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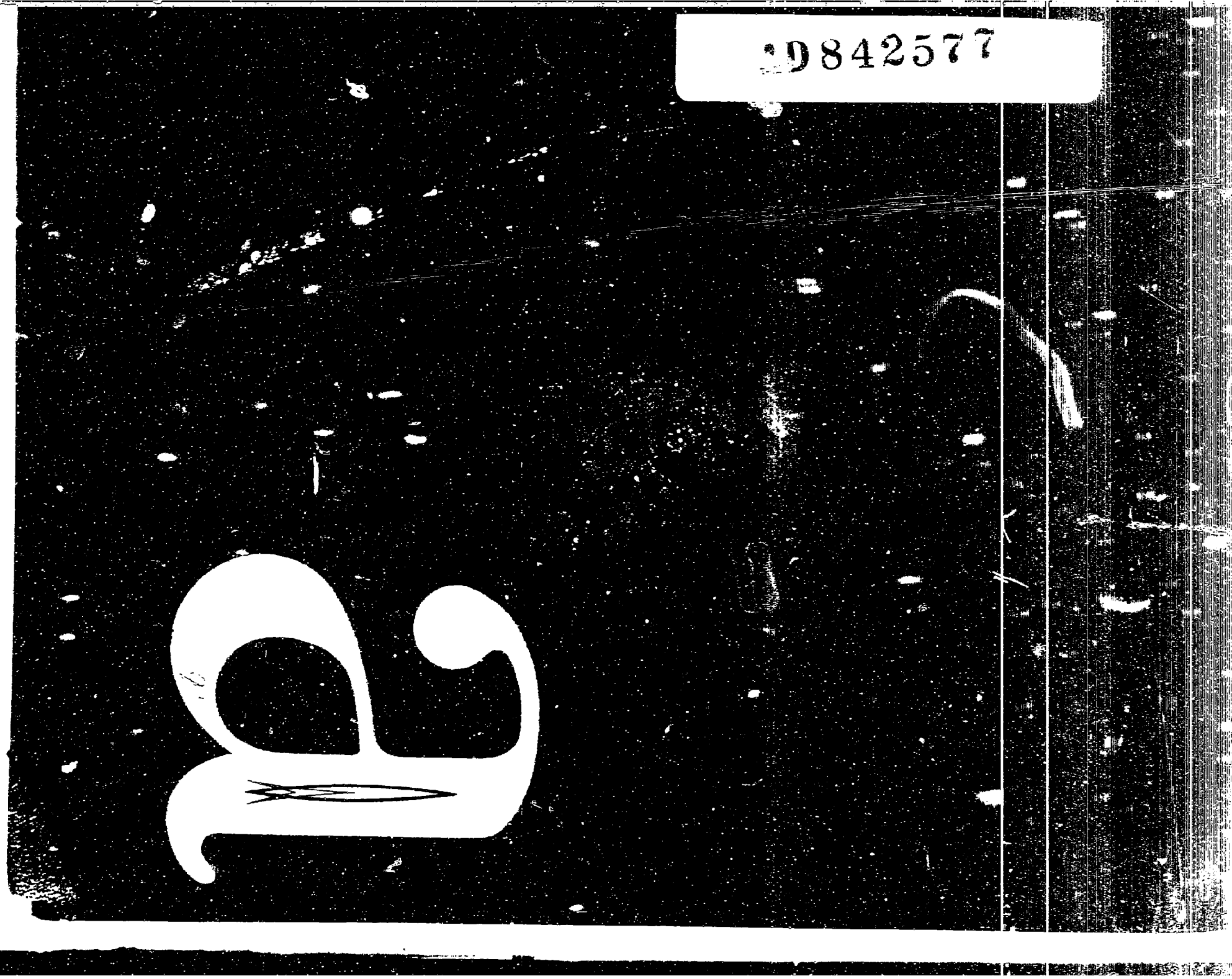

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Test Report AA 60-0118
31 October 1960

WS 107A-1 FLIGHT TEST WORKING GROUP

FLIGHT TEST REPORT

ATLAS MISSILE 71D

12 OCTOBER 1960

Log No. T-15010 Copy No. 64

AMR RANGE TEST NUMBER 1502

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SECRET

FOREWORD

This report has been prepared to present preliminary information relative to the flight of Atlas Missile No. 71D. The information presented is based on visual observation and data evaluation to the extent permitted by time limitations. It should be considered as preliminary only and the final reports on this flight referenced for further information. The technical content has been prepared and jointly agreed upon by members of the WS 107A-1 Flight Test Working Group.

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SUMMARY

Atlas Missile 71D was successfully launched from Complex 11, at AMR, on 13 October 1960, at 0434 EST. Planned range was 4387 nautical miles with impact at the southwest edge of the Station 12 MILS net. The best estimates of impact place it approximately two nautical miles from the target. Recovery of the RVX-2A Re-entry Vehicle was accomplished as planned. This was the last of seven D-AIG series missiles to be tested at AMR and the fifth D-AIG missile to be flown with the inertial guidance system controlling the flight.

Irregularities were noted in the operation of the booster No. 1 and sustainer engines; however, they did not have any adverse affects on overall propulsion system performance.

The optical beacon activated properly at sustainer cutoff. The data indicate the trigger pulses were irregularly spaced for the duration of system operation; however, ballistic camera data revealed the presence of images spaced at relatively regular intervals.

Operation of all other systems was satisfactory.

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FLIGHT TEST OBJECTIVES

The primary purpose of this flight was to evaluate the performance of an Atlas Missile when the guidance and discrete commands are performed by the all inertial guidance (AIG) system operating closed loop. Another first order objective was to recover the re-entry vehicle and evaluate the heat shield performance. ~~These objectives were satisfied.~~ Detailed objectives are listed on the following pages along with comments relative to the degree of satisfaction of each.

FORM AT 840-8

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
1 - First Order					
2 - Second Order					
3 - Third Order					
Weapon System					
1. Evaluate the performance and accuracy of the ARMA Missile Guidance Set (MGS), including the computer, platform, control unit, analog and digital converters, and discrete and steering commands.	1	X			
2. Determine the performance of the ARMA GSE, including the Alignment-Countdown Set (A-CS) and associated equipment.	2	X			
3. Obtain data on MGS pre-flight and flight environment.	2	X			
4. Demonstrate MGS compatibility with all associated missile systems.	2	X			
5. Evaluate Flight Control System performance.	2	X			
6. Evaluate re-entry vehicle heat shield performance with emphasis on ablation materials and design.	1	X			
7. Determine re-entry vehicle pressure distribution, vehicle loadings and vehicle motions.	2	X			

Form A1990-8

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
8. Evaluate the missile system with regard to engine start and potential causes for combustion instability.	2	X			
9. Obtain data on missile systems and GSE systems to establish performance and repeatability.	2	X			
10. Obtain data on the residual thrust of the missile.	3	X			
11. Obtain data on engine compartment temperature environment.	2	X			
Non-Weapon Systems					
1. Obtain data on the special experiments carried in the re-entry vehicle.	3			X	Lost one radiation package. Data questionable on parts of two experiments.
2. Determine performance of the Strobe Optical Beacon.	2	X			
3. Obtain data on the performance of the Azusa Mark II System.	3	X			

FLIGHT TRAJECTORY

The flight of Missile 71D was planned for a range of 4384 nautical miles. This was the third D/AIG missile with impact planned for the missile impact location system (MILS) splash net area. The missile trajectory appeared to be very close to nominal.

A tabulation of miss distances is presented in the table below.

	Miss Distance	Confidence*
Splash	3.45 nm short 0.5 nm left	Major Axis 0.210 Minor Axis 0.062 at 11.8° Azimuth
Azusa	2.85 nm short 1.8 nm left	Major Axis 2.097 Minor Axis 0.345 at 123.76° Azimuth
Sofar IBM 709	1.55 nm short 1.25 nm left	Major Axis 0.077 Minor Axis 0.040 at 32.7° Azimuth
MOD III Guidance	0.6 nm short 1.10 nm left	Major Axis 0.16 Minor Axis 0.16 at 123° Azimuth

