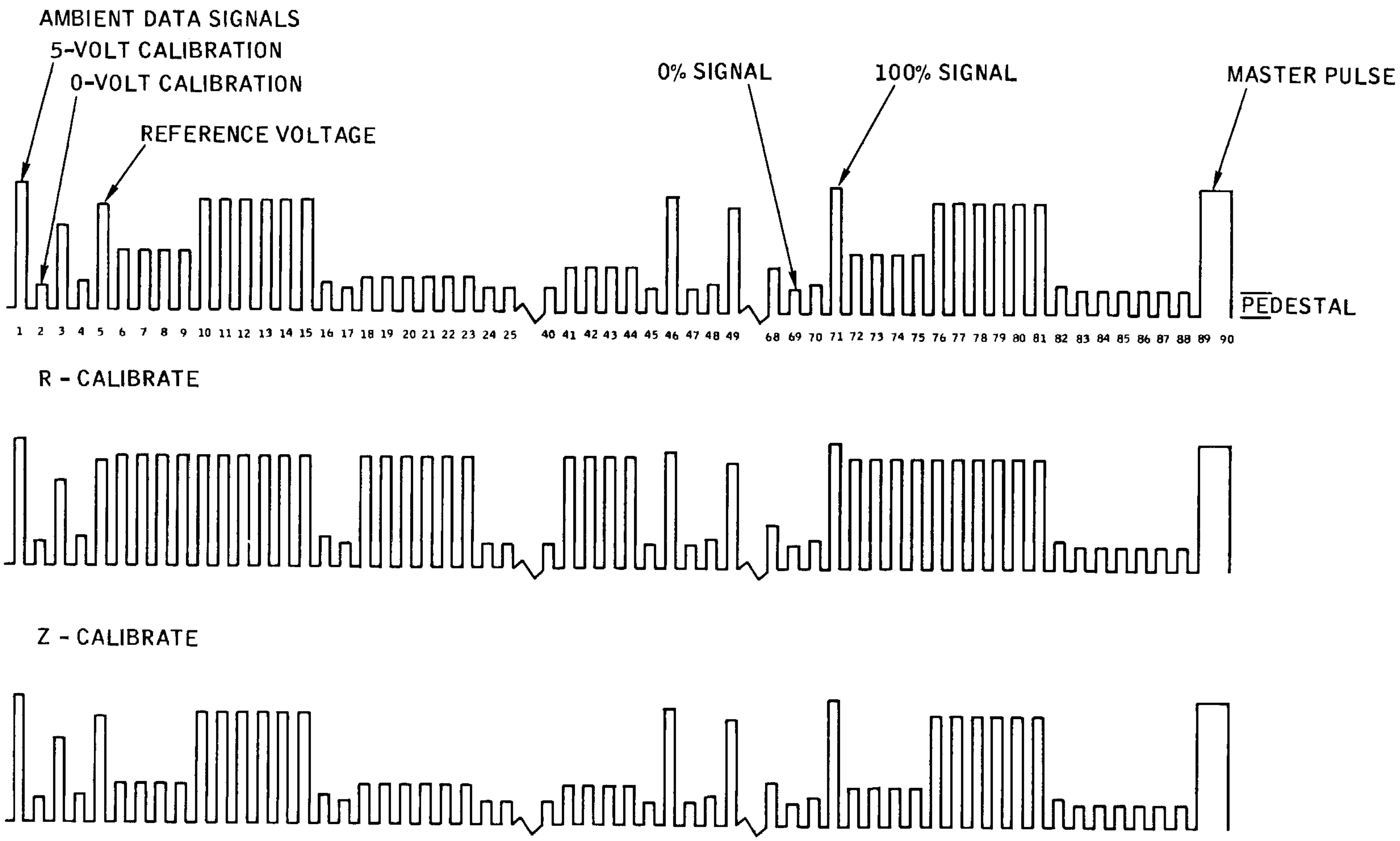


Figure 8-3. Commutator Waveforms

networks from the 28-volt regulated power supply, and the selection was accomplished by means of an electrically stepped wafer-type switch.

8.2.3.3 Sub-Carrier Oscillators — The sub-carrier oscillators were divided into two packages, A and B. Package A consisted of 11 standard frequencies, and B, 7 frequencies. Each package was multiplexed into a variable-gain wideband amplifier. This amplifier output was used directly to deviate a transmitter.

All oscillators used were of the voltage-controlled type and had a range of 0 to 5 volts as input. The 70-KC oscillators were set up to deviate ±12 percent from center frequency with an input impedance of 250K, and all other frequencies were operated ± 6 percent with an input impedance of 470K ohms.

8.2.3.4 RF Section — The RF section consists of a transmitter, power amplifier, power divider, and three antennas for each package. The transmitter used for each package is a crystal, stabilized, phase shift type with a power output of 2.5 watts and a deviation of ± 125KC. The power amplifier was used to produce approximately 15 watts, and contained adjustments to match input and output impedance of the coax cables.

The power divider, coax leads and antennas were made to be compatible for maximum power and area coverage. The divider was a passive, tuned cavity type and the output coax cables (3) were fixed in position and length. The antennas, three for each RF package, were of the notch type with a narrow band of approximately 2 megacycles. The antennas were mounted on the forebody of the vehicle in bands, and 120° apart for each RF. The divider and antennas were assembled and pre-tuned at the vendor factory and required no modification, servicing or adjustment.

8.3 CHECKOUT DIFFICULTIES REQUIRING DESIGN CHANGES

Several problems encountered during checkout necessitated design changes, as described in the following paragraphs.

8.3.1 DC-DC CONVERTER — The 28-volt DC to DC converter caused no problems regarding load, overload, low voltage input, or high voltage input. All of these difficulties had been corrected by the vendor. However, noise introduced into both the input and output systems by the converter created a problem. It was corrected by a combination input and output filter for all of the DC to DC converters.

8.3.2 TEMPERATURE SYSTEM — The temperature system required a design change by the vendor to change the output filter capacitor from a polarized type to a non-polarized type because of repeated failures. In addition to this change, the system required modification to eliminate excessive noise and allow the system to operate with the thermocouples grounded to the structure.

8.3.3 PRESSURE SYSTEM — The pressure system required filters on the output of each transducer to eliminate noise generated by the electronics of the transducer.

8.3.4 ACCELEROMETERS — The body accelerometers required capacitors on their outputs to eliminate excessive electronics noise.

8.4 CHECKOUT DIFFICULTIES REQUIRING DESIGN CHANGES

8.4.1 DIAGONAL BRACE STRESS — One DC amplifier was changed during checkout in San Diego, and one during checkout at WSMR. During the flight one channel failed; however, it did not appear to be an amplifier failure.

8.4.2 SUB-CARRIER OSCILLATOR CHANGE — During checkout in San Diego, the 70-KC oscillator of Package A was replaced because of excessive amplitude variation of output voltage between band edges. This oscillator was checked in the laboratory and returned to stock because the manufacturer does not have a specification on the output variation. During the checkout at WSMR, the 70-KC oscillator of Package A was rejected because of excessive non-linearity, and was replaced by the original rejected SCO. The requirement for voltage variation was waived at this time.

8.4.3 FIN ACCELEROMETER — During checkout at WSMR, the forward fin accelerometer of Fin No. 3 had no output. This was found to be caused by a high resistance short (180K ohms) in one of the coax fittings swaged on the fin to amplifier cable. The fitting was replaced and the system operated satisfactorily.

At some time after OCI checkout and before flight, the aft accelerometer system of Fin No. 3 failed. It is not known what caused the failure; however, the indication was the same as that for the forward accelerometer system failure.

8.4.4 TEMPERATURE SYSTEM — Other than problems that required design changes, some difficulty was experienced in obtaining a thorough system checkout of the Recruit temperature thermocouples. The thermocouples could not be heated after reconnecting into the system, and the normal checkout was waived in lieu of only an ambient check. This did not keep the channels from receiving a full calibration check from a millivolt source.

9 | MODULE INSTRUMENTATION SYSTEM

9.1 SUMMARY

All nine functions of the module instrumentation system were recorded on continuous channels and operated satisfactorily for 100 percent measuring system efficiency.

9.2 DESCRIPTION OF SYSTEM

Figure 9-1 shows the location of end instruments and contains a block diagram. Table 9-1 is the measurement list.

9.2.1 POWER — The primary power for the module system was a silver zinc battery (manufactured by Yardney Corp.) of nominally 30 volts. This battery differs from the vehicle battery in that it is rechargeable and has a lower amp-hour capacity.

9.2.1.1 Power Supply — One power supply is utilized to supply a variety of voltages used for the filaments and plate supplies for the telemetering package.

9.2.1.2 End instrumentation Power — The power for each end instrument was supplied by an individual power supply-amplifier combination which in turn was powered directly from the battery.

9.2.2 END INSTRUMENTS

9.2.2.1 Accelerometers — The four accelerometers used were of the unbonded strain gage type, powered by a power supply-amplifier combination and yielding an output of 0 to 5 volts for full range.

* The module instrumentation system is designated "Package C."

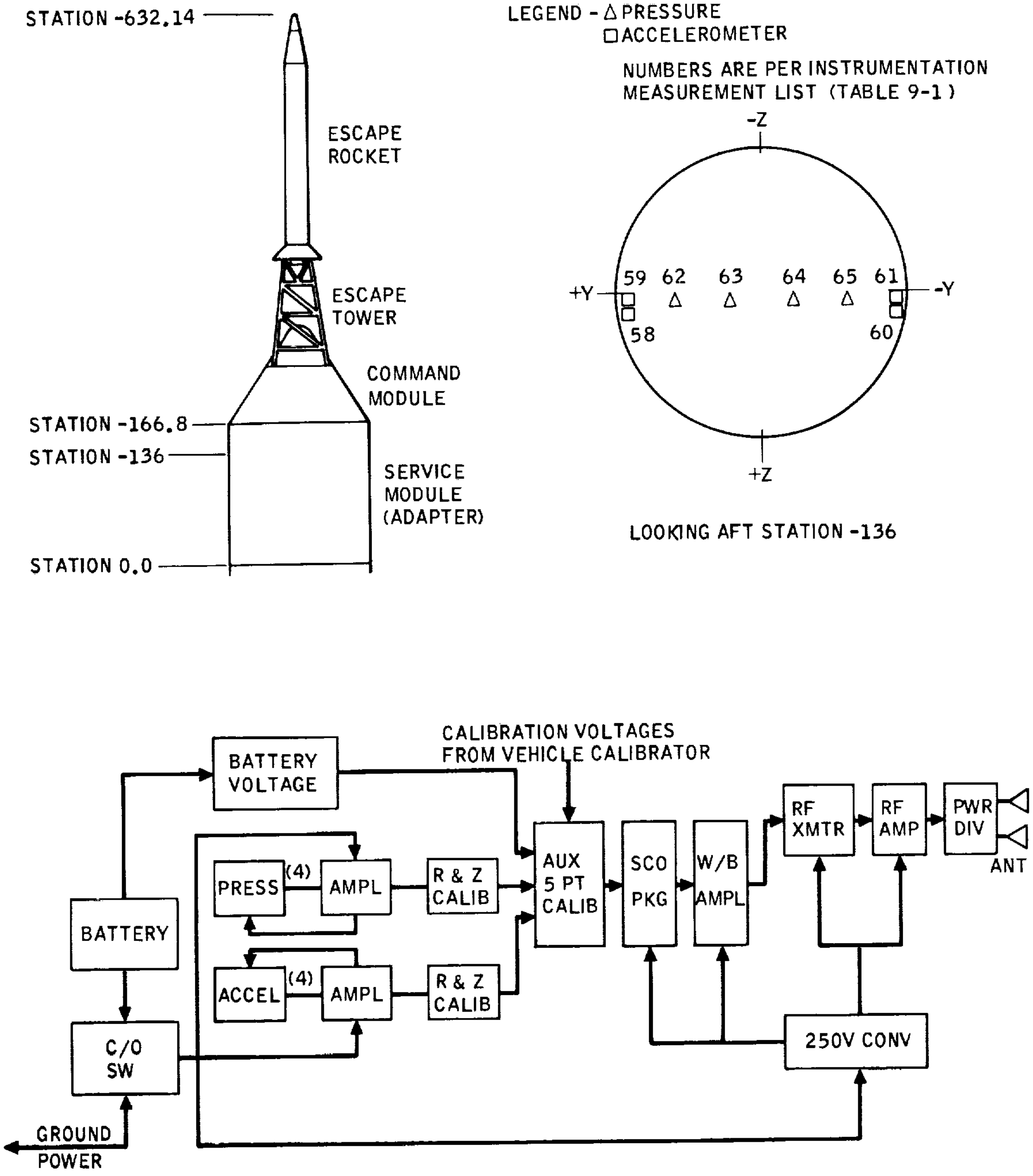


Figure 9-1. Module Instrumentation Location and Block Diagram

Table 9-1. Module Instrumentation Measurement List

Instrument No.	Type	Name	Location			TM System	TM Band		Commutator Segment	R Calib.	Z Calib.
			X In.	Y In.	Z In.		IRIG	Freq. ~KC			
58	Accel.	Module NX_1	-129.3	75.2	1.5	C	11	7.35		X	X
59	Accel.	Module NY_1	-131.6	76.75	0.85	C	13	14.5		X	X
60	Accel.	Module NX_2	-129.3	-75.2	1.5	C	12	10.5		X	X
61	Accel.	Module NY_2	-131.6	-76.75	0.85	C	14	22.0		X	X
62	Press.	Module internal press.	-136.0	69.9	-1.12	C	15	30.0			
63	Press.	Module internal press.	-136.0	23.3	-1.12	C	16	40.0			
64	Press.	Module internal press.	-136.0	-23.3	-1.12	C	17	52.5			
65	Press.	Module internal press.	-136.0	-69.9	-1.12	C	18	70.0			
66	E. M. F.	Instrumentation battery voltage				C	10	5.4			

9.2.2.2 Pressure Pickups — The four pressure pickups used were of the unbonded strain gage type, powered by a power supply-amplifier combination which yielded 0 to 5 volts for full range.

9.2.2.3 Voltage — Battery voltage was monitored using a voltage divider network to condition 30 volts to 5 volts.

9.2.3 TELEMETERING SYSTEM — The system is broken up into four parts for convenience: sub-carrier oscillator package, transmitter, power amplifier, and divider-antenna system.

9.2.3.1 Sub-Carrier Oscillator Package — The sub-carrier package consisted of 9 oscillators multiplexed into a wide-band amplifier. These oscillators were all operated 0 to 5 volts for ± 6% bandwidth. Calibration just prior to flight was accomplished using voltages automatically furnished by the vehicle 5-point calibrator.

9.2.3.2 Transmitter — The transmitter was a crystal stabilized phase-shift type with a deviation of ± 125 KC and a power output of approximately 2.5 watts.

9.2.3.3 Power Amplifier — The power amplifier incorporated an adjustment for matching to the output impedance and had an output of approximately 11 watts.

9.2.3.4 Power Divider and Antennas — The power divider was used to divide the RF power to two blade-type antennas with a wide band-pass capability. These antennas were located on each side of the module on the Y-axis.