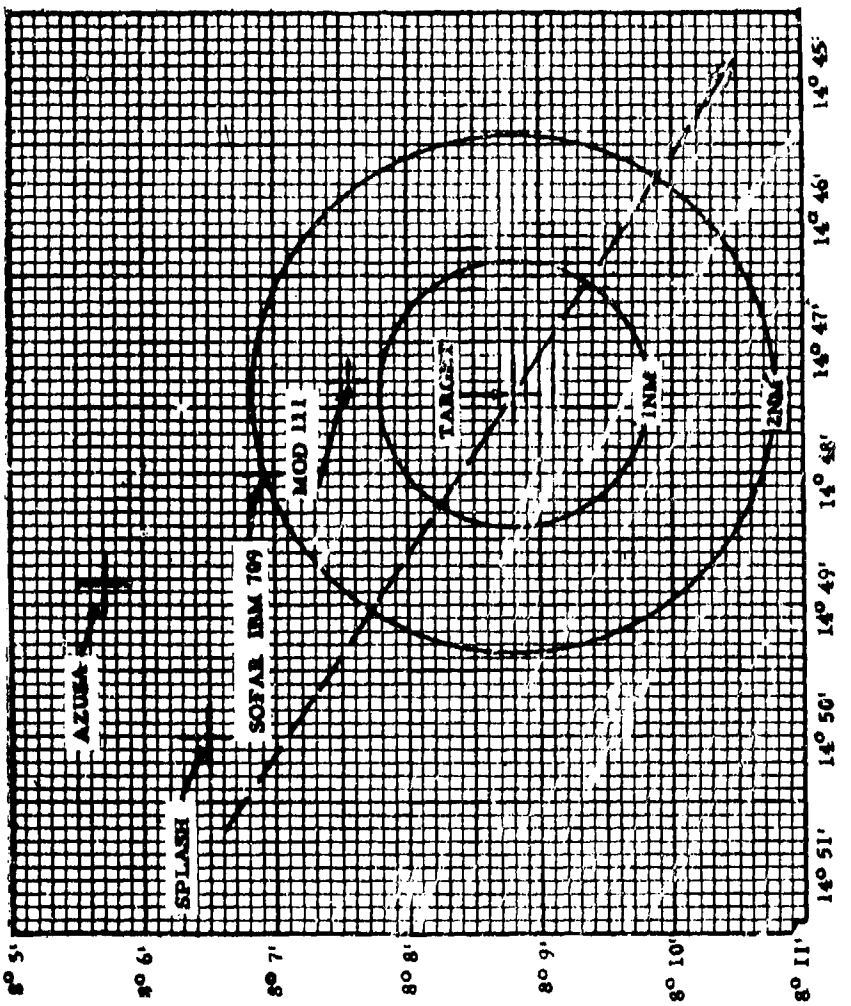
* Ellipse of 95 percent confidence.

Figure 1 graphically represents impact points as determined from these sources.

A comparison of nominal and actual cutoff times referenced to Range Zero (0434:38 EST) are presented below:

	Nominal	Actual
Booster Cutoff	138.2 sec	140.6 sec
Sustainer Cutoff	271.0 sec	267.8 sec
Vernier Cutoff	283.6 sec	281.9 sec.

IMPACT POINT COMPARISON



SYSTEM PERFORMANCE

AIRFRAME

Missile structural integrity was maintained throughout powered flight and well beyond re-entry vehicle separation.

All variable resistance type thrust section temperature measurements appeared normal with the highest reading of 110 degrees reached at the fuel staging valve between 145 and 150 seconds.

The majority of the thermocouple measurements remained below the low scale of 83 degrees. The highest temperatures of 348 degrees and 173 degrees were measured at the heater door and the Quad I firex door, respectively. These temperatures reached maximums at approximately 45 seconds.

The motion of the Quad II and III forward nacelle doors was instrumented by extensiometers. The extensiometers were restrained by a string until the closure of the doors at liftoff activated a knife and cut the string. This was done to prevent damage to the extensiometers when the doors slammed shut. Measurement A 815 D activated properly at door closure and indicated the Quad II door closed an additional 0.35 inches by 51 seconds and then started to reopen. The door did not open more than the launch reference position throughout the flight. Apparently the Quad III door measurement (A 816 D) did not activate until 80 seconds. At the same time a sudden 0.10 inch movement toward the open position was noted on the Quad II door position. After the Quad III door position measurement activated, it indicated a steadily increasing door open position and went out of band at 95 seconds. As the trace went out of band a 1 cps oscillation was present which corresponded with a 1 cps oscillation on the pitch rate gyro measurement.

Booster separation appeared satisfactory as indicated by M 26 D, Booster Section Separation. Re-entry vehicle separation was also satisfactory although physical separation was not discernible on Atlas telemetry data.

PROPULSION SYSTEM

Irregularities were noted in the operation of the B1 and sustainer engines; however, these did not affect the overall performance of the propulsion system.

The sustainer LO2 pump inlet pressure showed an abnormal decay between 117 seconds and booster cutoff, the B1 chamber pressure dropped in the last few seconds of booster phase, and sustainer engine performance dropped momentarily at booster cutoff. The cause of these occurrances and their interelationship has not been determined.

Telemetry data indicate that sustainer chamber pressure was higher than normal at approximately 750 psia throughout the flight. Landline data of this measurement was qualitative only. Other sustainer parameters, however, were at normal operating levels.

The telemetered sustainer LO2 pump inlet data indicated abnormal performance between 117 and 143 seconds. At 117 seconds the sustainer LO2 pump inlet pressure started to drop from 94 psia and by 118 seconds had reached a steady level of 62 psia. The pressure remained steady until 128.4 seconds when it started to decay once more. At 134.8 seconds the pressure was 47 psia where it remained until booster cutoff at 140.6 seconds. At booster cutoff the inlet pressure abruptly dropped and reached a minimum of 30 psia, at 141.0 seconds. The pressure then immediately began to recover and by 143.6 seconds had reached 43 psia. These data appeared normal for the rest of the flight. Other sustainer parameters reflected normal conditions until after booster cutoff.

Between 140.4 and 140.8 seconds the sustainer pump speed increased from 9940 RPM to 10,170 RPM. The pump speed then decreased and reached 9410 RPM by 141.0 seconds. The pump speed then increased to 10,230 RPM by 141.6 seconds and then back to 10,000 RPM at 142.0 seconds. The sustainer pump remained at essentially this level for the remainder of sustainer phase. This variation in pump speed was accompanied by transient decreases in all sustainer pressure data.

At 136.6 seconds the B1 engine performance decreased slightly and did not recover. The B1 pump speed increased from 6111 RPM to 6218 RPM. The B1 chamber pressure decreased from 540 psia to 510 psia at the same time. The missile acceleration decreased slightly at the same time and the booster engines made a slight correction in yaw for the change in thrust. The booster LO2 regulator reference pressure and the BGG combustion pressure showed no change in level. The B2 engine performance changed very little at this time with a chamber pressure drop of less than 10 psi just prior to booster cutoff. B2 pump speed data were not recovered.

The engine start sequence was normal and all valve and timer operating times were within specifications. This missile was launched without utilizing additional hold-down time after main engines complete and was dry started. No adverse affects were noted and engine performance during the start and liftoff sequences was satisfactory.

RCC accelerometer data recorded on the FM landline system indicated satisfactory levels for all 5 RCC systems varying between 5 and 15 G's RMS. Accelerometers mounted on the propellant high pressure ducting indicated levels of 10 to 40 G's RMS on the LO2 ducting and 5 to 30 G's RMS on the fuel ducting during mainstage. Low pressure ducting accelerometers indicated 4 to 15 G's RMS for the fuel ducting and 3 to 12 G's RMS for the LO2 ducting during mainstage.

The engine oxidizer and fuel tanks were repressurized during this flight by connecting the output of the booster cutoff relay directly to the tanks pressurizing solenoid. Pressurization prior to liftoff was by the normal means; however, this circuit was broken between the solenoid and its control relay at liftoff so that any spurious signals could not repressurize the tanks. Pressurization at booster cutoff was satisfactory. Instrumentation throughout the normal repressurizing circuit showed a proper signal generated by the autopilot programmer at BCO+ 64 seconds and no spurious signals at any other time.

Missile axial thrust levels during flight were as follows:

	Units	L/L After Liftoff	TLM After Liftoff	TLM Prior To BCO	TLM Prior To SCO	TLM Prior To VCO
Vernier No. 1	lbs	---	820	945	720	635
Vernier No. 2	lbs	---	850	965	730	650
Sustainer	lbs	*	64,800*	88,500*	87,400*	---
Booster No. 1	lbs	*	152,900	166,100	---	---
Booster No. 2	lbs	*	156,000	175,800	---	---

* Chamber pressure data qualitative only.

Evaluations used for computing thrusts were:

Verniers $F = (1.543 - \frac{P_o}{P_c} \epsilon) P_c A_t \cos \Theta$

Sustainer $F = (1.749 - \frac{P_o}{P_c} \epsilon) P_c A_t$

Boosters $F = (1.586 - \frac{P_o}{P_c} \epsilon) P_c A_t$

Where P_o = Ambient Pressure

P_c = Combustion Chamber Pressure

ϵ = Expansion Ratio (Vernier = 5, Sustainer = 24.6, B1 = 8.0, B2 = 8.0)

A_t = Throat Area (Verniers = 2.10 in^2, Sustainer = 67.5 in^2, B1 = 205.37 in^2, B2 = 205.30 in^2)

Θ = Angle of Verniers from Missile Longitudial Axis in Pitch Plane.

TIMER AND VALVE OPERATING TIME
(all time in seconds)

	Sequence		Test Value	Rocketdyne Specifications
1	BGG valve opening control signal until valve reaches full open		0.42	0.310 to 0.645
2.	Main LO2 valve opening control signal until valve reaches full open	B1 B2	0.35 0.34	0.260 to 0.500 0.260 to 0.500
3.	Main fuel valve opening control signal until valve reaches full open	B1 B2	0.11 0.13	0.060 to 0.230 0.040 to 0.250
4.	S HS valve opening control signal until valve reaches full open		0.64	0.480 to 0.780
5.	S PU valve opening control signal until valve reaches full open		*	0.480 to 0.770
6.	SGG valve opening control signal until valve reaches full open		0.41	0.340 to 0.560
7.	V Engine valve opening control signal until valve reaches full open	V1 V2	0.48 0.46	1.500 Maximum 1.500 Maximum
8.	Ignition Stage Limiter opening control signal		2.38	2.16 to 2.64

* Value not obainable due to EA pen malfunction.

PROPULSION TIME SLICE DATA

Measurement No.	Description	Unit	Steady State Nominal Value	L/L at Liftoff	After Liftoff	Prior To BCO	Prior To SCO	Prior To VCO
Engine Propellant Tank Pressure								
F 1288 P	ISS Pneu. Reg. Out	psia	615	663	674	596	596	615
P 27 P	Eng. Fuel Tank Press	psia	610	---	252	252	601	601
P 30 P	Eng. LO2 Tank Press	psia	610	---	26	26	681	601
Verniers								
P 28 P	V1 Thrust Chamber Press	psia	355	---	341	337	345	305
P 29 P	V2 Thrust Chamber Press	psia	355	---	352	344	352	312
Boosters								
F 1125 P	Ctl Pneu Reg Out	psia	765	761	768	744	---	---
P 1026 P	B LO2 Reg Ref	psia	568	566	575	550	---	---
P 1100 P	BCG Chamber Press	psia	441	*	456	468	---	---
P 1017 T	B2 Turbine Inlet	DGF	1200	1016	---	---	---	---
P 1001 P	B1 LO2 Pump Inlet	psia	---	*	---	---	---	---
P 1003 P	B2 LO2 Pump Inlet	psia	---	*	---	---	---	---
P 1002 P	B1 Fuel Pump Inlet	psia	---	*	---	---	---	---
P 1004 P	B2 Fuel Pump Inlet	psia	---	*	---	---	---	---
P 1020 T	B1 LO2 Pump Inlet	dgt	---	**	---	---	---	---

Measurement No.	Description	Unit	Steady State Nominal Value	L/L at Liftoff	After Liftoff	Prior To BCO	Prior To SCO	Prior To VCO
P 1054 T	B2 LO2 Pump Inlet	dgt	---	**	---	---	---	---
P 84 B	B1 Turbo Pump Speed	rpm	6169	---	6093	6218	---	---
P 83 B	B2 Turbo Pump Speed	rpm	6189	---	***	***	***	***
P 1039 P	B1 Fuel Pump Outlet	psia	788	*	---	---	---	---
P 1038 P	B2 Fuel Pump Outlet	psia	820	*	---	---	---	---
P 1487 P	B1 Ign Fuel Inj	psia	---	*	---	---	---	---
P 1488 P	B2 Ign Fuel Inj	psia	---	*	---	---	---	---
P 1091 P	B1 LO2 Ing Man	psia	649	*	---	---	---	---
P 1092 P	B2 LO2 Inj Man	psia	649	*	---	---	---	---
P 1093 P	B1 Fuel Inj Man	psia	658	*	---	---	---	---
P 1094 P	B2 Fuel Inj Man	psia	658	*	---	---	---	---
P 1060 P	B1 Thrust Chamber	psia	544	*	540	510	---	---
P 1059 P	B2 Thrust Chamber	psia	544	*	558	540	---	---
Sustainer Engine								
P 1344 P	S LO2 Reg Ref Press	psia	814	808	810	810	810	810
P 339 P	SGG Discharge Press	psia	589	---	608	624	624	---
P 530 T	S LO2 Pump Inlet	dgf	---	---	-292	-286	-288	-289

Measurement No.	Description	Unit	Steady State Nominal Value	L/L at Liftoff	After Liftoff	Prior To BCO	Prior To SCO	Prior To VCO
P 56 P	S LO2 Pump Inlet	psia	---	---	68	47	27	25
P 1326 T	S Turbine Inlet	dgf	1100	914	---	---	---	---
P 349 B	S Turbo Pump Speed	rpm	9970	---	9,880	9,940	9,930	---
P 330 P	S Fuel Pump Discharge	psia	974	---	915	900	900	---
P 830 D	PU Valve Position	deg	30.0	---	28.1	33.7	23.7	0
P 529 D	S Main LO2 Valve Pos	deg	---	---	*	*	*	*
P 351 P	S LO2 Inj Man	psia	814	---	810	790	790	---
P 1006 P	S Thrust Chamber	psia	693	*	760****	750****	740****	---
Miscellaneous								
P 1021 T	LO2 at Breakaway value	dgf	---	-291	---	---	---	---
P 671 T	Thrust Section Amb Quad IV	dgf	---	---	51	45	68	68
P 1673 T	B1 Ign FuelVlv Amb	dgf	---	72	---	---	---	---
P 1674 T	B2 Ign Fuel Vlv Amb	dgf	---	77	---	---	---	---
P 1675 T	Eng. Ctl Pneu Man	dgf	---	73	---	---	---	---
P 14 T	Eng Compt Amb	dgf	---	---	69	76	130	116

* Data Qualitative Only Due to Calibration Difficulties.
** No Calibrations on Test record.
*** Instrumentation malfunction.
**** Data Questionable

PNEUMATIC SYSTEM

Performance of the pneumatic system was satisfactory throughout the test. Missile 71D was equipped with Hadley "D" pneumatic regulators which operated satisfactorily. Missile tank and engine control bottle pressure were satisfactory prior to engine start and liftoff, and were satisfactorily maintained throughout the flight.

Tank Pressurization System

LO2 and fuel tank pressures were satisfactorily maintained throughout the flight and well beyond re-entry vehicle separation. Landline data indicated a LO2 tank pressure spike to 27 psia after engine ignition but prior to lift-off. However, this was not noted in the telemetered data and since the landline data appeared noisy it is not known whether the indication is valid or not. At approximately 98 seconds LO2 tank pressure data indicated a slight rise starting from 25.2 psi and reaching 27.5 psi at 108 seconds. Pressure decayed after this time and reached a steady 25.2 psi again at 126 seconds. A similar occurrance was noted on Missile 76D flight Data.

Engine Control Pressurization System

Sustainer control helium bottle pressure was adequate for engine functions throughout the test.

The booster control pneumatic regulator outlet pressure was essentially steady at 760 psia throughout booster phase. The booster control pneumatic regulator rose to 775 psig during a hold at -15 minutes due to the low temperature of the thrust section brought about by inadvertent shutdown of the thrust section heater. Regulator operation was satisfactory after the heater was turned back on. Operation of the ISS pneumatic regulator was satisfactory.

Specific values taken from landline and telemetry records are presented on the following page.

FORM 41594-8

PNEUMATIC TIME SLICE DATA

Measurement No.	Description	Unit	L/L at Liftoff	+5 Seconds	Prior to BCO	Prior to SCO	Prior to VCO
F 1001 P	LO2 Tank Helium	psia	40.3	40.1	25.2	23.2	23.7
F 1003 P	Fuel Tank Helium	psia	74.8	74.3	59.8	49.9	49.9
F 1246 P	B Tank He Bottle Hi	psia	2990	2796	634	---	---
F 1291 P	S Control He Bottle	psia	3008	2951	2601	2461	1621
F 1125 P	B Ctl Pneu Reg Out	psia	761	768	744	---	---
F 1288 P	ISS Pneu Reg Out	psia	603-663	674	596	596	613
F 304 P	Sep Btl Disch	psia	---	3115	3045	---	---

HYDRAULIC SYSTEM

Performance of the Hydraulic Systems was satisfactory during all phases of powered flight. The booster hydraulic system maintained an airborne pressure of 3200 psia until booster cutoff. The sustainer hydraulic system maintained an airborne pressure of 3220 psia until sustainer cutoff.

The operation of the vernier solo accumulator was satisfactory during the vernier phase of flight. At sustainer cutoff the vernier solo accumulator indicated a pressure level of 3220 psia. The pressure decreased to 1120 psia by vernier cutoff and the accumulator bottomed out when the pressure reached 770 psia, 24 seconds after sustainer cutoff. The accumulator was gas precharged to 1000 psi.

Prior to engine start adequate ground pressures were maintained; however, a discrepancy was noted in that telemetered data indicated the sustainer/vernier ground pressure was 2940 psia as compared to the normal pressure of 2000 psia. It is not known whether this pressure level was an accurate indication or not. EA engine sequence data indicated the sustainer hydraulic pressure switch activated properly at -0.27 seconds. This switch was set at 2500 psig ± 100 psig.

MISSILE ELECTRICAL SYSTEM

Performance of the Missile Electrical System was satisfactory. Telemetered data indicated that satisfactory a-c and d-c electrical power were supplied until after re-entry vehicle separation. System parameters remained within specifications at all times.

Missile main battery voltage remained between 26.7 and 28.3 vdc, and inverter phase A and phase C voltages remained between 115.2 and 116.0 vac and 115.9 and 116.9 vac, respectively, over the time interval from engine start to re-entry vehicle separation. Inverter frequency remained between 399.4 and 403.0 cps during this interval except during the sustainer cutoff transient when the frequency momentarily increased to 405.6 cps. The usual inverter frequency transients occurred at engine start, booster cutoff, sustainer cutoff, vernier cutoff and re-entry vehicle separation.