9.3 CHECKOUT DIFFICULTIES

During checkout in San Diego, some difficulty was experienced with one of the pressure channels. At this time, the connector cable was changed and the problem apparently corrected. During checkout at WSMR, a difficulty experienced with the amplifier-pickup combination necessitated a change. No problems were encountered during flight.

10 | LANDLINE INSTRUMENTATION

10.1 TEST RESULTS

The landline instrumentation required for the Little Joe II launch vehicle operated as designed and gave satisfactory information for 27 of the 45 functions being monitored. The monitoring was accomplished by means of indicator lights, meter readings and permanent analog recordings. Functions of the landline instrumentation can be divided into the following categories:

a. Temperature conditioning
b. Range
c. Launcher
d. Instrumentation
e. Firing currents

Table 10-1 lists the individual functions in each category. Figure 10-1 lists the location of each end instrument.

10.2 TEMPERATURE CONDITIONING SYSTEM INSTRUMENTATION

Instrumentation for the temperature conditioning system is required for the surveillance of the solid-fueled rocket motors. The data consisted of two cooling air-in temperatures, one cooling air-out temperature, two Algol inner grain temperatures, and two Algol case or outer grain temperatures. During the countdown, the payload battery temperature was monitored. The temperatures were sensed in each case by a thermocouple and recorded on a Brown recorder located in the power building. A permanent record was made on an "around-the-clock" basis, and consisted of a reading of each temperature every

Table 10-1. Landline Instrumentation

Function	Indicator			
	Meter	Dial	Light	Recorder
Temperature Conditioning: *				
Algol grain temp. (2)				X
Algol case temp. (2)				X
Conditioning air at inlet (2)				X
Conditioning air at outlet				X
Module battery case temp.				X
Range:				
Lift-off signal	+ Time clock			
Destruct signals (3)			X	
Launcher:				
Umbilical system pressure			X	
Support arm system pressure			X	
Support arm retract pressure			X	
Launcher azimuth position		X		
Launcher elevation position		X		
Instrumentation:				
Ground power source			X	
Vehicle power source			X	
Vehicle power status			X	
Battery voltage (2)	X			
Ground power voltage	X			
Converter voltage	X			
Recorder status (2)			X	
Firing line status (7)			X	
Commit time	Digital			
Ignition			X	
Firing Currents: *				
Recruit firing currents (6)				X
Algol firing currents (4)				X

* Recording system installed, calibrated, maintained and operated by WSMR.

13 minutes. The data pertaining to the eight functions of the temperature conditioning system is inconclusive and can not be considered to be consistent with the accuracy normally associated with this type of instrumentation.

10.3 RANGE LANDLINES INSTRUMENTATION

The range landlines were utilized for destruct system monitoring and supplied a lift-off signal. This information came through the vehicle umbilical, and the lift-off signal consisted of the loss of a ground when the umbilical was removed. This was accomplished by a lanyard secured to the launcher and occurred at approximately +4 inches of vehicle travel.

10.4 LAUNCHER POSITIONING INSTRUMENTATION

Launcher positioning instrumentation consisted of two transmitters (elevation and azimuth) and two resolvers located on the blockhouse control console. The data was not recorded, and consisted of a visual digital readout only when the system was turned on. Other launcher functions, such as pneumatic pressure and umbilical position, were monitored by use of indicator lights on a go/no-go basis.

10.5 INSTRUMENTATION LANDLINES

The instrumentation landlines consisted of indicator lights for gross information, such as vehicle internal or external power, and a voltmeter for four finite voltage measurements. The voltages, selected to the expanded scale meter by a selector switch, were ground power, converter power, vehicle battery, and payload battery.

10.6 FIRING CURRENTS

The firing currents were recorded on a CEC oscillograph located in the power building and operated automatically at -2 seconds by the timer. The sensors were toroids that produced an electrical output with a change of current in the firing line; however, they had no physical connection to the firing line.

A positive going pulse was received for an increase in current, and a negative going pulse was received for a decrease in current.

A separate channel was provided for each of the 10 firing lines. The data for all ten firing lines indicated current. Maximum time interval of current application was 3 milliseconds, as anticipated from OCI tests.

The magnitude of the currents can not be determined from this type of pickup. The duration of the current of each firing line is indeterminate because of the record produced by the type of pickup and the common power supply for the current. Data received from the instrumentation system could not be analyzed sufficiently to be used for failure analysis, if this had been necessary. The system should be improved.

Proper oscillograph operation was monitored on the blockhouse console by means of indicator lights for oscillograph "Ready" and "Fail."

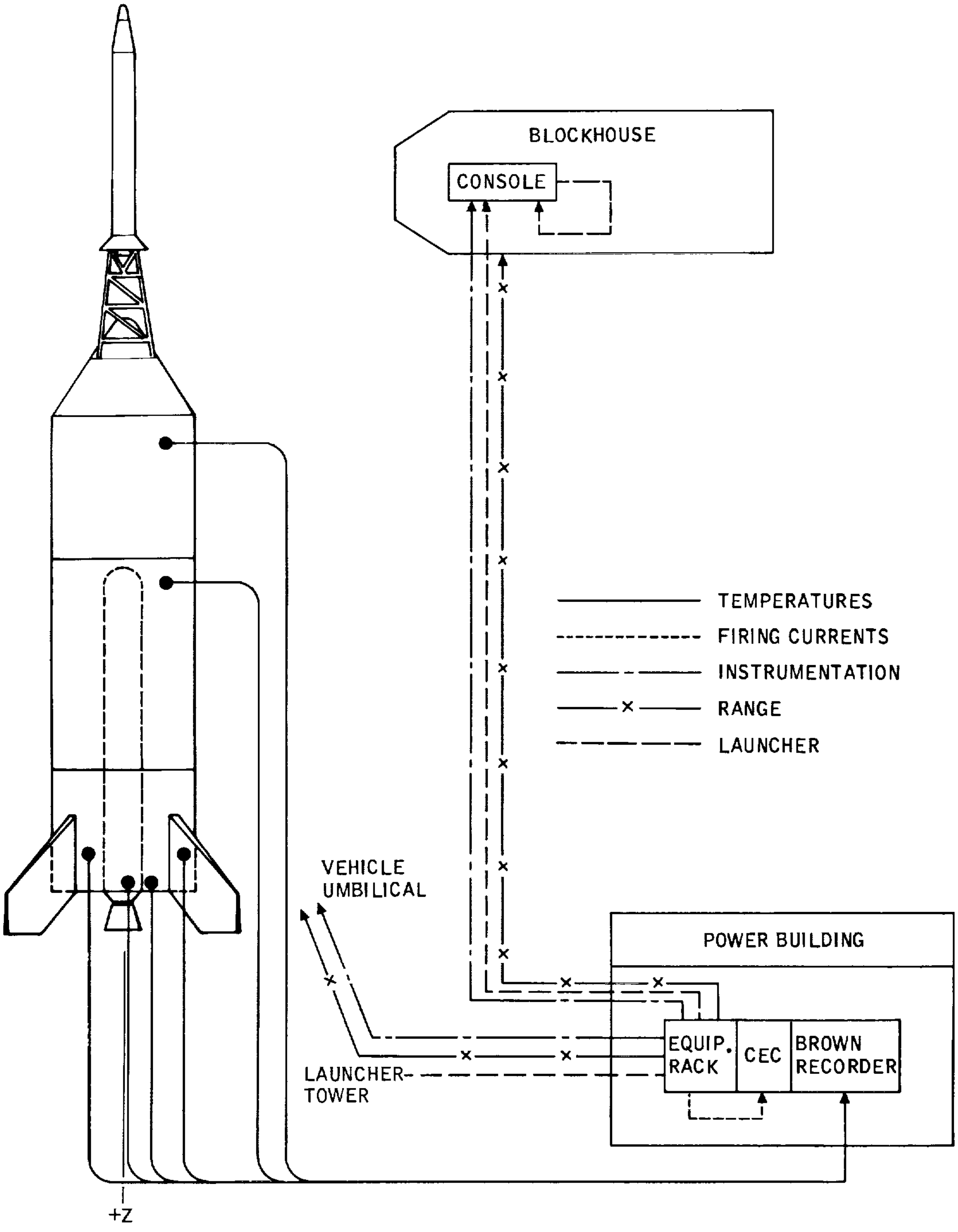


Figure 10-1. Landline Instrumentation Location

11 | LAUNCH COMPLEX

11.1 LAUNCH FACILITY DESCRIPTION

The Army Launching Area (ALA-3) at the White Sands Missile Range, New Mexico, was utilized as the Little Joe II launch facility. This complex, built for the Redstone vehicle, was modified to accommodate the Little Joe II/Apollo Project.

ALA-3 facilities provided for the Little Joe II launch included 1) a portion of the existing blockhouse; 2) a new pad constructed approximately 1,100 feet from the blockhouse; 3) the existing service tower, modified for the Little Joe II launch vehicle; 4) a power and signal cable trench interconnecting the blockhouse to the pad area; 5) a barricade structure building containing a power room; 6) a vehicle assembly building, and 7) a communications network. Additional government-furnished equipment at the pad included an air conditioning trailer for the launch vehicle and a telemetering checkout trailer.

A portion of WSMR Building 1540, located at the main base area, was assigned to Convair for administrative office space, storage and handling of supplies, receiving inspection, and as an auxiliary shop area containing miscellaneous machinery provided by Convair's San Diego facility.

11.1.1 LAUNCH PAD AREA — The launch pad is a 150 x 100-ft. concrete area, with the longest dimension on an east-west line. The Little Joe II launcher was located on the east end of the concrete area with the pivot point 34 feet from the eastern edge. The 34.5 x 26.25-ft. area immediately under the launcher was

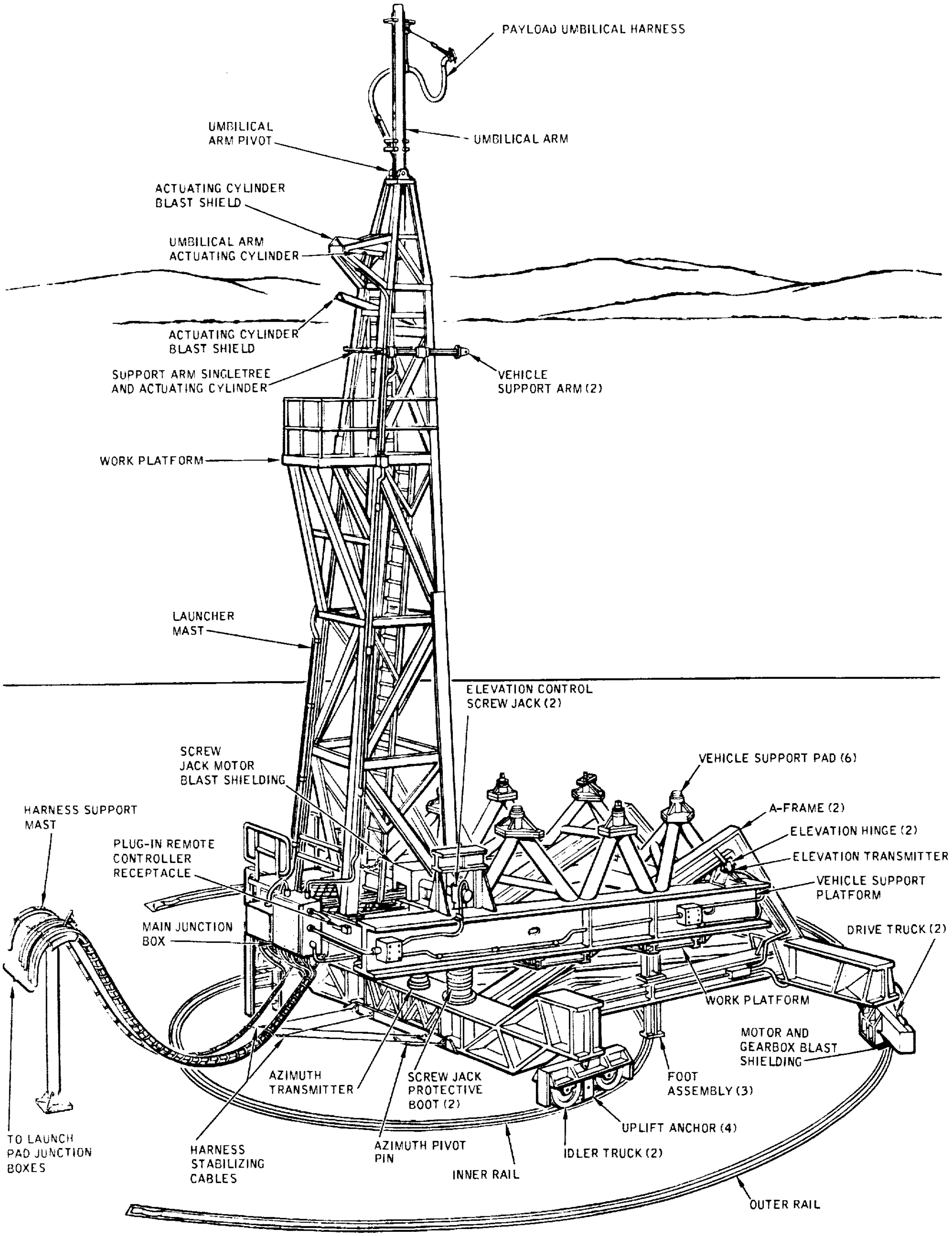


Figure 11-1. Vehicle Launcher

paved with fire brick to withstand rocket motor heat and blast. Rails were set in concrete to support the launcher and permit azimuth pointing. The inside rail is a complete circle with a 10.83-ft. radius, and the outside rail (25.58-ft. radius) covers an arc from 278 degrees through North to 150 degrees.

The launch location and rail installation permitted mating with the service structure for vehicle build-up, by pointing the launcher to 90 degrees. All areas of the launch pad were satisfactory, both during the vehicle build-up phase and during launch. The fire brick immediately under the center of the vehicle showed slight fusing caused by the heat of the Algol motor during launch.

A mobile air conditioning unit was used at the launch pad to condition the booster section of the vehicle and maintain the Algol grain temperature within desired limits for launch. The unit maintained the Algol grain temperature within the desired limits; however, considerable trouble was experienced when the flexible return duct collapsed, causing the air conditioning unit to surge. Also, the breakaway and handling of these ducts during the countdown was ungainly and time consuming. Redesign of the duct system is required to prevent surging, and also to facilitate handling.

11.1.2 BLOCKHOUSE — The direction and control of the Little Joe II launch vehicle was conducted from the western half of the ALA-3 blockhouse. The console, used for control of the launcher and vehicle electrical circuits, was installed in the blockhouse, with adjacent stations for the Test Directors. Communication centers were provided at each station. The 110-volt, 400-cycle power supply for launcher position indication was also located in the blockhouse. All components in the blockhouse performed satisfactorily, except for the launcher position indicator power supply (GFE), which tripped off the line nine times during the countdown. The power was re-established each time without creating a hold condition.