The inverter phase B voltage, as measured at the guidance system, exhibited the same varying characteristics that have been observed during other D/AIG Series flight tests. These variations are not considered to be a true indication of the missile inverter output, but may reflect load changes within the user system.

OPTICAL BEACON SYSTEM

Performance of the Optical Beacon System has not been completely determined. Telemetered data indicated that groups of timing output pulses and also single output pulses occurred. There also appeared to be variation in the pulse spacing. It is possible that a definite pulse pattern may be established among the timing output pulses after further system evaluation. The reason for the spurious groups of output pulses has not been determined.

Preliminary evaluation of the ballistic camera data revealed the presence of images spaced at relatively regular intervals. Images were recorded on the plates at all BC-4 camera sites.

Telemetry Channel 1-C switched to monitor Optical Beacon System operation satisfactorily at 267.330 seconds and the first timing output pulse occurred at 267.569 seconds.

RANGE SAFETY COMMAND SYSTEM

Performance of the Range Safety Command System was satisfactory. Automatic sustainer and manual fuel cutoff command signals were transmitted by AMR and were properly decoded by the airborne system during flight. The data indicated that the automatic sustainer fuel cutoff signal was decoded by the system before the guidance system sustainer cutoff discrete was generated. It could not be determined which signal effected sustainer engine cutoff. Telemetered r-f input/agc data indicated that received signal strength was adequate to maintain proper system operation from launch until after re-entry vehicle separation.

The automatic sustainer fuel cutoff signal, generated by the A-1 Computer at GMCF No. 1 and transmitted by AMR as a backup sustainer cutoff signal, was decoded by the airborne system at 267.312 seconds. The manual fuel cutoff signal, which served as a backup re-entry vehicle separation signal, was planned and requested for 320 seconds. The signal was decoded by the airborne system at 321.434 seconds.

AZUSA SYSTEM

Performance of the Azusa system was satisfactory. This was the first flight on which Azusa Mark II tracked actively. Azusa Mark I tracked actively and Azusa Mark II tracked passively until 145 seconds. At this time Mark II assumed active track with Mark I tracking passively. The changeover from Mark I to Mark II was accomplished satisfactorily. Azusa Mark I was used for realtime impact prediction from 52 to 150 seconds. The Cape FPS-16 radar was used for realtime impact prediction from 150 seconds until after termination of powered flight. Azusa Mark I was then used to obtain a final impact prediction point.

Solid r-f lock was acquired by Azusa Mark I at 32 seconds and track was maintained until 350 seconds. All ambiguities were resolved to fine at 47 seconds and no further resolutions were required for the remainder of the flight.

Resolution of ambiguities at Azusa Mark II was satisfactory with the exception of the range channel. The slew rate of the intermediate range channel was too low to permit the resolved light to illuminate and control was left in the intermediate mode longer than was required. During the interval of passive track a twenty kc hum was observed on the signal received at Mark II. This hum was not present on the signal during the interval of Mark II active track.

Telemetered data indicated that transponder operation was satisfactory throughout the flight.

During the countdown AMR reported a "GO" transponder. Received signal strength at Azusa Mark I was -122 DBW at -29 minutes (0401 EST). Recovery, modulation, and coherency were satisfactory and the 95 cycle sweep was present. No change was reported prior to launch.

FLIGHT CONTROL SYSTEM

Flight Control System performance was satisfactory. Thrust Chamber displacements at engine start were within the tolerance of $\pm$ 0.6 degrees. Satisfactory pitch and roll programs were accomplished. Propellant slosh effects during the booster phase were as expected with the incorporation of Series "E" Filter Servo amplifier package. Engine movements at booster cutoff and during staging were normal and response to guidance steering commands during sustainer phase was satisfactory.

Missile 71D was the second missile in which the roll program was generated entirely by the Arma Inertial Guidance System with no preset roll program being generated by the autopilot. The desired roll program was 89 degrees. Flight Control System data and radar plots indicated that the guidance system generated the proper roll program and that the proper pitch program was electronically generated by the autopilot system.

The missile was also the second D/AIG missile to fly with a Series "E" Filter Servo amplifier package. Because of the additional lag introduced by the Series "E" stabilization filter, the increased booster phase propellant slosh on this missile was expected, as was the case on other missiles which utilized this filter. Maximum slosh in the pitch and yaw planes occured at approximately 95 seconds with a peak-to-peak rate of 7.5 degrees per second in pitch and 3.5 degrees per second in yaw. This resulted in a maximum booster engine movement of 4.75 degrees in pitch and 2.0 degrees in yaw.

The decrease in Booster No. 1 thrust just prior to booster cutoff was reflected by the flight control gyros and a corresponding shift of approximately -0.5 degree of the booster engines in yaw.

The missile rates and sequence of events at booster cutoff and staging appeared normal.

Response to Arma guidance steering commands was normal as indicated by rate and displacement gyro data.

A low-level roll limit cycle of approximately one cps began after staging and was intermittently evident throughout the sustainer and vernier phase. Maximum associated roll rate was 0.80 degrees/second, peak-to-peak, with accompanying vernier engine movement in roll of approximately 3 degrees, peak-to-peak.

All countdown and precountdown tests were satisfactory.

INERTIAL GUIDANCE SYSTEM

Operation of the Inertial Guidance System was satisfactory. The missile guidance set (MGS) correctly issued all discrete signals and steering commands. There were no malfunctions of the airborne components during flight. All telemetered MGS measurements appeared normal. The Alignment-Countdown Set performed normally.

System Accuracy

Guidance accuracy was evaluated by comparison of GE/Burroughs Mod III velocity and position data with velocity and position data telemetered from the ARMA computer.

Defining the guidance system error as the differences between the two sets of data, the indicated guidance miss was: 1.38 nm Left, 0.0 nm Short. The standard method of evaluation used is defined in STL letter 7420.2-92 dtd. 5-15-60.

Trajectory

As in all previous D/AIG flights, the missile was somewhat fast, high and to the right of the nominal trajectory at staging. As indicated in the following tabulations, all conditions at staging and at vernier cutoff were well within the three sigma values.

STAGING CONDITIONS

(First sequence 4 after $\dot{x} \geq K$ 91)

Function	Units	Actual[1]	Nominal[2]	Difference[3]	Three Sigma Limits
Time[4]	sec	147.25	148.25	-1.00	$\pm$ 6
$\dot{X}$	ft/sec	10,519.75	10,536.75	-17.00	$\pm$ 70
$\dot{Y}$	ft/sec	307.75	455.25	-147.50	$\pm$ 600
$\dot{Z}$	ft/sec	4,858.25	4,361.25	+497.00	$\pm$ 950
X	ft	518,912	515,776	+3,136	$\pm$ 19,500
Y	ft	56,192	61,632	-5,440	$\pm$ 25,500
Z	ft	252,096	234,816	+17,280	$\pm$ 35,700

Function	Units	Actual[1]	Nominal[2]	Difference[3]	Three Sigma Limits
CEF[5]	rad	-.009673	-0.00089	-0.008783	---
REF[5]	rad	3.902610	3.7268	+0.175810	---

Vernier Cutoff Condition

(First sequence before REF = 0)

Function	Units	Actual[1]	Nominal[2]	Difference[3]	Three Sigma Limits
Time[4]	sec	288.5	293.625	-5.125	± 21
$\dot{X}$	ft/sec	20,940.75	21,205.25	-264.50	± 450
$\dot{Y}$	ft/sec	571.75	538.75	+33.00	± 60
$\dot{Z}$	ft/sec	5,326.26	4,726.25	+600.00	± 1200
X	ft	2,685,888	2,751,616	-65,728	± 300,000
Y	ft	127,040	133,824	-6,784	± 70,000
Z	ft	943,168	856,320	+86,848	± 200,000
CEF	rad	-0.000030	-0.00002	-0.00001	± 0.00006
REF	rad	+0.000038	+0.000060	-0.000022	± 0.00006

NOTES:

[1] Actual computer quantities include nominal system biases.

[2] Nominal values are taken from STL compilation of guidance information.

[3] Actual minus nominal.

[4] Times are from AIM.

[5] Values for REF and CEF are for 1/2 second after staging.

Data Checker Tests

Countdown GAP Tests - Checks to verify digital telemetry data quality were made with the Data Checker during the countdown at -144 minutes and -65 minutes. The results indicated satisfactory data quality, with no dropouts.

Flight Test - Telemetry data quality was satisfactory. Noise spikes in the digital data caused the nine errors shown in the table below. This number of errors is exceptionally low for flight data.

Tape	Word	Bits Excluded	Start Errors	Total Errors	To
RCA T-144	All	2^0, 2^1, 2^2	0	0	268 seconds
RCA T-0	All	2^0, 2^1, 2^2	0	9	SECO

Platform and Control

The roll program from 2 to 15 seconds and the roll trim from 15 to 19 seconds were accomplished satisfactorily. The trim correction was from 1.6° right to 0°, as measured on the platform azimuth resolver.

At the time pitch steering was enabled, the missile was 2.24° nose up from the desired pitch angle. The desired angle was attained by 164.3 seconds.

Servo error signals did not exceed 1 minute of arc throughout the test.

The performance of the gyros was satisfactory. Gyro drifts measured prior to launch were:

Azimuth	±0.37°/hr	(Precount, 10-12-60)
Pitch	±0.1°/hr	(Syst. Test, 10-11-60)
Roll	±0.3°/hr	(Syst. Test, 10-11-60)

Gyro temperature differed from neutral buoyancy values as follows:

		-10 sec.	At VECO
Pitch/Redundant	601	±0.6°C	±0.48°C
Roll/Azimuth	602	±0.08°C	±0.08°C

Performance of the accelerometers was satisfactory throughout the flight. Scale factors measured during the precount and countdown were:

Scale Factor	X	Y	Z
cps/ft/sec^2	2.00018	1.99883	1.99874

All three platform resolvers functioned normally throughout the flight.

The temperature control was satisfactory. The mag amp. voltage was at its maximum value from liftoff to 15 seconds, then went off from this time to 33 seconds after which time it operated for the remainder of the flight within the control range.

Platform pressure was maintained without change throughout the flight.

All platform voltages were at normal operating levels throughout the test. Actual values are listed in the table below:

Platform Voltage Summary

Voltage	-10 Seconds	VECO	Countdown
-22.5V	22.44	22.38	-22.20
115 ØB	114.2	114.0	114.6

Computer

The computer operated correctly throughout the countdown and the flight. All engine cutoff commands and prearm were properly generated. There was the usual 300 millisecond delay between the issuance of booster cutoff command and an indication of thrust decay in the computer X velocity.

Although the automatic sustainer cutoff point was moved approximately seven miles further downrange than on previous flights, the ASCO (Seco backup) signal arrived at the autopilot 22 milliseconds prior to the Seco signal. The guidance accuracy was not affected.

Yaw Steering was satisfactory. The crossrange error existing at staging was corrected very smoothly with one overshoot. At guidance enable the missile was yawed left 7 degrees. After approximately 27 seconds CEF was reduced to zero and a 7 degree right turn returned the missile tothe target course. There was one overshoot of 2.7 degrees and steering was essentially complete in 40 seconds.

Conditions at Guidance Enable (152 seconds) were as follows:

	Actual	Nominal	Actual-Nom.	Approx. limits of (Actual-Nom)
$\dot{Y}$	306 fps	457 fps	-151 fps	$\pm$ 600 fps
Y	57,728 ft.	63,232 ft.	-5,504 ft.	$\pm$ 25,000 ft.
CEF	-0.009795rad	-0.00089	-0.008	$\pm$ 0.04 rad

All measurements of computer environment were within specification limits during the flight. Computer temperature increased from 28°C at launch to 37°C at VECO. All computer voltages were normal. Typical values were:

Computer Voltage

Time	-10V	-16.5V	-50V	± 38V	±4V
Countdown	-10.1	-16.6	-48.4	36.5	4.12
-10	-10.12	-16.82	-48.81	38.1	4.23
Veco	-9.70	-16.43	-48.59	38.8	4.08

Alignment Countdown Set

A-CS performance was satisfactory. Some difficulty was experienced in reading gyro spin excitation voltage in the blockhouse, but satisfactory readings were obtained in the transfer room.

Accelerometer zeros were within the specified tolerances before the launch, as measured by the A-CS. This indicated proper operation of the zeroing loops.

Function	Nominal	Compensated Nominal	Measured	Error (cps)
X-Offset	0.667	0.692565	0.692426	-0.000139
X	1.000	---	0.999728	-0.000272
Y	1.000	---	1.002062	±0.002062
Z	65.25407	65.21375	65.21268	-0.00107

Instrumentation

All channels of the Analog Signal Converter (ASC) functioned normally throughout the test.

Instrumentation of platform and computer vibrations was deleted for this test.

ASC temperature was very stable during this test. The initial value was 15°C at reset and 14.5°C at Veco.

The Digital Signal Converter functioned normally during the entire test.

MOD IIIE INSTRUMENTATION SYSTEM

Performance of the Mod III E Instrumentation System was satisfactory. All impact prediction and range safety test objectives were met. The automatic sustainer fuel cutoff signal was generated properly by the A-1 Computer and transmitted to AMR.

The missile was tracked off the pad in monopulse mode and monopulse tracking was maintained until the limit of range. The track receiver was operated in manual gain control until 72.6 seconds to obtain data during the period when received signal is accompanied by noise.

The rate subsystem was locked from 14 seconds until 358 seconds, except for 5 seconds at booster staging. Improved performance of the rate subsystem on this flight was partially attributed to the airborne rate beacon modification ECR A3-41.

Telemetered data indicated that airborne system performance was satisfactory.

Performance of the individual subsystems was as follows.

Track Subsystem

Performance of the track subsystem was satisfactory. The missile was tracked off the pad in monopulse mode and monopulse tracking was maintained until the memory occurred during times of lower received signal strength at 325, 366, and 392 seconds. These periods appear to be associated with the slowly changing missile attitude which usually occurs after vernier cutoff.

From launch until 72.5 seconds the track receiver was held in manual gain control to obtain data during the period when received signal is accompanied by noise. The transition to automatic gain control was normal. The 3 cps elevation error signal oscillation which has been observed previously was not seen on this test.

The signal strengths during the booster and sustainer phases were -33 dbm and -47 dbm respectively. The peak-to-peak monopulse errors during the sustainer phase were 0.05 mils elevation and 0.07 mils azimuth.

Rate Subsystem

Performance of the rate subsystem was satisfactory. Except for 5 seconds at booster cutoff, rate was solidly locked from 14 seconds after liftoff until 358 seconds. At 372 seconds rate relocked and, except for a period of 15 seconds starting at 388 seconds, rate was still locked when the recorders were stopped.

The lock history on this test reflects the beacon modification ECR A3-41 which was installed to improve the beacon's ability to remain locked in the presence of amplitude modulated signals. During the early part of the flight, the data showed considerable amplitude modulation; hence, the preliminary results indicate that there was improvement in the rate beacon performance.

During booster phase, after about 60 seconds of varying signal strength which is usually associated with liftoff, the rate received signal strength averaged -74 dbm. During sustainer phase the average signal strength was -87 dbm.

A-1 Computer

The computer operated satisfactorily during the countdown and flight periods. There were no known equipment malfunctions. A simulated rerun of the flight was completed without any recorded errors. The following final impact position data were computed on the basis of free-flight data, assuming nominal re-entry and gravitational effects.

	Mean Miss Distance	Standard Deviation	Standard Deviation of Mean
Downrange	0.61 nm short	0.35 nm	0.08 nm
Crossrange	1.10 nm left	0.31 nm	0.08 nm

The automatic sustainer fuel cutoff signal was generated at 0439:15.245 EST or 267.245 seconds Range Time. The IIP at effective sustainer engine cutoff was 32 $\pm$ 2 nm uprange of the target. Design cutoff was 31 nm uprange.

RE-ENTRY VEHICLE

The RVX-2A (423) successfully withstood the re-entry environment and was recovered. The recovered re-entry vehicle plus the intelligible telemetry data received from liftoff to impact should enable a full evaluation of the ablation materials and the "J" experiments aboard the re-entry vehicle. Both telemetry links functioned properly throughout the flight; the effect of the 32 seconds of signal fade-out during re-entry was cancelled by the successful continuous storage and reproduction of 40 seconds of real time data over the playback link. The Cook Recovery Package functioned as planned. The re-entry vehicle floated. A total of 24.6 seconds of telemetry signal was received while the re-entry vehicle was floating. The "C" band beacon was tracked to re-entry, then lost and not reacquired.

Some of the significant data and events are as follows:

The inflight connector separation (296.2 sec.) was complete and the re-entry vehicle separation (297.6 sec.) was smooth.

Start of Re-entry fade	1854 seconds (10:05:42Z)
Max. Longitudinal Deceleration approx. 55.5g	1884 seconds (10:06:12Z)
Max. Yaw rate approx. $\pm$ 120 degrees per second @ 3 cps	1883 seconds (10:06:11Z)
Max. Pitch rate approx. $\pm$ 100 degrees per second @ 3 cps	1883 seconds (10:06:11Z)
End of Re-entry fade	1886 seconds (10:06:14Z)
Recovery Package events	
Aft Cover ejected	1903 seconds (10:06 31Z)
Parachute Out	1905 seconds
Parachute Disreefed	1909.2 seconds
Bucket Out	1920.2 seconds

400 cps tone (Bucket out indication) reported by A/C and Ship	1920 seconds (approx.)
Re-entry Vehicle Impact (LOS)	1959.1 seconds
ORV WHISKEY Sighted impact (3 nm @141°)	
ORV reacquired signal	1963.2 seconds
ORV final LOS	1987.8 (10:07:56Z)
ORV sighted balloon (2.5nm)	10:08 Z
MOD II(Sta. 121) reported chaff (247° Az., 0.1° El. -28 nm)	10:10 Z
A/C 630 reported reception of Sarah beacon (balloon) signal	10:11 Z
A/C 630 reported "Over package & see plenty dye marker"	10:23 Z
ORV alongside re-entry vehicle	10:32 Z

(Radar Position of ship - 8°7.1'S 14°49.2'W)

As indicated, data were acquired on the following Space Lab experiments:

Experiments	Data Obtained
J21	Yes
J22	Yes
J26	Questionable
J28	Yes
J29	Yes
J30	Yes

Experiments	Data Obtained
J32A	Yes
J32B	Yes
J37	Yes
J39 - 1 Pkg	Yes
1 Pkg	Questionable
J45-1A 1 Pkg	Yes
1 Pkg	Lost - sheared off of aft external mounting Plate
J46 1 Pkg	Yes
1 Pkg	Questionable
J47-1	Yes
J47-2	Yes
J48	Yes
J54-1	Yes

ACOUSTICA PROPELLANT UTILIZATION SYSTEM

Closed-loop performance of the Acoustica Propellant Utilization (PU) System was satisfactory. Telemetered data indicated that all sensors uncovered properly and delay times of monostable outputs were within tolerances. Error time counter output was correct both in magnitude and direction at all stations.