11.1.3 POWER BUILDING — The power building, a barricaded structure located at the southern edge of the launch pad, houses the equipment rack, AC and

DC power supplies, launcher power control boxes, final ignition arming box, and an area for the NAA checkout van. The building is air conditioned by an air conditioning unit mounted outside along the west wall. This unit was protected for the launching by an additional sandbag barricade. All components and controls within this building functioned satisfactorily, and the building was unaffected by blast during the launch.

11.1.4 LONG RUN CABLE TRENCH — The 1,090-ft. cable trench houses the electrical control cables that connect the console in the blockhouse with the equipment rack in the power building and the vehicle mounted on the launcher. The trench is concrete lined, with a corrugated steel cover secured to the top of the concrete wall with anchor bolts and steel angles. The trench was completely unaffected by the launch blast and heat.

11.2 VEHICLE LAUNCHER DESCRIPTION

The launcher (Figure 11-1) is a fabricated steel structure supported by two curved rails. The basic components include a pivot frame mounted on double-flange, crane-type trucks; an azimuth pivot pin assembly; support platform mast; and elevation control screwjacks. A pneumatic system is used to retract the umbilical arm and two vehicle support arms on the launcher mast. Switches on the launcher control panel in the blockhouse console control the operation of the arms, as well as position the launcher in azimuth and elevation. A selsyn motor connected to the azimuth pivot pin transmits a signal to the blockhouse for azimuth position information relative to the White Sands Range coordinates. A similar selsyn motor located in the support platform pivot transmits elevation angle information to the blockhouse.

The umbilical arm retraction mechanism was deactivated for this launch, and the payload umbilical plug was not installed. Launch preparations revealed a failure in a pneumatic system pressure switch. The switch was replaced, and all other functions performed satisfactorily for the launch.

11.2.1 VEHICLE LAUNCHER OPERATIONS AND PERFORMANCE

— The launch vehicle is supported on six vehicle support pads on the launcher, 14 feet above the surface of the launch pad. The launcher rotates about a fixed pedestal and on the two curved rails. It is adjustable in azimuth, ±45 degrees from a nominal heading and between 75 and 90 degrees elevation. Final pointing requirements for the Little Joe II launch vehicle were 4 degrees 56 minutes azimuth and 82 degrees 48 minutes elevation. The elevation was set precisely, and azimuth was set at 4 degrees 56 minutes 30 seconds. The electrical and ignition umbilical extraction and support arm retraction was normal. Launch preparations, execution of the countdown, and launch were conducted as planned, and successfully demonstrated the compatability of the launch complex/launcher equipment and the flight configuration. Post-launch inspection of the complex/ launcher showed the general condition of the equipment to be satisfactory — only minor damage to the launcher flame and blast protection was experienced.

11.3 SUMMARY OF LAUNCH COMPLEX DIFFICULTIES

Late additions and deletions to the launch complex and from interface coordination between Convair, MSC/WSMR and the U. S. Army Corps of Engineers, necessitated changes in the launch complex configuration.

OCIs and the dry-run countdown revealed additional facility discrepancies. Most of the changes required to make the facility compatible with the vehicle were electrical wiring revisions. They were accomplished by "up-date" engineering during modification of the facilities, and were not considered to be a major task. The result of interface coordination and the conduct of OCIs left certain voids which were filled by field engineering, as described in Table 11-1.

Table 11-1. Launch Complex Difficulties and Remedial Actions

System	TPS	Date	Difficulty	Remedial Action
Complex Powerhouse	E-27	6-18-63	Supporting structure, conduits and wiring were not available to complete interface connections in the powerhouse.	Installed cable trays, conduits and receptacle box to provide 28-volt DC, normal emergency and ignition power to the equipment rack and 110-volt DC power to a recorder station.
Complex Cable Trench	E-28	6-18-63	Impossible to make necessary bend in 3-in. conduit to complete connections to SJB-4 as installed. Also, cables were routed on floor of cable trench, from cable trays to underground conduit openings in trench.	Moved SJB-4 to a new location along wall of trench to provide room to make comduit connections. Also, installed cable support hooks in wall of trench to support cables.
Complex Manhole at Blockhouse	E-30	6-21-63	Cables had sharp bend radius where they entered the manhole, and also were laying in dirt at the bottom of the manhole.	Installed cable support hooks on manhole wall to hold cables off ground and to ease strain on cable where they entered manhole.
Complex Blockhouse	E-43	7-18-63	Wire bundle was unsupported in blockhouse, where it routed across wall from underground cable trench to the overhead cable tray.	Installed clips on blockhouse wall and end of the cable tray to support the wire bundle.
Complex Powerhouse	E-45	7-19-63	Cables delivered with equipment rack were too short to route on existing cable trays and still reach connecting point in the underground cable trench.	Created additional cable support structure in power room to support cable between equipment rack and entry to underground conduit.

System	TPS	Date	Difficulty	Remedial Action
Complex Ignition System	E-54	7-29-63	Ignition circuit breaker shorted to ground.	Eliminated a jumper wire no longer used between STB-86 pin 3 and STB-43 pin 3 which connected the ignition power directly to ground.
Complex Commit Time Circuit	E-55	7-29-63	Commit time circuit not complete — wire not called out on wiring data sheets.	Installed wire from STB-15 pin 14 to STB-15 pin 13 to complete circuit shown on schematic drawings, but not covered in the wire data information.
Equipment Rack	E-59	7-30-63	Diodes were shorting to ground from their case through metal support clips.	Replaced metal support clips with plastic.
Complex Console and Equiptment Rack	E-60	7-31-63	Timer would not reset from control on console in the blockhouse. Problem involved excessive voltage drop in long run cables.	Relays were not readily available for use in a controlled power circuit; consequently, spare wires were utilized to add additional "copper" to the circuit, thereby reducing voltage drop to an acceptable level.
Complex Blockhouse	LV-50	8-10-63	Assist to WSMR.	Installed a multipin electrical connector in SJB-2 to provide WSMR range with monitor and control of command destruct system.
Complex Blockhouse	E-67	8-1-63	Circuit continuity did not exist in the umbilical fail circuit.	Installed jumper on STB-41 pins 3 and 4 in STB-2 to take the place of a mechanical buss bar not installed in original manufacture.

System	TPS	Date	Difficulty	Remedial Action
Complex Timer Circuit	E-70	8-2-63	Timer could not be reset when stopped at T-4 seconds. Troubleshooting showed timer cutoff relay was being held in by electrical lock.	Rewired timer cutoff relay to install relay suppressor diode in front of (electronically) blocking diode.
Complex Azimuth Ind. Circuit	E-76	8-3-63	Azimuth indication on console moved in reverse direction to actual launcher motion.	Reversed the field circuits in selsyn motor (at launcher) to correct indication problem.
Complex Grounding System	E-87	8-6-63	Ground potential was out of limits during the OCI checks.	Removed unnecessary ground in data correlation box at console, thereby eliminating separate ground potential in a single system.
Complex Elevation System	E-56	7-30-63	Elevation switches failed in the open position, preventing movement of the launcher in the opposite direction.	Replaced switches with improved switches which were sealed and potted.
Complex Inst. Plate Voltage Circuit	LV-100	8-18-63	Voltage drop was excessive to instrumentation 250-volt converter input.	Utilized spare wires to add wiring to long run cables, to reduce voltage drop to an acceptable level.
Complex Ignition Batteries	LF-95	8-16-63	Ignition battery voltage had to be increased to provide desired firing current.	Added cells to ignition battery supply and also modified charger to provide increased voltage.
Complex Emergency Batteries	LF-102	8-19-63	Line loss between emergency batteries and vehicle DC/DC converter excessive.	Added cells to emergency battery to provide increased voltage to overcome the line loss.
Complex Ignition System.	LV-134	8-26-63	Shielding not grounded.	Added ground-to-ignition wiring shields at SJB-5 in the Power Building.

11.4 SUMMARY OF POST LAUNCH DAMAGE

The damage to the launch complex/launcher was limited to charred elevation jack protective boots and missing areas of transite heat barrier from the launcher framework (Figure 11-2). The elevation jack boots did not burn through, thereby protecting the jack mechanism from the corrosive effect of the rocket motor blast. The missing transite was broken loose by the blast and was not burned away; therefore, metal parts of the launcher were not damaged by the heat. Electrical cables, junction boxes and conduits were not damaged by the blast or heat.

11.4.1 VEHICLE UMBILICAL SEPARATION — Lanyards were provided (as per Convair Dwg. 12-61007) for unlocking and withdrawing the ignition and electrical umbilical connectors from the base of the launch vehicle. These lanyards (in the form of a loose loop) pass around a structural member of the launcher platform. The lanyard pulls a collar on the electrical connectors, which in turn releases a ball lock and permits withdrawal of the pin connection. The lanyards are adjusted by wrapping them (by means of safety wire or additional loops) around the structural member to facilitate removal of the electrical connector at 4 inches of vehicle travel and the ignition connector at 10 inches of vehicle travel.

Withdrawal of the connectors was accomplished satisfactority during the launch. Post launch inspection showed the lanyard on the electrical connector to have failed at the swaged terminal on one end of the lanyard. This failure occurred after the plug was withdrawn, as evidenced by lack of electrical wire damage, and was caused by the plug being accelerated when subjected to the exhaust blast.

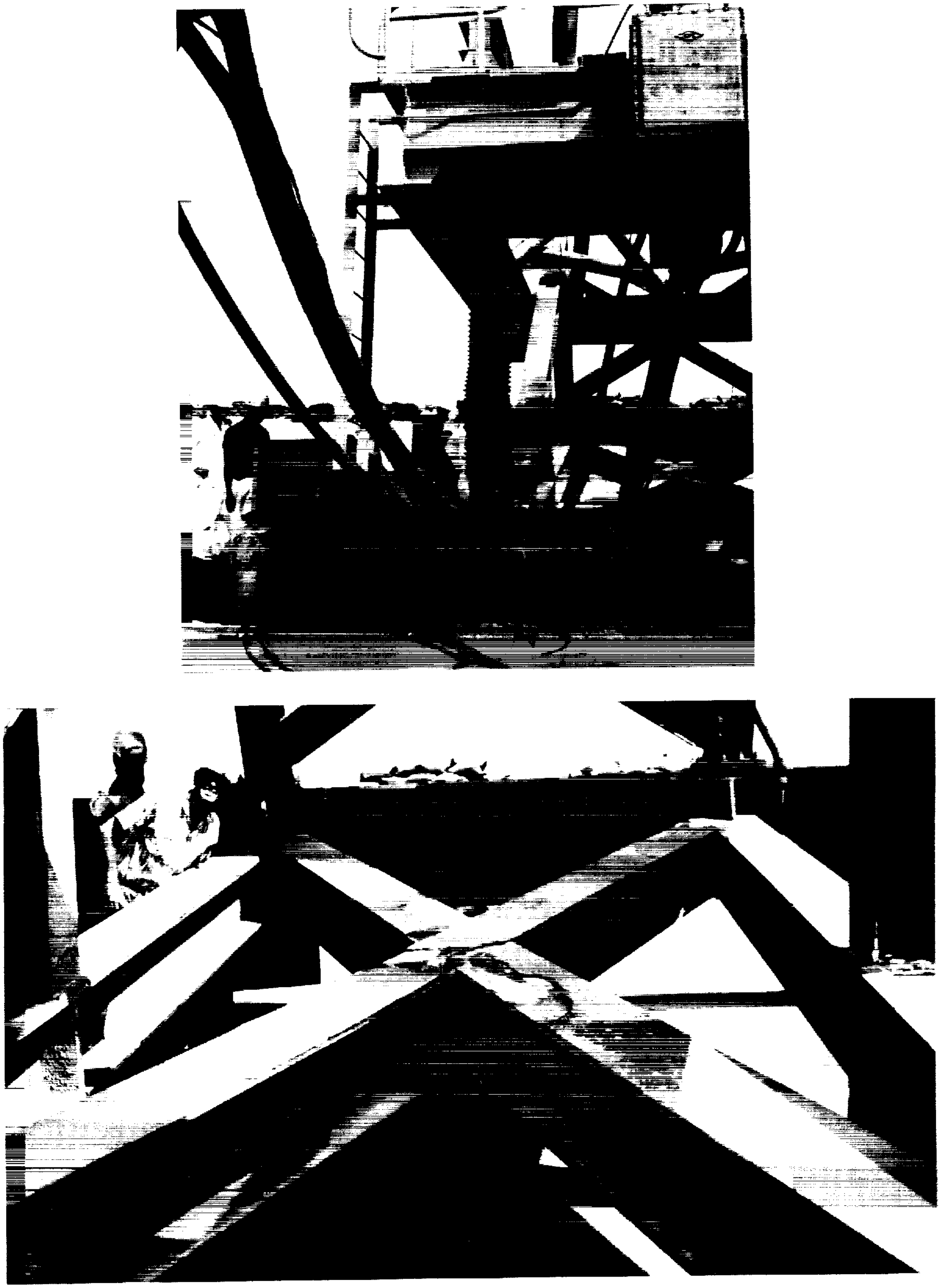


Figure 11-2. Launch Damage to Vehicle Launcher

12 | RANGE DATA SUPPORT

Complete information pertaining to WSMR range data support is not available to make a thorough evaluation at this time. When the information is obtained, this section will be prepared and submitted in a revised flight test report.

13 | VEHICLE

13.1 VEHICLE CONFIGURATION

A detailed configuration of Launch Vehicle 12-50-001 is beyond the scope of this report; however, more complete configuration data may be found in References 5, 6, 7, 8, 9, 10 and 11. The Little Joe II Qualification Test Vehicle was a Model 12-50-001 fixed-fin version, manufactured by General Dynamics/Convair, and a dummy payload simulating the boilerplate Apollo spacecraft. Figure 13-1 shows a general layout of the vehicle.

13.2 AIRFRAME

The Little Joe II used for this mission was a fin-stabilized airframe in which one Aerojet Algol 1D (Mod II) and six Thiokol Recruit solid-propellant rocket motors were installed. The 154-in. -dia., 350-in. long body consisted of a 227-in. forebody section and a 123-in. aftbody section. These sections were fabricated from truncated-form, corrugated aluminum sheets stabilized by ring frames. Four fixed fins, swept 45 degrees with an area of 50 square feet for each fin, were attached to the aftbody. Air conditioning access doors were provided in the airframe to permit proper temperature conditioning of the rocket motors prior to flight. Most of the components of the vehicle subsystems were installed in the equipment compartment area (located in upper portion of forebody), which has three doors spaced 120 degrees apart for access. Figure 13-2 shows an exploded view of vehicle airframe structure.

13.3 PAYLOAD

The dummy payload simulated Apollo command and service modules (subcontracted by Convair to Colby Crane and Manufacturing Co. for fabrication) and

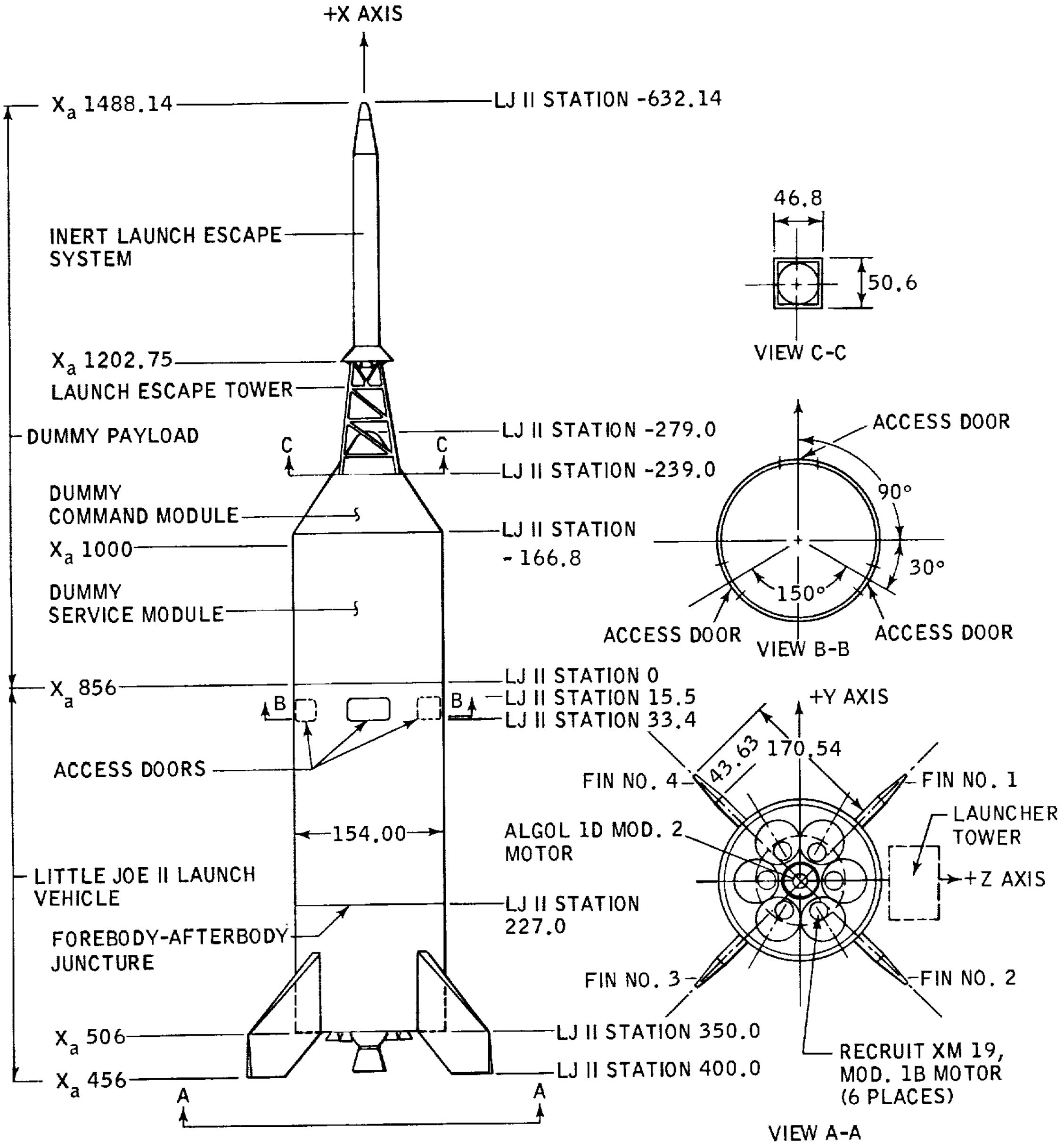


Figure 13-1. Little Joe II Flight Configuration

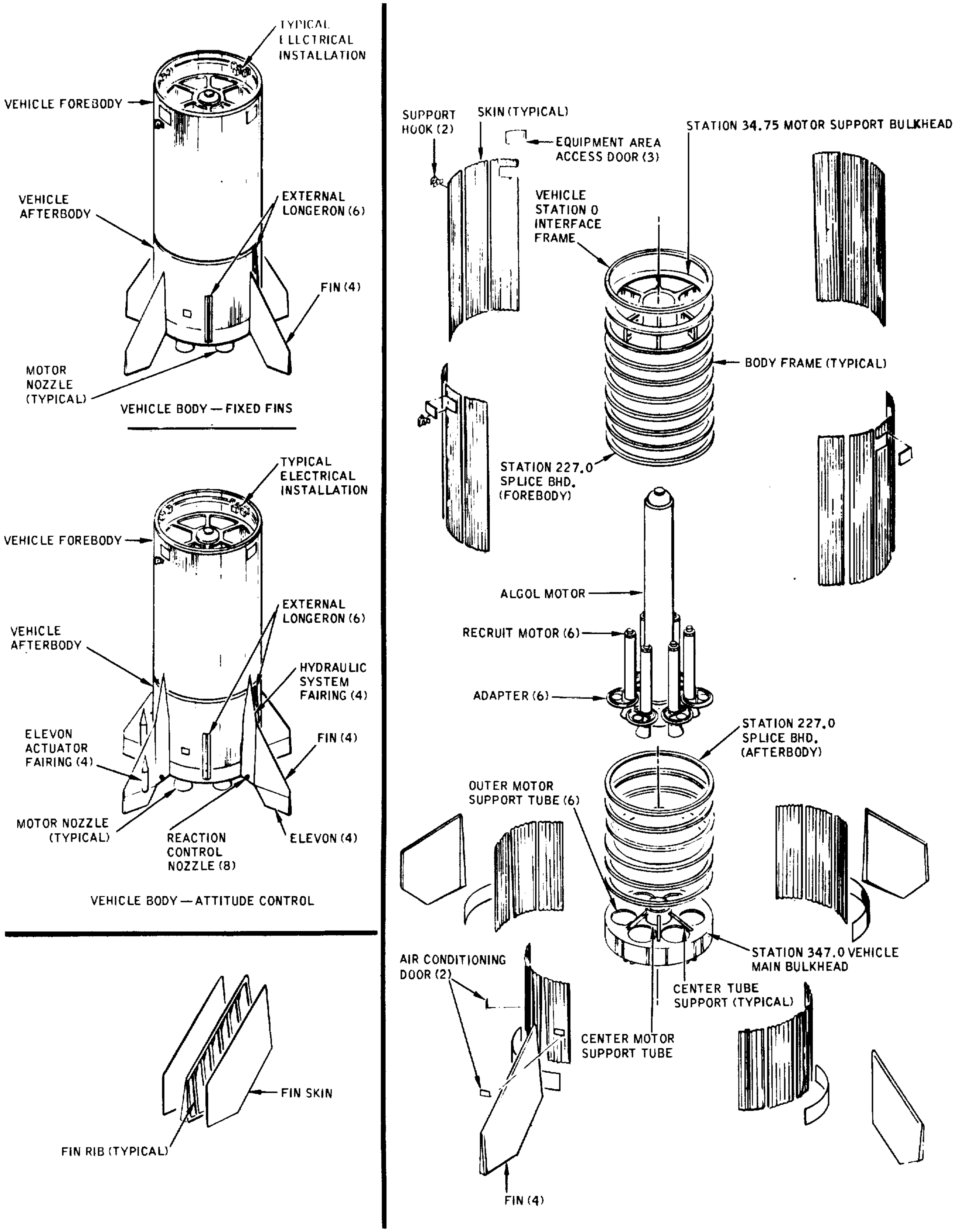


Figure 13-2. Launch Vehicle Airframe Structure

an inert launch escape system (LES) provided by NASA. The modules were fabricated from welded steel plate stock, except for the 12-in. kirksite nose cone section of the command module. The dummy payload (42-ft., 8-in. length) simulated the aerodynamic shape of the Apollo spacecraft.

13.4 PROPULSION SYSTEM

The propulsion subsystem consists of one Algol 1D Mod II (Aerojet-General Model 33KS-120,000) rocket motor and six Recruit P/N E-15349-13 (Thiokol Chemical Corporation) rocket motors. The Algol motor is bolted to a retaining ring in the thrust bulkhead of the vehicle afterbody; adapters are provided for attaching the Recruit motors to the rings. The bulkhead at Station 34.75 of the forebody provides lateral support for the Algol motors. There are no support provisions for the forward end of the Recruit motors. The motors are ignited by an electrical signal from the vehicle ignition system. The ignition current pulse to each motor igniter is recorded in the power building from the blockhouse landlines.

The Algol motor grain temperature is monitored prior to launching in order to determine that the motor assembly is conditioned to produce grain temperatures within ±5° F of 70° F. A Brown temperature recorder in the power building records the Algol inner grain core and outer case temperatures.

13.5 ELECTRICAL SYSTEM

An airborne electrical system supplying DC power to dependent vehicle measurement subsystems is provided. The system consists of a remotely activated silver-zinc battery, a battery-driven static DC to DC converter, and a power changeover switch. The power changeover switch assembly transfers dependent vehicle measurement subsystems from the external power source (power building) to vehicle electrical power (internal) prior to launch.

13.6 RANGE SAFETY COMMAND DESTRUCT SYSTEM

A dual-command destruct subsystem is installed to terminate the Algol motor thrust. The system consists of a command electronics subsystem (2 receivers, 2 batteries, 6 flush-mounted antennas, 2 destruct control relay assemblies) and a pyrotechnic subsystem (2 destructors, 4 primacord trains, and destruct charges attached to Algol motor). The receivers, destructors, batteries and destruct charges are government furnished.

13.7 TELEMETRY SYSTEM

The telemetry system transmits data from the various launch vehicle instrumentation systems to the ground telemetry station. The system is composed of three telemetry packages: TM-A and TM-B in the launch vehicle, and TM-C in the payload. Eleven telemetry channels are available in the TM-A package, seven in the TM-B, and nine in the TM-C.

13.8 RADAR BEACON SYSTEM

The vehicle radar beacon transmission system affords the WSMR Radar Range greater tracking accuracy during vehicle flight. It consists of three antennas, an antenna coupling transformer, a beacon transponder and a battery. This system is constructed and supplied by the WSMR Radar Laboratory.

14 | PREFLIGHT INFORMATION

14.1 TESTING

The purpose of this section is to summarize all Launch Vehicle 12-50-001 preflight tests, including factory and WSMR testing.

14.1.1 SUMMARY OF FACTORY TESTING — The following Operational Checkout Instructions (OCIs) were accomplished on the vehicle prior to shipment to WSMR:

OCI 81012	Five Point Calibration
OCI 81018	Commutator Subsystem
OCI 81017	Voltage Measurement
OCI 81008	Algol Chamber Pressure
OCI 81005	Vehicle Base Pressure
OCI 81007	Temperature Subsystem
OCI 81006	Thrust Bulkhead Strains
OCI 81013	Subcarrier Oscillators
OCI 81016	Vehicle Body Pressure
OCI 81004	Body Acceleration
OCI 81015	Fin Acceleration
OCI 81019	Transmitter Frequency Deviation
OCI 81014	Transmitter and Amplifier
OCI 81020	RF Link
OCI 81002	Instrumentation System
OCI 83201	Command Destruct System

OCI 83301	Radar Transponder Beacon
OCI 86001	Electrical System
OCI 86004	Integrated Vehicle
OCI 85108	Test Console
OCI 85115	Equipment Rack
OCI 81022	OCI Plan
OCI 81024	Auxiliary Calibrate Box (Payload)
OCI 81025	Subcarrier Oscillators (Payload)
OCI 81025	RF Transmission and Frequency Deviation (Payload)
OCI 81026	Body Pressure (Payload)
OCI 81027	Body Accelerations (Payload)

14.2 OPEN ITEM STATUS OF VEHICLE 12-50-001 WHEN DELIVERED TO WSMR

The configuration of the vehicle conformed to specifications for this model. At the time of delivery, 16 July 1963, the following tasks had not been accomplished — it was planned that they be completed at the test site (WSMR).

FTI/DWG/OCI Planning Ref.	Description of Task
FTI 99-00502-003	To verify factory calibrations of Wiancko low-pressure transducers, P/N P2-1402. A total of 16 units were calibrated and functionally tested.
FTI 90-02600-004 90-14900-001	To verify factory calibrations of Endevco accelerometer and amplifiers. A total of 8 units were calibrated and functionally tested.
FTI PA208TC-50-350 PA911TC-50-350 PA130TC-50-350	To verify factory calibrations of Statham absolute-pressure transducers. A total of 4 units were calibrated and functionally tested.
FTI 90-15075-002	To verify factory calibrations and Microdot direct-coupled amplifiers. A total of 4 units were calibrated and functionally tested.
FTI 90-02600-005, -006, -007	To verify factory calibrations of Donner Scientific accelerometers. A total of 12 units were calibrated and functionally tested.

FTI/DWG/OCI Planning Ref.	Description of Task
FTI 90-15003-003, -004	Functional test of TM amplifiers TM-A and TM-B (Teledynamics), TM-C (Bendix).
FTI 96-47702-001, -002, -003, -004, -006, -007, -008, -009	Resistance check of Bendix oscillators to verify factory functional tests. A total of 9 units were tested.
FTI 99-04806-002, -003	Resistance check of Teledynamics TM transmitters TM-A and TM-B to verify factory functional tests.
FTI 99-04807-001	Resistance check of Bendix TM transmitter (TM-C) to verify factory functional tests.
FTI 96-47701-001, -002, -003, -004, -005, -006, -007, -008, -009, -010, -011	Resistance check of Teledynamics oscillators to verify factory functional tests. A total of 18 units were tested.
EM 2000-D1, 2000A-3	Resistance check of Engineered Magnetics amplifiers (DC) to verify factory functional tests. A total of 8 units were tested.
FTI 99-00502-004	Verification of factory calibrations of Statham pressure transducers. A total of 3 units were tested.
FTI 12-10000-903	Resistance check of TM-C amplifier mounts to verify factory functional tests. A total of 4 units were tested.
FTI A69TC-20-350	To verify factory calibrations of Statham accelerometers. A total of 4 units were calibrated and functionally tested.
FTI 99-66801-001	To verify factory calibrations of the Kinetics (P/N M833-1) DC-DC converters. A total of 4 units were calibrated and functionally tested.
STM-170	Boroscope inspection of Algol rocket motors, S/N 367904-19 and 806665.
OCI 12-82003	Prepare Algol Motor Assembly No. 80665 for installation: Thermocouple check, igniter installation, destruct charge installation and chamber pressure instrumentation.
DWG 12-10012	Installation of Algol igniter pressure transducer (reference OCI 12-82003).

FTI/DWG/OCI Planning Ref.	Description of Task
OCI 12-83203	Installation of primacord net in the launch vehicle.
OCI 12-82004	Operational checkout of Algol squibs.
OCI 12-82008	Operational checkout of Recruit igniters.
OCI 12-86008	Installation of the Recruit expendable ignition harness per Convair photos 84092, 84093, 84094, 84095 and 84096.
OCI 12-86604	Connection of rig launcher vehicle support arms and installation of clamps.
OCI 12-86702	Launch vehicle and fin alignment checks.
DWG 12-13100	Connection of T/C (landline instrumentation) to monitor Algol grain temperature and air conditioning air supply.
DWG 12-60003	Installation of vehicle aft body umbilical wiring and plugs.
Planning Ref. 12-07901-902	Completion of the aft-body base heat insulation (field application). Subject task completed after installation of the Algol and Recruit motors.
Planning Ref. 12-10001-901	Sealer installation on fin accelerometers and thermocouples.
Convair ECN 311-82	Installation of lift hook assembly on the escape rocket nose cone to provide access to instrumentation accelerometers.