PU valve response to the error time counter output was correct at all stations; however, data obtained from P 830 D, PU Valve Angle, was considered qualitative only since there appeared to be poor valve angle correlation with the calculated expected valve position and the PU Valve Position Feedback data. Acoustica PU valve position feedback data were satisfactory at all stations; however, at Station 4 correlation with the expected valve angle calculation based on error time was poor.

At booster cutoff, an unusual increase in the PU valve angle was noted. The valve opened 3 degrees and remained there until activation of Station 5 fuel monostable multivibrator. The PU valve position feedback data reflected this movement also; however, no other associated data reflected changes which would explain this anomaly. This change in valve position has been experienced on previous flights both with Acoustica and Convair Propellant Utilization systems; however, the acoustica system on Missile 76D also failed to return the valve to its original position after excursion.

This flight utilized a 6 card computer which had a built-in fuel rich error time of 0.25 seconds at Station 4 and a built-in LO2 rich error time of 1.20 seconds at Station 5.

The LO2 propellant head sensing port did not uncover prior to sustainer cutoff. Fuel sensing port data were invalid. The measurement indicated zero percent IBW during the major portion of flight and then commenced to rise at approximately 220 seconds reaching 38 percent IBW at sustainer cutoff. Consequently, residual propellants were not calculated.

The following constants were applicable on Missile 71D:

Booster Phase

PU Valve Upper Electrical Limit	48.0 degrees
Nominal	30.0 degrees
PU Valve Lower Electrical Limit	22.5 degrees
PU Valve Mechanical Limit	22.0 degrees

Sustainer Phase

PU Valve Upper Electrical Limit	38.0 degrees
Nominal	30.0 degrees
PU Valve Lower Electrical Limit	27.0 degrees

Time shared oscillator output times, monostable output error times, PU Valve position feedback, PU Valve angle, and calculated PU Valve angles based on error times are listed on the following page.

Station No.	LO2 Sensor Uncovering Time	LO2 Monostable Output	LO2 Delay Time	Fuel Sensor Uncovering Time	Fuel Monostable Output	Fuel Delay Time	Monostable Error Time	Error Sensed	PU Valve Feedback Position	PU Valve Angle	Expected PU Valve Angle
Prior to Station 1									30.0	29.0	
1	7.45	9.80	2.35	7.40	9.75	2.35	0.05	FF	29.3	28.4	29.7
2.	48.40	50.77	2.37	48.79	51.04	2.25	0.27	LF	32.5	30.6	34.3
3.	39.12	91.48	2.36	89.14	91.58	2.44	0.10	LF	30.5	28.7	31.8
4.	122.78	125.26	2.48	123.39	126.10	2.71	0.84	LF	34.5	30.9	39.0
5.	173.00	175.52	2.51	168.96	170.48	1.52	5.04	FF	26.4	24.3	26.6
6.	228.73	231.00	2.27	225.30	227.80	2.50	3.20	FF	26.3	24.0	26.6

NOTE: Accuracy of times quoted for sensor uncovering is plus zero, minus 33 1/3 milliseconds.
Accuracy of times quoted for monostable operation is plus or minus 25 milliseconds.
All times are in seconds, and PU Valve angle positions are in degrees.

PROPELLANT TANKING

Fuel tanking was accomplished on X-1 Day utilizing the Acoustica Propellant Loading Control Monitor (PLCM) as the primary tanking system. The load cells, PLCU, and flow totalizer served as backup systems. Flight level was midway between the 100 and 100.2 percent PLCM probes. Final level was attained by tanking 350 pounds above the PLCU overfill probe since the 100 percent PLCM probe was inoperative. The flow totalizer data were invalid but correlation among the other weight indicating systems was satisfactory.

LO2 was tanked during the countdown utilizing the Acoustica PLCM as the primary tanking system. Flight level was obtained by tanking 650 pounds above the 100.2 percent PLCM probe. The load cells served as a backup system. Correlation between weight indicating systems was satisfactory.

The following tabulated data reflect the correlation between desired weights and actual weights as indicated by the various systems.

	Units	Desired	PLCM	PLCU	Load Cells
LO2 at Ignition	lbs	174,282	174,332	-----	174,318
Fuel at Ignition	lbs	75,991	75,991	75,991	75,505
Liftoff Weight	lbs	263,707	263,757	------	263,257

Missile weight is based on the Final AMR Dry Weight.

WEATHER

	Fuel Tanking	Ignition
Temperature	82.4°F	71.8°F
Pressure	29.990 Inches of Hg.	29.915 In. of Hg.
Humidity	58 Percent	96 Percent
Wind-Velocity and Direction	6 Knots, NNE	2 Knots, SW
Cloud Coverage	3/10	Clear

HOLDDOWN AND RELEASE SYSTEM

The Holddown and Release System operated satisfactorily in restraining the missile prior to release and in releasing the missile at liftoff. All data taken from oscillograph records were within specifications with the exception of B1 residual pressure which was 126 psig over specification. All test values are questionable since there were no calibrations for the record and zero points were measured from the base line and cannot be considered accurate.

Event	Specification	Test Value
Release signal to 2550 psig	0.5 sec. max.	0.484
Time difference between start of B1 and B2 cylinder pressure decay	0.010 sec. max.	0.009
Time intercept of tangent at 2550 psig	0.110 sec. min.	B1 = 0.238 B2 = 0.140
Residual pressure 0.5 seconds after 2550 psig	350 psig max.	B1 = 476 B2 = 328
Maximum differential cylinder pressure after 2550 psig	400 psid max.	390 psid @ B2 = 2550 psig

EXTERNAL INSTRUMENTATION

Operation of the external data systems was satisfactory. These include all data systems other than telemetry and Convair acquired landline instrumentation, as reported in Item 1.0-10, Preliminary Estimate of Data Coverage.

Instrumentation	71D DTO Requirement	Test Results
Optical Coverage		
38 Engineering Sequential Cameras	4.1.5.1 and 4.1.5.2	Satisfactory except for 1.2-6 and 1.2-31 which reported zero coverage.
1 Engineering Sequential Camera	4.1.5.6	Satisfactory.
19 Metric Cameras	4.1.53 and 4.1.5.4	Satisfactory.
Ballistic Cameras	4.1.5.5	Station 4.1 reported observing burnout and 2 flares. Station 5.1 reported observing burnout and 6 flares.
Electronic Coverage		
FPS-16 (XN-1 at PAFB)	5.4.1.1	Tracked from 15 to 270 seconds.
FPS-16 (XN-2 at GBI)	4.5.1.1	Tracked from 65 to 303 seconds.
FPS-16 (Ascension Island)	4.5.1.1	Tracked from 1642 to 1863 seconds.
Mod IV (X-Band)	5.4.1.2	Tracked from 15 to 100 seconds.
Azusa Mk-I (Active)	5.4.1.3	Tracked from 30 to 140 seconds.
Azusa Mk-I (Passive)	5.4.1.3	Tracked from 140 to 350 seconds.

AIRFRAME INTERNAL INSTRUMENTATION SYSTEM

Operation of the Telemetry System was satisfactory and RF signals were received at the Cape for approximately 16 minutes.

There were four discrepancies noted in telemetry measurements:

1. P 83 B, B2 Pump Speed, did not activate.
2. P 529 D, Sustainer Main LO2 Valve, lost excitation prior to liftoff.
3. U 81 P, Fuel Tank Head, read zero percent until the latter portion of sustainer phase. It then rose to approximately 30 percent by sustainer cutoff.
4. P 6 P, Sustainer Chamber Pressure, appeared to be invalid.

Missile 71D contained three Bendix Mod 7 FM telemeter packages operational at the following frequencies and with the following subcarriers and commutation capabilities.

RF No.	Frequency	Continuous Channels	Commutated Channels
1	227.7	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, E	11, 12, 13, A, C
2.	229.7	2, 3, 4, 5, 6, 7, 8, 9, 10, 12, A, C	11, E
3.	232.4	5, 8, 9, 12, 13, A, C, E	11

Basic telemetry channel assignment is given to Convair Report AZC-27-070-71. Included in that report are channel assignment, commutation information, frequency response, and made and model of transducer.