14.3 SUMMARY OF WSMR PREFLIGHT TESTING

The Little Joe II aft/forebody combination arrived at WSMR on 16 July 1963. Off loading proceeded as planned, and the units were stored in Building 1540. The payload arrived 18 July, and off loading was accomplished on 19 July. Receiving inspection of the assemblies and associated components was conducted during the week of 22 July. Functional and calibration checks of the vehicle instrumentation and electrical components removed for transportation were accomplished in WSMR Standards Laboratories. This activity started 20 July and was satisfactority completed 1 August.

On 26 July, MSC/WSMR directed Convair to proceed with vehicle buildup, checkout and launching of the QTV. During the following week, vehicle sections were moved to the NASA Vertical Assembly Building (used as a staging area). On 6 August, the aft body was placed on the launcher, thus initiating structural assembly of the launch vehicle. Assembly was completed 9 August, and checkout of vehicle systems and instrumentation was initiated. The dummy payload and launch escape system were installed 20 August. Checkout of all systems and instrumentation was completed 24 August 1963. Figure 14-1 is an outline and tabulation of the OCIs performed on the launch vehicle, together with OCI operation times and completion dates.

14.4 MAJOR SYSTEM COMPONENTS

a. Algol Motor — P/N 367904, S/N 806665.

b. Recruit Motors, Canted Adapters, Nozzle Assys:

(1) Recruit Motors:

Pos'n	P/N	S/N
1	E-15349-13	PV16-224-15
2	E-15349-13	PV16-258-6
3	E-15349-13	PV16-258-11
4	E-15349-13	PV16-224-14
5	E-15349-13	PV16-258-7
6	E-15349-13	PV16-258-10

(2) Canted Adapters:

Pos'n	P/N	S/N
1	E13292-02	T-32
2	E13292-02	T-20
3	E13292-02	T-28
4	E13292-02	T-27
5	E13292-02	T-34
6	E13292-02	T-23

		DAY	SA	T	W	T	F	SA	SU	M	T	W	T	F	SA	SU	M	T	W
	AUGUST 1963	DATE	10	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
		TIME																	
OCI	86001-VEHICLE ELECTRICAL		■																
	81012-FIVE POINT CALIBRATOR		■																
	86203-IGN. SYS. FIRING CURRENTS	4:06			■														
	81013-SUBCARRIER OSCILLATORS	12:30			■	■	■												
	81019-XMTR. FREQ. & DEVIATION	1:40				■													
	81006-THRUST BULKHEAD STRAINS	4:33					■												
	81005-VEHICLE BASE PRESSURE	6:19						■											
	81016-VEHICLE BODY PRESSURE	:42							■										
	81014-XMTR. & AMPLIFIER (TM)	1:45							■										
	81015-FIN ACCELEROMETERS	:41							■										
	81017-VOLTAGE MEASUREMENTS	2:38							■										
	81007-TEMPERATURE	5:40								■									
	81008-ALGOL CHAMBER PRESSURE	:30								■									
	83204-COMMAND DESTRUCT (LESS GFP)	:54								■									
	86204-IGN. SYST. RESIST. MEAS.	:36				■													
	81020-RF LINK	1:35								■									
	85106-TIE-DOWN CABLE CHECK	1:00									■								
OCI	86702-VEHICLE ALIGNMENT	4:30									■						■		
TPS	86 -EMERG. DC PWR. SUPPLY CHECK	:45						■											
TPS	87 -COMMUTATOR DECOM CHECK	:25							■										
OCI	81004-BODY ACCELERATION	6:19										■							
	81024-AUX CALIBRATE BOX	:17										■							
	81023-PAYLOAD SUBCARRIER OSCILLATORS	1:22										■							
	81025-PAYLOAD RF XMISSION, PWR & DEV.	2:26										■							
	81028-PAYLOAD RF LINK	:28										■							
	81026-PAYLOAD INTERNAL BODY PRESS.	3:34											■						
	81027-PAYLOAD BODY ACCELERATION	1:05											■						
	81002-INSTRUMENTATION SYSTEM	11:30											■						
	83301-RADAR BEACON	:30											■						
	83201-COMMAND DESTRUCT SUBSYSTEM	:41												■					
	83205-DESTRUCT LANYARD PULL TEST	1:00								■									
	86004-INTEGRATED VEHICLE	4:49												■					
	83203-PRIMACORD INSTALLATION	3:00												■					
	------ -FINAL COUNTDOWN	6:10																	■

Figure 14-1. Little Joe II Operations at WSMR

(3) Nozzle Assemblies:

Pos'n	P/N	S/N
1	E2982-01	5009
2	E2982-01	5008
3	E2982-01	5012
4	E2982-01	5005
5	E2982-01	5016
6	E2982-01	5020

c. Pressure Transducers, Amplifiers:

Set No.	Location	Xducer P/N	Xducer S/N	Ampl. P/N	Ampl. S/N	Location
1	TMT-23	PA-130-TC-50-350	13923	EM2000A-3	8480	TAR-13
2	TMT-24	PA-130-TC-50-350	13924	EM2000A-3	8440	TAR-13
3	TMT-21	PA-208-TC-50-350	25974	EM2000A-3	8445	TAR-12
5	TMT-22	PA-911-TC-50-350	24024	EM2000A-3	8446	TAR-12

d. Module and Launch Escape Tower, Accelerometers:

Location	P/N	S/N
TA-7	90-02600-007	8597F
TA-8	90-02600-007	8599F
TA-9	90-02600-005	8187F
TA-10	90-02600-005	8689F

e. Fin, Accelerometers and Amplifiers:

Fin No.	Location	Accel. P/N	Accel. S/N	Ampl. P/N	Ampl. S/N	Location
1	TA-1	90-2600-004	FB-70	90-14900-001	FA-06	TAR-1
1	TA-2	90-2600-004	FC-23	90-14900-001	FA-07	TAR-2
3	TA-1	90-2600-004	FB-68	90-14900-001	FA-05	TAR-3
3	TA-2	90-2600-004	FB-67	90-14900-001	FA-04	TAR-4

f. Payload, Accelerometers and Amplifiers:

Set No.	Location	Accel. P/N	Accel. S/N	Ampl. P/N	Ampl. S/N	Location
1	TA-14	A69TC20-350	6248	EM2000-D1	11395	TAR-11
2	TA-12	A69TC20-350	6246	EM2000-D1	11397	TAR-11
3	TA-13	A69TC20-350	6249	EM2000-D1	11396	TAR-14
4	TA-15	A69TC20-350	6252	EM2000-D1	11398	TAR-14

g. TM-A, Transmitter, Oscillators and Wide Band Amplifier:

(1) Transmitter Package — P/N 99-04806-002, S/N 1337.

(2) Subcarrier Oscillators:

P/N	S/N	Center Freq.
96-47701-001	22630	2.3
96-47701-002	23041	3.0
96-47701-003	23349	3.9
96-47701-004	22928	5.4
96-47701-005	22716	7.35
96-47701-006	23120	10.5
96-47701-007	23409	14.5
96-47701-008	21552	22.0
96-47701-009	21889	30.0
96-47701-010	23075	40.0
96-47701-011	22057	70.0

(3) Wide Band Amplifier — P/N 90-15003-003, S/N 23130.

(4) DC/DC Converters:

Location	P/N	S/N
TUR-2	92-66801-001	0002
TUR-1	92-66801-001	005

(5) RF Amplifier:

Location	P/N	S/N
TAR-9	90-15751-001	401

h. TM-B, Transmitter, Oscillators and Wide Band Amplifier:

(1) Transmitter Package — P/N 99-04806-003, S/N 1352.

(2) Subcarrier Oscillators:

P/N	S/N	Center Freq.
96-47701-002	23153	3.0
96-47701-003	22812	3.9
96-47701-004	22810	5.4
96-47701-006	23001	10.5
96-47701-007	23354	14.5
96-47701-008	21833	22.0
96-47701-011	02067	70.0

(3) Wide Band Amplifier — P/N 90-15003-003, S/N 22923.

(4) DC/DC Converters:

P/N	S/N
99-66801-001	0004
99-66801-001	0003

(5) RF Amplifier:

Location	P/N	S/N
TAR-10	90-15751-001	406

i. TM-C, Transmitter, Oscillators and Wide Band Amplifier:

(1) Transmitter Package — P/N 99-04807-001, S/N 001.

(2) Subcarrier Oscillators:

P/N	S/N	Center Freq.
96-47702-009	283869	5.4
96-47702-001	314621	7.35
96-47702-002	345591	10.5
96-47702-003	314637	14.5
96-47702-004	335428	22.0
96-47702-005	345633	30.0
96-47702-006	2x4574	40.0
96-47702-007	345671	52.5
96-47702-008	314671	70.0

(3) Wide Band Amplifier — P/N 90-15003-004, S/N 2x439.

j. TM-A, B and C Antennas:

Antenna Location	P/N	S/N	Frequency
TE-1	90-17411-001	19	229.9
TE-2	90-17411-001	17	229.9
TE-3	90-17411-001	18	229.9
TE-4	90-17411-002	35	237.8
TE-5	90-17411-002	14	237.8
TE-6	90-17411-002	13	237.8
TE-8	90-17411-003	395	-UHF
TE-9	90-17411-003	16052	-UHF

k. Body and Base Pressure Transducers:

Location	P/N	S/N
TMT-1	90-00502-003	64684W
TMT-2	90-00502-003	64697W
TMT-3	90-00302-003	64695W
TMT-4	90-00502-003	64689W
TMT-5	90-00502-003	64687W
TMT-6	90-00502-003	64688W
TMT-7	90-00502-003	64690W
TMT-8	90-00502-003	64699W
TMT-9	90-00502-003	64698W
TMT-10	90-00502-003	64685W
TMT-11	90-00502-003	64694W
TMT-12	90-00502-003	64686W
TMT-13	90-00502-003	64692W
TMT-14	99-00502-004	1401

l. Temperature System — P/N 90-15204-001, S/N 1.

m. Commutator — P/N 340-23-5, S/N 009.

n. Switch Assembly — P/N 98-64007-012.

o. Five-Point Calibrator Assembly — P/N 12-10017.

p. Strain Gage Amplifier:

P/N	S/N
90-15075-002	38
90-15075-002	39
90-15075-002	41
90-15075-002	40

q. Astronetics, DC/DC Converter — P/N 12-011007, S/N 4.

r. Vehicle Aft Body and Forebody Accelerometers:

Location	P/N	Model No.	S/N
TA-3	90-02600-005	4310	8185F
TA-4	90-02600-005	4310	8183F
TA-5	90-02600-005	4310	8690F
TA-6	90-02600-005	4310	8691F
TA-11	90-02600-006	4310	8603F

s. Command Destruct Receivers — U-RE1 and U-RE2.

t. Command Destruct Batteries — U-BT1 and U-BT2.

u. Radar Beacon Transponder — AN/APN-65, S/N 69.

v. Radar Beacon Battery — Y-BT1, HR-10.

w. Instrumentation Battery (Vehicle) — Eagle Picher, MAP-4094-3.

x. Instrumentation Battery (Payload) — Yardney, YAEL-34.

14.5 WEIGHT AND BALANCE SUMMARY

Total weight of the Little Joe II QTV (including payload) at ignition was 57,165 pounds; at burnout, 36,564 pounds. Table 14-1 shows the distribution of mass properties.

Table 14-1. Distribution of Mass Properties

Item	Weight(Lb.)	CG in Inches X	Y	Z	Moment of Inertia About CG, Slug Ft.^{2} x 10^{-3} I_x	I_y	I_z
Forebody	2,002	96.0	0.0	0.8			
Aft Body	4,041	321.1	-0.2	-0.5			
Fins (4)	1,554	345.4	-0.2	-0.1			
Electrical	153	173.5	5.1	37.4			
Measurement and Destruct	367	92.5	-17.5	-10.2			
Recruit, Algol Installation Provision	460	346.0	0.0	0.0			
Unaccountable Weight	20	261.7	-0.8	-0.1			
Launch Vehicle, Less Motors	8,597	261.9	-0.79	0.16			
Algol ID Model II Case	3,130	249.5	0.0	0.0			
Algol Propellant	18,996	187.2	0.0	0.0			
Recruit TE-29IIA (6)	613	311.6	0.0	0.0			
Recruit Propellant (6)	1,605	299.1	0.0	0.0			
Launch Vehicle with Motors	32,941	220.4	-0.21	0.04	12.8	83.9	83.9
Launch Escape System	6,612	-438.4	0.03	-0.05	0.3	10.0	10.0
Dummy C/M with Adapter	17,612	-133.4	0.34	0.00	17.0	31.6	31.6
Launch Vehicle with Payload - Liftoff	57,165	35.2	-0.01	0.02	30.1	797	797
Algol Propellant	-18,996	187.2	0.0	0.0			
Recruit Propellant (6)	- 1,605	299.1	0.0	0.0			
Launch Vehicle with Payload - Burnout	36,564	-55.4	-0.02	0.03	28.8	582	582

14.6 SUMMARY OF PRE-LAUNCH DIFFICULTIES

Table 14-2. Major Difficulties Experienced From 17 July to 28 August

System	Date	IR/DR TPS-NO.	P/N and/or S/N	Difficulty	Remedial Action
Pyros	8-7-63	IR 12814 IR 12910	PV-16-224-9	Recruit motor igniter adapter damaged upon installation.	Replaced S/N 9 with S/N 15.
Pyros	7-23-63	DR-14	367904-19A	Algol motor assembly, S/N 806665 was received from Aero-Jet with temperature record in excess of 100° F, for the period of 2:00PM 6-17-63 to 12:45AM 6-18-63.	Motor reconditioned at 70° F — two hours for every one hour the motor was exposed to the higher temperature.
Pyros	7-26-63	DR-22 IR 12929	X1-10F	Internal resistance of igniter failed to meet the minimum allowable difference of ±0.03 ohm. Measured difference was ±0.06 ohm.	Replaced unit with new stock.
Pyros	8-24-63	DR-87 IR CO9685	X1-10F S/N 2	Internal resistance of igniter failed to meet the minimum allowable of 0.94 ± 0.03 ohm. Measured resistance was 0.88 ohm.	Replaced unit with new stock.
Pyros	8-24-63	DR-85	X1-10F S/N 255	Internal resistance of igniter failed to meet the minimum allowable of 1.06 ± 0.03 ohm. Measured resistance was 1.02 ohm.	Replaced unit with new stock.

System	Date	IR/DR TPS-NO.	P/N and/or S/N	Difficulty	Remedial Action
Pyros	8-7-63	DR-13	MS-20002C5	MS washers, as installed per dwg. 12-23001, were too large in OD., interferring with installation of can adapter into the recruit motors.	Replaced MS washers with 12-23001-19A; outer dia. of 0.510 in.
Pyros	8-21-63	DR-61	12-23001	Recruit motor installation bolts were bottoming out before tightening.	Bolts removed and replaced after addition of 12-23001-21 washer, and retorqued.
Instr.	8-9-63	DR-15	12-011007	The electrical DC to DC converter output voltage too low at 28.137 volts DC; specification callout 28 ± 0.1 VDC.	Replaced unit S/N 1 with new stock S/N 4.
Instr.	8-15-63	DR-23	12-011007	DC to DC converter cannon plug of the improper type, P/N 3102A145-75, installed as required 3102A145-7W.	Installed Convair 92-40334-037 plug and 12-60200-9059 harness per ECN Chg. BV, dwg. 12-60200.
Instr.	8-16-63	DR-41 IR CO9676	90-15075-002	The Microdot amplifier installed at position TAR-7 would not meet specification.	Removed S/N 42 and installed S/N 40.
Instr.	8-23-63	DR-80	PA911TC50-350	Payload internal body pressure amplifier and transducer installed at TMT-22; would not meet specification.	Removed amplifier S/N 8442 and transducer S/N 24025 and installed amplifier S/N 8446 and transducer 24024.
Instr.	8-18-63	DR-52	90-17411-002	Antenna S/N 15 would not meet radiation specification.	Removed Antenna S/N 15 and installed S/N 35.

System	Date	IR/DR TPS-NO.	P/N and/or S/N	Difficulty	Remedial Action
Instr.	8-26-63	DR-55	TCP-1	Fin No. 3 accelerometer lower body cable (between TCP-7 and and TCP-1) had high resistance of 270K.	Removed TCP-1 cable connector and replaced with new stock.
Instr.	8-15-63	DR-32 IR CO9674	96-47701-011	Subcarrier oscillator in TM-A unable to hold required specification.	Removed oscillator S/N 23366 and installed S/N 22057.
Mech.	8-26-63	TPS-135	98-62805-022	Launcher vehicle support arm unlock light indication would not function.	Faulty pressure switch, replaced S/N 006 with S/N 007.
Mech.	8-20-63	DR-59	12-70001	During assembly of abort tower to command module, the MS20006-26 bolts were found to be too tight.	Escape tower and module bolt attach holes reamed to 0.375 in. diameter.
Mech.	8-20-63	---	B17-320049	During checkout operations, the fibre glass bulkhead at Vehicle Station 0 "oil-canned" downwards over a maximum area of 2 x 4 ft.	Bulkhead returned to its original position. No detrimental effect was noted due to the buckling. (See Section 14, paragraph 14.6.1, for detailed outline of the problem.)

14.6.1 SUMMARY OF SHOCK WAVE BARRIER BULKHEAD PROBLEM — During the vehicle prelaunch checkout operations, the fibreglass shock wave barrier bulkhead at Vehicle Station 0 "oil-canned" downward over a maximum area of 2 x 4 ft. Hand pressure to the underside of the buckled area would restore it to the original configuration; however, the bulkhead would resume the oil-canned condition periodically and at random times during the checkout process.

Deformation of the barrier bulkhead was attributed, initially, to personnel working in the payload area and occasionally supporting their weight on the domed side of this member. Continued buckling was due to the combination of personnel in this area and periodic surging or unstable operation of the booster section air conditioning unit, which created pressure surges across the barrier bulkhead. This domed shaped barrier bulkhead was supplied by North American Aviation Company, and was designed to contain pressure buildup in the booster section (lower side of the barrier) to 15 psi (22.5 psi ultimate) and for payload (top side of barrier) pressure of 1.75 psi. Prelaunch inspection of the bulkhead structure indicated that the oil-canning had not caused stress or fatigue lines in the polyester impregnated glass cloth material; therefore, the member was considered acceptable for flight.

14.6.1.1 Recommendation — For future operations where this type of shock wave barrier is required, it is suggested that adequate work platforms be provided so that personnel required to enter the payload area will not impose their weight on the bulkhead, and also that the bulkhead be clearly marked as a "no step" area. In addition, it is suggested that the ducting to the air conditioning unit be stiffened to prevent duct collapse and subsequent surging of this unit.

14.7 LAUNCH VEHICLE CONFIGURATION — NASA ACCEPTANCE

a. No deviations were made from contractual requirements for this vehicle.

b. No factory shortages existed, and all tasks were accomplished.

c. No interim or substitute equipment was installed on this vehicle.

14.8 COUNTDOWN SUMMARY

The Little Joe II Launch Vehicle was scheduled for a 6-hour, 10-minute countdown. The dry run for the countdown indicated that an additional hour would be required to complete the telemetry checkout. To avoid holding all stations on standby during this period, the telemetry checkout was started one hour early to permit concurrent completion with other scheduled tasks.

The countdown began at 0150 hours MST, on 28 August 1963. All tasks were accomplished as planned with only minor deviations in schedule. No holds were required. Launch occurred on schedule at 0900 hours MST.

14.8.1 COUNTDOWN TIME AND EVENTS — The Little Joe II QTV launch on 28 August 1963 was conducted as follows: (See Reference 12 for detail countdown.)

MST	Actual Countdown Time	Scheduled Countdown Time	Event
0150	-7H 10M		Countdown starts (telemetry only).
0150	-7H 10M		Ground power system checkout starts.
0155	-7H 05M		Ground power system checkout complete.
0155	-7H 05M		Telemetry checkout starts.
0245	-6H 15M		General countdown starts.
0245	-6H 15M		All stations report "on station", and precount requirements complete.
0250	-6H 10M	-6H 05M	Ignition relay checkout starts.
0255	-6H 05M	-6H 05M	Radar beacon tests start.
0255	-6H 05M		Forecast Algol grain temperatures "GO."
0311	-5H 49M	-5H 50M	Radar beacon tests complete.
0319	-5H 41M	-5H 05M	Ignition relay checkout complete.
0338	-5H 22M	-5H 15M	Telemetry checkout complete.

MST	Actual Countdown Time	Scheduled Countdown Time	Event
0340	-5H 20M	-5H 05M	Lift-off signal checkout starts.
0345	-5H 15M	-5H 00M	Lift-off signal checkout complete.
0347	-5H 13M	-5H 00M	Algol squib firing circuit checkout starts.
0347	-5H 13M	-5H 00M	Air conditioning equipment removal starts.
0359	-5H 01M		Algol squib firing circuit checkout complete.
0425	-4H 35M	-4H 15M	Command destruct systems tests start.
0405	-4H 55M	-4H 30M	Air Conditioning equipment removal complete.
0440	-4H 20M		Command destruct systems tests complete.
0440	-4H 20M		All stations maintaining RF silence.
0440	-4H 20M		Algol squib installation and connection starts.
0450	-4H 10M	-4H 15M	Algol squib installation and connection complete.
0450	-4H 10M		Meteorology reports weather conditions are "GO."
0450	-4H 10M		Final arming of command destruct systems starts.
0540	-3H 20M		Final arming of command destruct systems complete.
0545	-3H 15M	-3H 35M	Radar interrogation checks start.
0557	-3H 03M	-3H 30M	Radar interrogation checks complete.
0557	-3H 03M	-3H 00M	Fly-over checkout for target acquisition starts.
0557	-3H 03M	-3H 35M	Service tower withdrawal operations start.
0557	-3H 03M	-3H 35M	Launcher preparation for movement starts.
0606	-2H 54M	-2H 15M	Fly-over completed.
0615	-2H 45M	-3H 15M	Launcher preparation for movement complete.
0620	-2H 40M	-3H 15M	Service tower clear of launcher.

MST	Actual Countdown Time	Scheduled Countdown Time	Event
0620	-2H 40M	-3H 15M	Launcher pointing starts.
0627	-2H 33M	-2H 35M	Launcher pointing complete.
0627	-2H 33M		Launcher support arm check.
0627	-2H 33M	-2H 35M	Forecast of launch-time pneumatic pressures.
0630	-2H 30M	-2H 30M	Recruit igniter firing circuit checkout starts.
0655	-2H 05M		Recruit igniter firing circuit checkout complete.
0655	-2H 05M		All stations maintaining RF silence.
0655	-2H 05M		Recruit igniter installation and connection starts.
0714	-1H 46M	-1H 30M	Recruit igniter installation and connection complete.
0730	-1H 30M	-1H 30M	Final firing circuit validation checks start.
0753	-1H 07M		Service tower withdrawal complete.
0800	-1H 00M		Final firing circuit validation checks complete.
0813	-47M		Final arming of ignition circuits starts.
0814	-46M	-45M	Final arming of ignition circuits complete.
0814	-46M	-35M	All personnel retire to firing stations.
0820	-40M		Inspection reports all inspections are "GO."
0830	-30M	-30M	Telemetry transmission starts.
0845	-15M	-15M	Final launcher pointing starts.
0847	-13M		Final launcher pointing complete.
0847	-13M		Recovery team deployment confirmed.
0852	-08M	-08M	Support arms unlocked.
0853	-07M	-07M	Destruct transmitters and receivers "ON."

MST	Actual Countdown Time	Scheduled Countdown Time	Event
0855	-05M	-05M	Switch to internal power.
0857	-03M	-04M	Telemetry calibration.
0858	-02M	-02M	Console ready-for-launch check.
0859	-01M	-01M	All stations report status "GO."
0859:30	-30S	-30S	Ignition key on firing line ready.
0859:45	-15S	-15S	Timer start.
0900	00S	00S	Timer "ZERO."
*			Zero time of missile lift 0900 hours, 02.348S MST.
0900:32.5	+32.5S	+32.5S	Destruct signal transmitted.
0901:41	+01M 41S		Impact.

15 ANALYSIS OF ALGOL MOTOR THRUST TERMINATION SYSTEM FAILURE

15.1 POSSIBLE CAUSES OF SYSTEM FAILURE

Investigation of the failure of the Algol motor thrust termination system was centered around the following possible causes.

a. The destruct signal was not transmitted from the destruct receiver to the destruct block.

b. The destruct lanyard failed to arm the destruct block.

c. The primacord or shaped charge failed to propagate the shock wave.

15.1.1 DESTRUCT SIGNAL TRANSMITTAL — Two relays in each destruct system (receiver to destruct block circuit) were monitored by telemetry and records indicate signals were transmitted and received. Records indicate a change in these relay positions, for approximately 13 milliseconds, which occurred at 32.4 seconds after lift-off. This was within 0.1 second of the planned destruct signal time (Figure 15-1). These relays should have stayed in the "DESTRUCT" position (vs. the "OFF" position) as long as a destruct signal was being received (Figure 15-2). However, after 13 milliseconds had elapsed from the off to the destruct position, the relays again indicated the off position. The instrumentation system which monitored this relay terminal was wired to indicate 5 volts in the off position, and zero volts in the destruct position.

Ground monitored signals (Figure 15-3) show that a destruct tone was sent to the vehicle approximately 32.35 seconds after lift-off, and was continuous throughout the rest of the flight. It is a reasonable assumption that receipt of

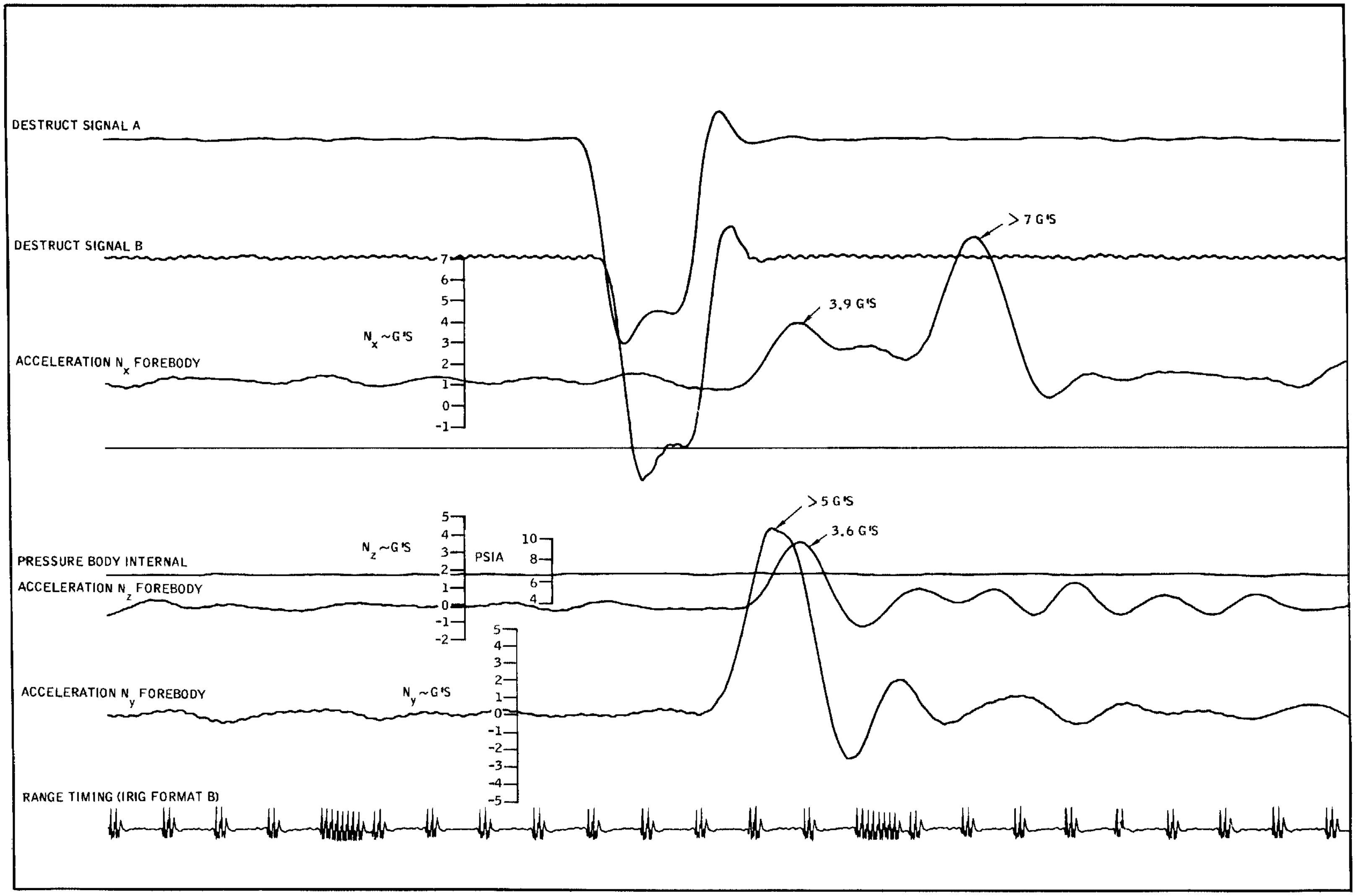
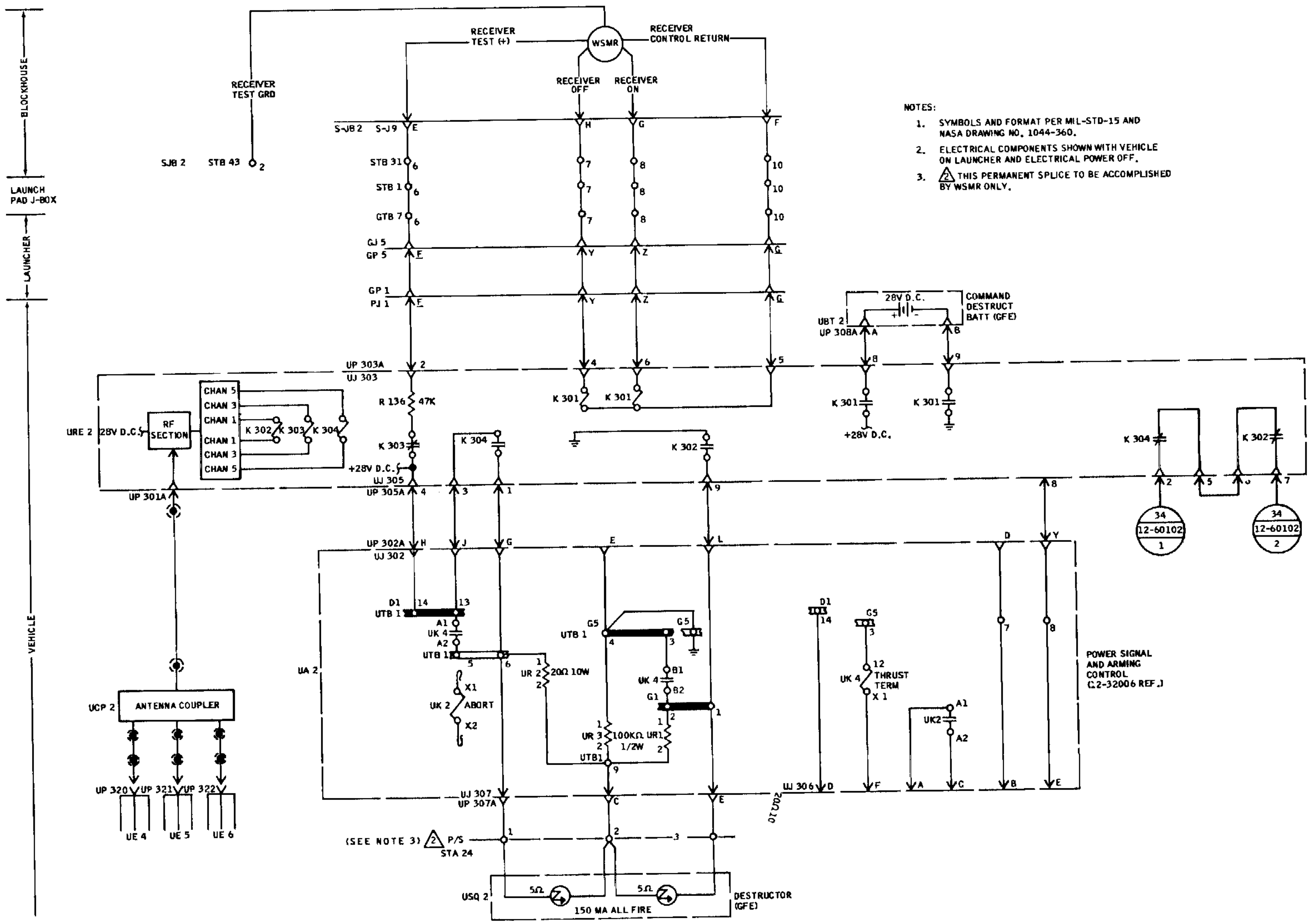