LANDLINE INSTRUMENTATION

Little satisfactory information was provided by the landline oscillograph and the FM system prior to missile liftoff. Because the calibration portion of Landline Oscillograph No. 1 was overexposed, no calibrations were obtained and consequently measurements, L1127P, B1 Holddown Cylinder, L1128P, B2 Holddown Cylinder, P1059P, B2 Thrust Chamber, and P1060P, B1 Thrust Chamber, were qualitative only no output was received from P1006P, Sustainer Chamber Pressure, on this record. Also measurements P1020T, B1 LO2 Pump Inlet, and P1054T, B2 LO2 Pump Inlet, were qualitative only due to calibrations being omitted from Landline Oscillograph No. 2.

All pressure measurements recorded on the FM tape were qualitative only because many calibrations appeared to be invalid.

Instrumentation	71D DTO Requirement	Test Results
Electronic Coverage		
Azusa Mk-II (Active)	5.4.1.3	Tracked from 160 to 325 seconds.
Azusa Mk II (Passive)	5.4.1.3	Tracked from Liftoff to 140 seconds.

FILM REVIEW

A review of quick process engineering sequential film indicated all missiles and launcher systems functioned properly from ignition to the limit of camera coverage.

Operation of both east and west launcher heads appeared normal and in general launcher operation was satisfactory.

A tabulation of film items reviewed is presented below.

Item Number	Camera Pad	Frames Per Sec	Size MM B & W Or Color	Fixed or Tracking	Field of View
1.2-7	11-10	16C	400	Fixed	Top of flame deflector to above vernier. View of Quad IV.
1.2-8	Ramp	16C	400	Fixed	Top of flame deflector to above vernier. Views Quads I and II.
1.2-15	D17R39	16C	48	Track	Entire missile.
1.2-16	U75R6	16C	48	Track	Entire missile.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The flight was successful.

2. There were irregularities in the performance of booster number one and sustainer engine during the last few seconds before booster cutoff.

Recommendations

1. Investigate booster number one and sustainer engine performance to determine the cause for irregular operation.

COUNTDOWN TIME VERSUS EVENTS

This test was scheduled for a 150 minute countdown and started at 2330 EST, as planned. However, three holds, one recycle, and one countdown advance were required totaling 154 minutes which resulted in a total countdown time of 304 minutes. The holds, recycle, and countdown advance occurred:

1. At -15 minutes (0145 EST), for 120 minutes, because LO2 tanking pump LC failed to start for LO2 topping. The countdown was recycled to -70 minutes to start detanking LO2. After LO2 had been detanked to approximately 65 percent, an investigation was made of pump LC associated wiring in the power room and in the blockhouse. LO2 was then completely detanked and further investigation revealed that the wrong plug had been inadvertently inserted into the LC pump power receptacle at the LO2 storage area. The countdown was advanced to -45 minutes and resumed at 0345 EST.

2. At -7 minutes (0423 EST), for 2 minutes, because of the presence of a ship in the downrange area.

3. At -3 minutes 30 seconds (0429 EST), for 2 minutes. This additional time was required for the ship to clear the range. The countdown was resumed at -3 minutes 30 seconds at 0431 EST and continued as planned without further difficulties.

The following notations were made by an observer in the blockhouse.

EST	Countdown Time	Countdown Procedure	Event
2327			ARMA Computer Warm-up Test Started.
2330	T-150	T-150	Countdown Started.
	T-150		Autopilot Gap Test Prep Started.
	T-150		Acoustica Test Equipment Warm-Up.
2335	T-145	T-145	GAP Test Readiness Callout by Flight Control.
2336	T-144	T-144	Gap Test Started.

EST	Countdown Time	Countdown Procedure	Event
2343	T-137		Gap Test Completed Satisfactorily.
2344	T-136	T-135	Zero Z, Scale X(Plus 1 G Field) Accelerometer Checks Started.
2345	T-135	T-135	Range Safety Command Test Started.
2354	T-126	T-125	Start Electrical Connection of Red Destruct Box.
2355	T-125		Range Safety Command Test Completed Satisfactorily.
	T-125		Zero Z, Scale X Accelerometer Checks Finished.
2358	T-122		Red Destruct Boxes Installation Completed.
2400	T-120		Retro-Rocket Installation Completed.
2401	T-119		Activate Telemetry Batteries and Missile Main Battery.
2409	T-111		Remove ARMA Landline Umbilicals.
	T-111	T-90	Normal Align - Scale Z Accelerometer Checks Started.
2420	T-100	T-75	Computer DSC Test Started.
2425	T-95	T-100	Flight Control System Test Delayed 10 Minutes due to work in the Thrust Section.
2435	T-85	T-85	Helium Storage Preparation Started.
	T-85	T-90	Nose Cone Telemetry and Beacon Check Started.
2441	T-79		Helium Storage Preparation Finished.
2445	T-75		Rerun Computer DSC Check

EST	Countdown Time	Countdown Procedure	Event
2449	T-71		Service Tower Secured.
2455	T-65	T-65	Gap Test Preparations Started.
2456	T-64		Nose Cone Beacon and Telemetry Checks Finished.
	T-64	T-65	Mod III Beacon Lockon Check Started.
2458	T-62	T-62	Gap Test Started.
0105	T-55		Gap Test Completed Satisfactorily.
0115	T-45	T-45	LO2 Tanking Preparations Started.
0115	T-45	T-35	Insert X Offset Checks Started.
0118	T-42		Landline Electrical Calibrations are Completed.
	T-42		Mark I Azusa Ground Station has a Problem.
0125	T-35	T-35	LO2 Tanking Started.
0128	T-32		Final Computer Checks Started.
0131	T-29	T-30	Autopilot System Final Checks Started.
0132	T-28		Azusa System Turned "ON".
0136	T-24	T-18	Accelerometer Adjustment Checks.
0138	T-22	T-22	Range Safety Command Final Test Started.
0141	T-19	T-20	Start Telemetry Final Warm Up.
0144	T-16		Pump LC not Operating.
0145	T-15 H		Start Detanking.

EST	Countdown Time	Countdown Procedure	Event
0146	T-70 H		Recycled to T-70 and holding.
0345	T-45		Countdown Resumed.
	T-45	T-45	LO2 Tanking Preparation Started.
0355	T-35	T-35	LO2 Tanking Started.
0356	T-34		Azusa Problem With Ground Station.
	T-34		Azusa Turned "ON".
0400	T-30	T-30	Autopilot System Final Checks Started.
0402	T-28		Final Computer Check.
0408	T-22	T-22	Range Safety Command Final Test Started
0409	T-21	T-18	Accelerometer Adjustment Check.
0411	T-19		Start Telemetry Final Warm Up.
0417	T-13	T-13	Azusa Check Finished.
0420	T-10	T-10	Start Telemetry Final Check.
0421	T-9		Autopilot System Final Check Completed.
	T-9		Range Safety Command Check Completed.
	T-9		Acoustica Sensor Response Check Finished.
0423	T-7 H		Holding for Range.
0425	T-7		Countdown Resumed.
0427	T-5		All Communications Switch to Channel 1.
	T-3:50	T-3:50	Status Check - All System Report "GO".
0429	T-3:30 H		Holding Momentarily for Range.
0431	T-3:30		Countdown Resumed.

EST	Countdown Time	Countdown Procedure	Event
0431	T-3:30		Tememetry "INTERNAL".
0432	T-3:00	T-3:00	Timer Off-Ready Switch to "READY".
	T-2:40	T-2:40	Nose Cone Switch to "INTERNAL"
	T-2:30	T-2:30	Turning Water Systems "ON".
	T-2:10	T-2:10	Securing LO2 Tanking.
0433	T-2:00	T-2:00	Starting Flight Pressurization.
			Commands to "INTERNAL".
	T-1:45	T-1:45	Arm Switch To "ARM".
			Engine Preparation Complete Light "ON".
	T-1:40	T-1:40	Missile to Internal Power.
	T-1:25	T-1:25	Command to "ARM".
	T-1:15	T-1:15	Status Check - All Systems Reported "GO".
0434	T-0:60	T-0:60	T-60 Seconds And Counting.
			Missile Helium To "INTERNAL".
			Autopilot to "ARM".
	T-0:55	T-0:55	Water Full Flow.
			PSO Range Ready Switch "ON"
	T-0:40	T-0:40	Status Check - All Systems Reported "GO". All Pre-Start Panel Lights are Correct.
			Ready Light "ON".
	T-0:25	T-0:25	Oil Evacuate.
	T-0:18		T-18 Seconds.

EST	Countdown Time	Countdown Procedure	Event
			All Recorders to Fast.
			T-18 Seconds and Counting.
			Engine Start.
0434.48			Range Zero.