Figure 15-1. Station 39.75 Environmental Instruments at Time of Destruct Signal



NOTES:

1. SYMBOLS AND FORMAT PER MIL-STD-15 AND NASA DRAWING NO. 1044-360.
2. ELECTRICAL COMPONENTS SHOWN WITH VEHICLE ON LAUNCHER AND ELECTRICAL POWER OFF.
3. △2 THIS PERMANENT SPLICE TO BE ACCOMPLISHED BY WSMR ONLY.

Figure 15-2. Diagram of the Command Destruct System Wiring

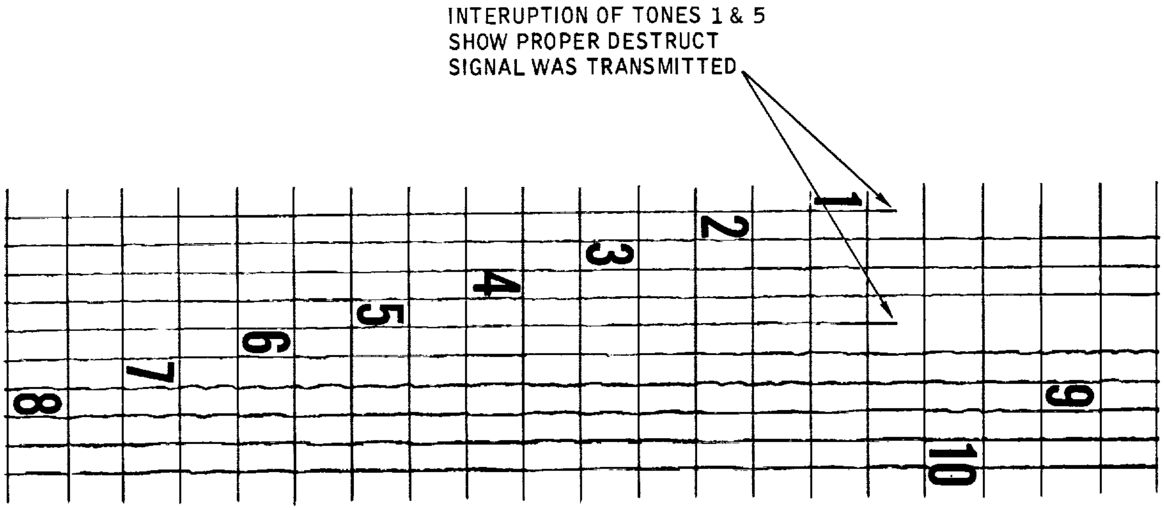


Figure 15-3. Ground Record of Destruct System Transmission

the destruct signal in the vehicle was broken because of fragments from the destructor blocks cutting the destruct signal wiring and/or other destruct components, which are in close proximity to each other (Figure 15-4). The most logical areas of damage would be to the destruct battery or destruct receiver. Either condition would allow the relay T/M signal to again indicate the off position after the blocks had fired.

Records indicate that at least one destruct block fired normally, since the three upper body accelerometers showed the following movements (after change in the relay position):

Function	Start of Acceleration
N_x	8.3 Milliseconds
N_y	2 Milliseconds
N_z	8.3 Milliseconds

Note: The start of acceleration was measured from the indicated change in destruct relay positions.

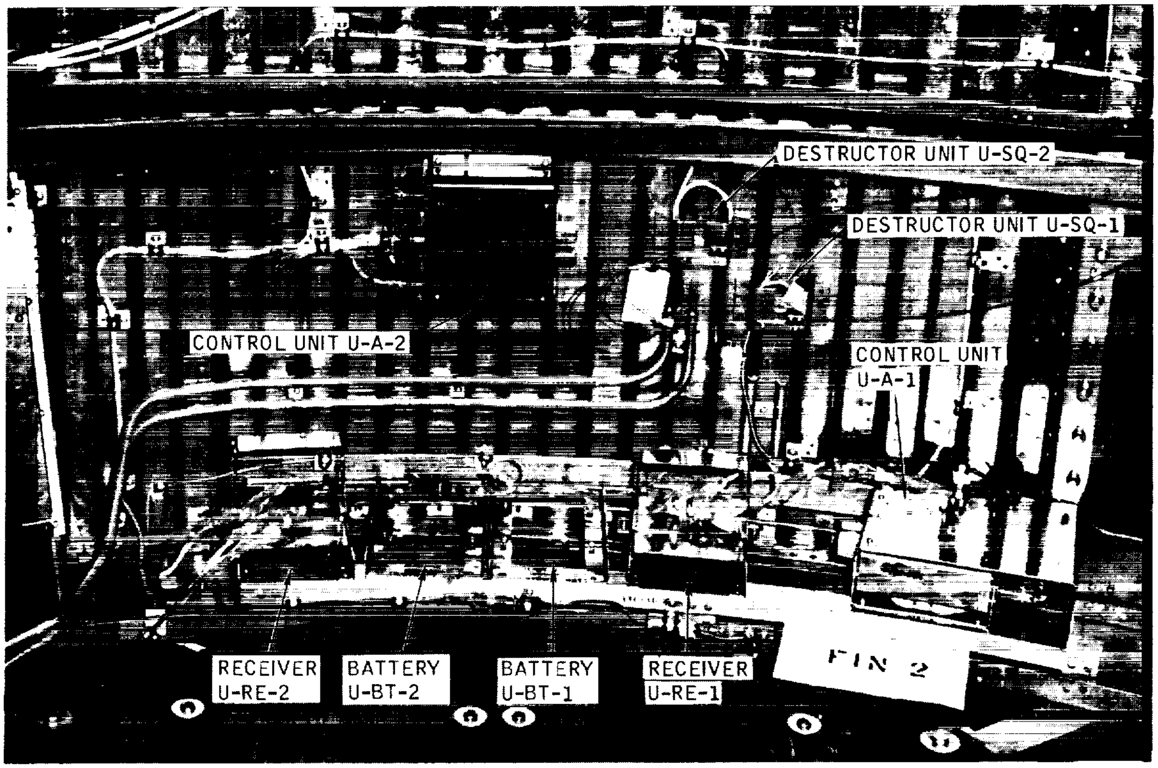


Figure 15-4. Interior of Little Joe II Showing Dual Command Destruct Installation

Figure 15-5. Lanyard Attachment to Launcher

Figure 15-6. Tips of Lanyard After Launch

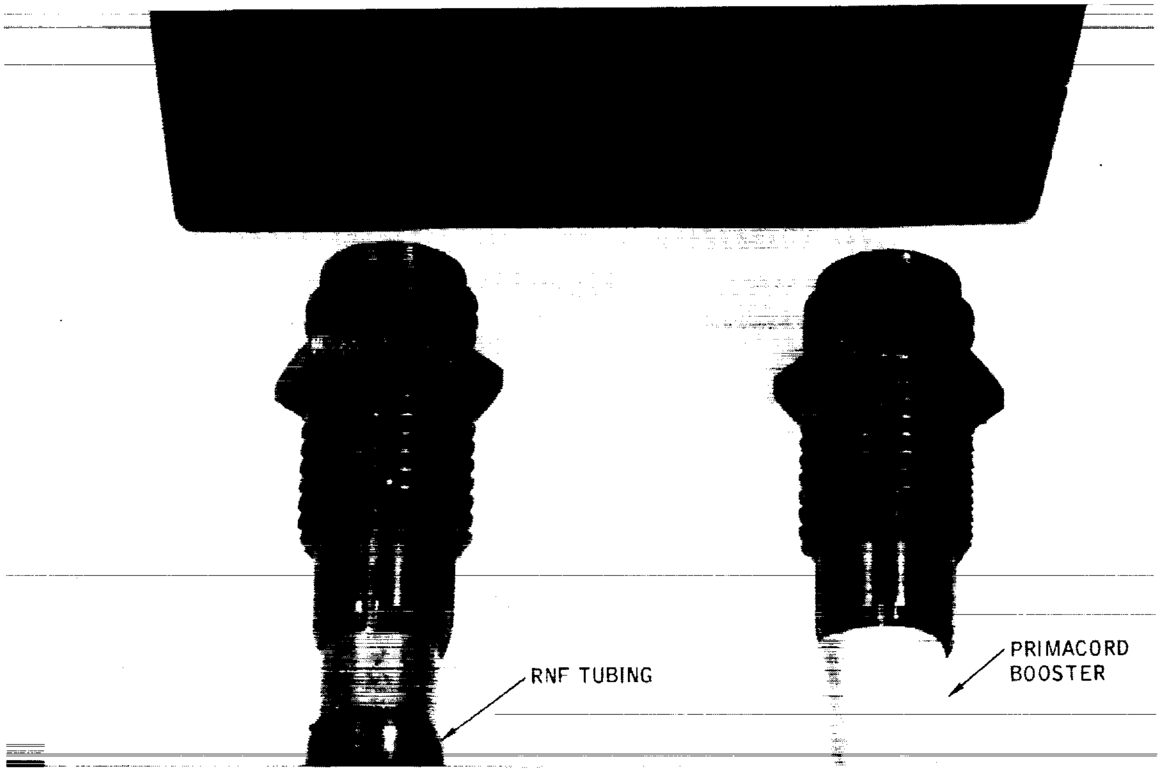


Figure 15-7. Destruct Block Collets

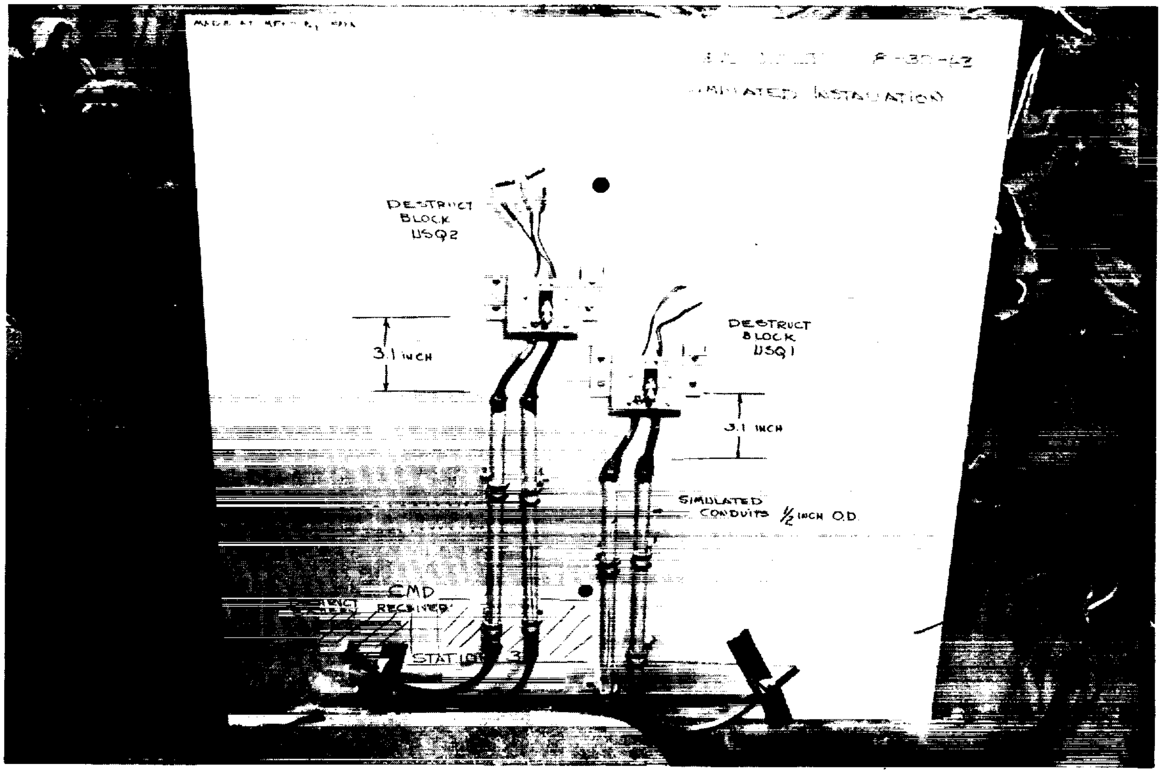


Figure 15-8. Post Flight Test No. 1 Setup

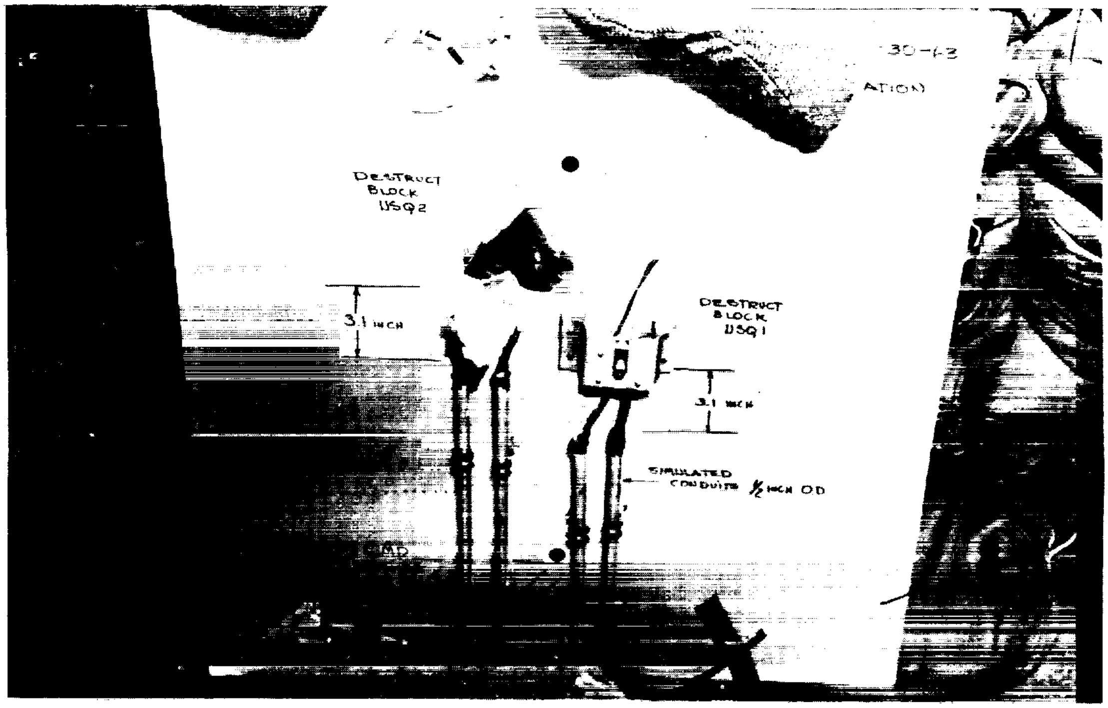


Figure 15-9. Post Flight Test No. 1 Results

Figure 15-10. Comparison of Flight and Post Flight Test No. 1 Fragments

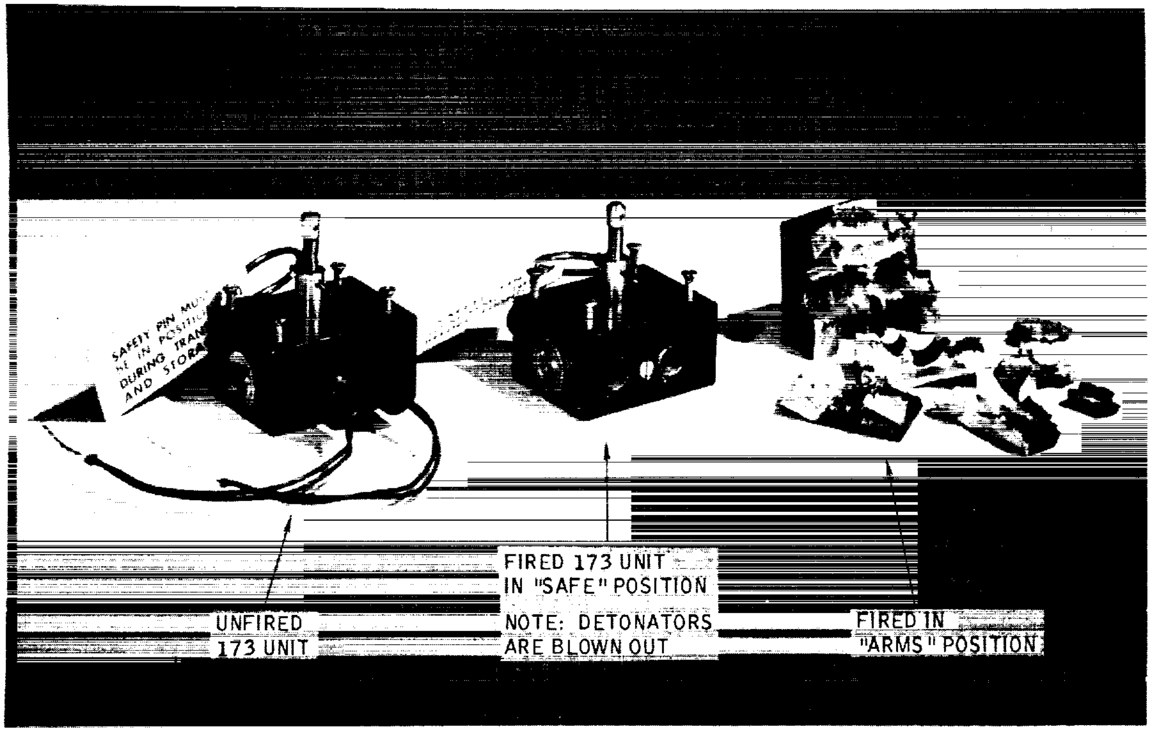


Figure 15-11. Destruct Block "Unfired", Fired in "Safe" Position, and Fired in "Arm" Position

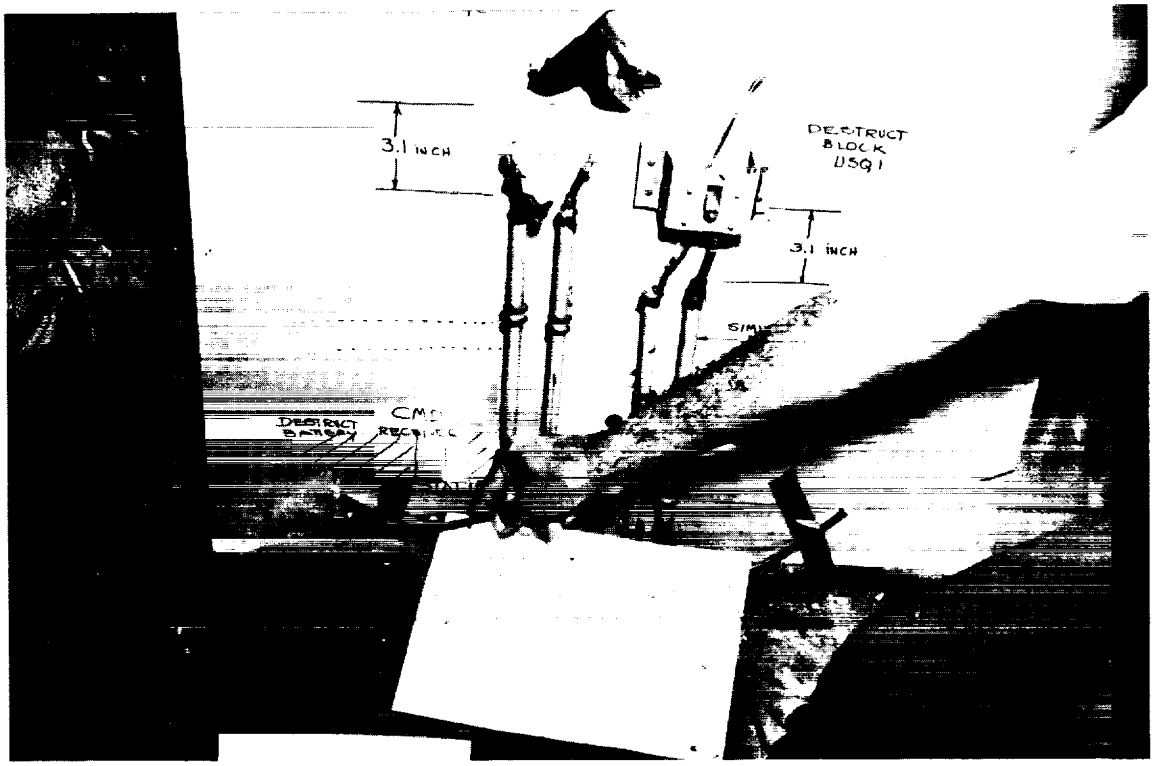


Figure 15-12. Fragments From Post Flight Test No. 1

The traces for both destruct relay signals and the three accelerometers were clean, without cross talk, dropout or spurious noise. At no other point in the flight do these traces show the same characteristics as at the point 32.4 seconds after lift-off.

15.1.2 DESTRUCT LANYARD ARMING OF DESTRUCT BLOCK — The destruct lanyards are 0.032-in. piano wire, routed through wire-wound conduit (AREN control type) while in the vehicle. On the exterior of the vehicle, the wire is bare with the end secured to the launcher. The other end of the wire also leaves the conduit and protrudes through the destruct block arming pin. Movement of the vehicle pulls the wire from the destruct block.

Test lanyards had been pulled through the conduits seven times prior to launch. To preclude possible hardening of the lanyards from use, they were replaced with new units and pulled one time only prior to flight. These pull tests were accomplished by OCI 12-83205. Whipping of the lanyard was severe on all tests, although no physical damage to the wire was ever noted. Wire friction on withdrawal was less than one pound.

Post-flight inspection revealed that both lanyards were still attached to the launcher (Figure 15-5). Approximately 10 inches of wire was missing from one of the lanyards at the vehicle end. The break indicated that the missing piece was whipped off following extraction from the vehicle. This was evident from the type of break (Figure 15-6), which is typical of a kink or loop thrown in tool steel wire prior to breakage. A loop or kink could not have occurred within the conduit because of the close tolerance between the wire and its conduit.

15.1.3 PROPAGATION OF SHOCK WAVE BY PRIMACORD OR SHAPED CHARGE — Prior to the launch, a section of primacord was checked for proper insertion into the destructor block collets. It was found that the collets would require reaming with "D" size (0.246) drill, plus spreading the tangs of the collets to allow insertion of the primacord — complete with Thermofit heat covering (0.253) or with the heat covering stripped (0.245) (Figure 15-7).

Installation of the primacord into the vehicle was through aluminum tubing and clips. Routing required that the exterior of the primacord be coated with a light layer of silicon grease (Convair GRE-35 MIL-L-4343) prior to insertion into the tubes. The ends of the primacord containing the boosters were then butt faced with the shaped charge booster and the units tightened together. The other end of the primacord was pulled toward the destruct blocks and the excess left for final cutting to length after the destructor blocks were installed.

The actual primacord hook-up by MFSO/WSMR required cutting through both the Thermofit heat covering and the black plastic center cover. It was also necessary to bend the primacord in an "S" form to properly align the primacord for placement into the collets. This was caused by the end of the conduit being out of line with the collet, and the top of the conduit being within 3.1 inches from the bottom of the destruct block.

15.2 POST-FLIGHT TESTS

Two destructor block firing tests have been completed since the launch. Test No. 1 duplicated the installation of the primacord as installed on the flight article (Figure 15-8). This included stripping back the primacord protective layers, flexing the primacord in an "S" form as required for installation, and taping the primacord to prevent movement in the conduit.

Test No. 2 was identical to Test No. 1 except that the primacord was not flexed for insertion into the destruct block, although a section farther away from the destruct block was flexed several times. (Note: This section did not have the protective coverings removed in the flexed area.) Both tests used an aluminum sheet, brackets, conduit, etc., representing the routing, locations and distances of the components as installed in the Little Joe II launch vehicle. The mockup was placed in a sand-bagged bunker so that pieces could be collected after firing.

The primacord failed to explode in Test No. 1. The ends inserted into the destruct block were blown clear of the block and both showed heavy fraying of the inner lace for about 0.5 inch (Figure 15-9). One end of the destruct block recovered after this test was very similar to a piece recovered from the flight article (Figure 15-10). Both of these pieces are nearly identical to the large piece that is shown in the right-hand corner of Figure 15-11 (photo provided by destruct block manufacturer). It is evident that all three pieces are from destruct blocks fired in the armed position. This is also proof that the flight article had the lanyard pulled; otherwise, the piece recovered from the wreckage would have been intact or would have looked like the destruct block in the middle of the photo (Figure 15-11), which was fired in the "SAFE" position. Many fragments from this test, as well as Test No. 2, were recovered in the vicinity of the destruct receiver and destruct battery (Figure 15-12). Sufficient velocity was developed to tear through the aluminum backup plate and rip several sandbags.

Test No. 2 resulted in the complete destruction of the primacord, including the portion which had been deliberately flexed. The destruct block broke up into smaller pieces on this test, apparently the result of the impetus added by the primacord explosion.

15.3 CONCLUSIONS

a. A destruct command was received by both receivers.

b. The firing signal passed from at least one receiver to destruct block, as shown by the heavy accelerations occurring at 32.4 seconds after lift-off.

c. The firing signal from the receivers was interrupted after the initial activation,as shown by the telemetry instrumented relays going back to the off position. Probable cause of failure was the damage to the destruct batteries, or damage to the destruct receivers from destruct block fragments.

d. Lanyard removal was normal.

e. Failure to destruct was caused by the need to flex the primacord and to strip back the protective covering prior to insertion into the destruct blocks. This allowed the RDX grains to separate, which precluded propagation of the shock wave. Contributing to this condition was the short distance between the top of the conduit and the bottom of the destruct block, which required flexing of the primacord to allow entry into the destruct block collets.

15.4 RECOMMENDATIONS

Convair is now investigating this problem to determine if the present command destruct system should be modified or a complete redesign should be accomplished. A recommendation will be submitted when the conclusions of this investigation are finalized.

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1. Requirements for Work and Resources (RFWAR), White Sands Missile Range, New Mexico; RFWAR No. 378R3, Little Joe II Revision No. 3, 14 June 1963.

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4. T-12-17 Base Heating — Little Joe II Mission "F", E. Ogden.

5. Narrative End Items Report, GD/C-63-153, Volumes 4, 5, 6.

6. Launch Vehicle Familiarization, GD/C-63-003.

7. Airframe Maintenance and Repair, GD/C-63-010C.

8. Command Destruct System, GD/C-63-011C.

9. Electrical System, GD/C-63-012C.

10. Measurement System, GD/C-63-013C.

11. Propulsion System, GD/C-63-014C.

12. Operations Manual, GD/C-63-072B.