MISSILE CONFIGURATION

The Atlas Missile consists of three basic sections: re-entry vehicle, body section, the propulsion system. There are no external aerodynamic control surfaces. The re-entry vehicle was an instrumented, recoverable research test vehicle. The body section of the missile consist primarily of a thin-walled, pressure stabilized, stainless steel tank, housing the missile propellants. Missile propulsion is provided by the Rocketdyne MA-2 rocket engine propulsion system. Missile stability is accomplished by a flight control system consisting of an autopilot and a hydraulic system to gimbal the thrust chambers.

The following is a resume of the major systems and components comprising Missile 71D. Additional details are included for systems being flight tested for the first time, as well as systems which have received significant modifications.

Airframe

Standard "D" Series AIG configuration with the oversized "bump pod" for AIG equipment, and subsequent relocation of other airborne items.

Re-entry Vehicle

The RVX-2A Re-entry Vehicle was an instrumented, recoverable research test vehicle approximately 147 inches long, of a sphere-cone configuration, and weighed 2600 lbs.

The vehicle was designed for high velocity re-entry into the atmosphere and the testing of various types of ablative materials. The materials utilized with this test vehicle were fabricated by General Electric.

The RVX-2A contained a recovery subsystem that decelerates the vehicle from its high re-entry velocity. A parachute decelerates it to approximately 100 ft/second, then after impact, a balloon is used for flotation for a period of up to 36 hours. The vehicle was also fitted with styrofoam to provide an additional means of keeping the vehicle afloat. The recovery system provides aids for vehicle location as follows: saltwater-activated, battery-powered, SARAH beacon, a light beacon, SOFAR bomb, radar chaff, and dye marker. The recovery system also includes shark repellant.

The vehicle carried a "C" Band Beacon which was to operate from liftoff to impact.

Two FM/FM VHF telemetry transmitters were utilized. One to transmit real-time data from range zero to impact. The other to continuously play back the signal from the 40 second delay recorder. This recorder was de-activated by a programmer sub-routine at -25 g decreasing and the re-entry data were stored for recovery.
A back-up recorder was installed which was programmed to start at separation and stop at -25g decreasing. This would enable recovering the re-entry data after vehicle recovery in the event of playback recorder failure during flight.

A flight programmer was used to switch the accelerometers and rate gyros from fine to coarse range.

The following "piggy-back" experiments were carried on board the RVX-2A flown with Missile 71D.

Experiment	Description
J21	Ion Sheath
J22	Ultraviolet Background
J26	Hot Gas Radiation Spectrograph
J28	Passive Transpiration Cooling
J29	Fuel Cell
J30	Cloud Coverage
J32	X-Band Propagation
J37	Magnetohydrodynamics
*J39	Nuclear
*J45	Cosmic Ray
*J46	Radiation
J47-1	Bio Specimen (Mouse)
J47-2	Bio Specimen (Mice)
J48	Integrating Accelerometer
*J54	Emulsion Package

* Not Telemetered

Separation of the re-entry vehicle from the missile tank structure was effected in the same manner as the Mark II Series (Separation latches and associated harnessing).

Pneumatic System

Standard "D" Series pneumatic system with Hadley "D" tank pressurization regulators. The VTP circuit was rewired (Similar to 66D) to avoid spurious vernier tank venting and repressurizing.

Hydraulic System

The hydraulic system was comprised of three independent hydraulic systems which provided pressure for the booster stage subsystems, the sustainer/vernier subsystem, and the vernier solo subsystem. A 25 cubic inch accumulator was utilized to furnish vernier solo hydraulic power.

Electrical System

Rotary inverter, remotely activated missile main battery, two manually activated range safety command batteries, three remotely activated telemetry batteries, and a remotely activated Optical Beacon battery.

Propellant Utilization System

Acoustica PU System operated closed loop.

Anti-Slosh Control

Eleven annular baffle rings were installed in the LO2 tank to reduce propellant "sloshing."

Propulsion System

Basic Rocketdyne MA-2 engine assembly. The propulsion system utilized a "dry" start and there was no holddown time delay for this flight test.

Booster Staging System

Standard "D" Series configuration, which utilized a separate fiberglass bottle to supply pneumatic pressure to actuate the release fittings.

Instrumentation System

Three telemetry links for missile system data. Two telemetry links for re-entry vehicle data.

Range Safety Command System

Range Safety Command System consisting of two ARW-62 receivers, (AVCO AD-319600 MKI), power and signal control unit, and destruct package.

Impact Predictor

GE Mod IIIE instrumentation beacon system in conjunction with the GE/ Burroughs Mod III system.

Azusa Transponder

Type B-1A coherent carrier transponder in conjunction with Azusa Mark I and Azusa Mark III.

Inertial Guidance System

Guidance was provided by ARMA Lot III m.all-inertial guidance (AIG) system. For this test the complete roll program was generated by this system.

1. Sensing Platform - contained three accelerometers, two 4×10^6 gyros, three pendulums and an alignment prism.

2. Digital Computer - integrated the accelerations and flight deviations sensed by the platform, and generated correction signals and engine cutoffs.

3. The final component of the MCS was a control central in which the necessary start, heat, alignment, and operation controls were housed.

R and D testing at AMR requires the use of two additional components for the airborne portion of the AIG equipment, a digital signal converter (DSC) and an analog signal converter (ASC).

Flight Control System

The Convair autopilot packages used on D/AIG missiles

differ from that used on previous "D" Series missiles in the following respects:

1. The canisters were rectangular in shape rather than round.

2. Switching in the programmer package was electronic, rather than electro-mechanical.

3. The excitation transformer was removed from the filter servo-amplifier package and set in a separate housing.

4. For pitch and yaw channels from T-0 to booster staging a 4 cps quadratic lead triple-lag filter was utilized. From staging throughout the remainder of powered flight a triple-lag filter was used. A normal 4 cps filter was used in the roll channel.

Optical Beacon System

A Strobe Optical Beacon was installed in the forward end of the B1 pod at approximately Station 917.5, and was powered by a remotely activated primary battery.

HISTORY OF XSM-65D MISSILE NO. 71

Atlas Missile 71D arrived at AMR by air transport (C-133) on 19 August 1960. Transfer of the missile from the IOC trailer to the R and D trailer and to the north bay of Hangar K was effected the same day. Hangar checkout was initiated on 22 August 1960 and terminated on 23 September 1960.

Missile 71D remained at AMR for a period of approximately eight weeks before being launched. This time was utilized in performing missile system tests, completing modification tasks and in readying the missile and launching complex for the flight test. Pre-launch operations were performed in accordance with planning documented in Report AA 60-0064, Flight Test Directive, Series "D" Missile No. 71. Unplanned operations were performed on an "as required" basis.

Significant events concerning Missile 71D from arrival at AMR to launch are delineated chronologically below.

Date	Event
19 August 1960	Arrived at AMR by air transport, transferred to north bay of Hangar K.
22 August 1960	Hangar checkout and modification tasks initiated.
20 September 1960	Demated in Hangar K to replace 5 lines to Vernier engines. One LO2, one fuel, one pneumatic purge and two hydraulic lines damaged because of improper installation of a fairlead. Remated.
23 September 1960	Weighed in Hangar K.
26 September 1960	Transferred to Complex 11 and erected.
30 September 1960	Successful Fuel and LO2 Tanking.
3 October 1960	Successful Flight Acceptance Composite Test.
6 October 1960	X-1 Day Operations
7 October 1960	Attempted launch. Terminated at -7 minutes in the countdown because of loss of modulation on nose cone telemetry link 4.

Date	Event
12 October 1960	X-1 Day Operations
13 October 1960	Flight

Attempted Launch

A launch was attempted on 7 October, but was terminated at -7 minutes in the countdown when loss of modulation on nose cone telemetry link 4 was reported by nose cone personnel.

This test was planned for a 150 minute countdown and started at 2330 EST as planned. The count proceeded normally until -7 minutes (0153 EST) when a hold was called by the range to change a generator at one of the electronic sky screen sites. After holding for 34 minutes, the range reported ready to continue the count; however, ARMA was having difficulty obtaining proper accelerometer readouts and requested that the hold be continued. At 0235 EST the count was recycled to -70 minutes and held to recarbon the search lights and replenish the LO2 supply in the LO2 storage tank.

After holding for a total of 131 minutes, the count was picked up at -45 minutes (0404 EST) and continued without difficulty until -2 minutes, 20 seconds. At this time the B1 backup RCC test switch was inadvertently activated, giving an engine cutoff. The count was recycled to -7 minutes and held at 0446 EST. While holding to establish the cause of the engine cutoff, nose cone personnel reported loss of modulation on telemetry link 4 and the test was cancelled.

The countdown time consumed for the holds and recycles totaled 166 minutes which, when added to the original scheduled time of 150 minutes, makes a total elapsed countdown time of 316 minutes.

The following notations were made by an observer in the blockhouse.

EST	Countdown Time	Countdown Procedure	Event
2330	T-150	T-150	Countdown Started. GAP Test Preparations Started. Acoustica Test Equipment Warm Up Started.
	T-147	T-147	Start Telemetry Warm Up.
	T-143	T-144	GAP Test Started.
	T-136		GAP Test Completed Satisfactorily.
	T-135	T-135	Range Safety Command Test Started.
2355	T-125	T-125	Range Safety Command Test Completed Satisfactorily. Start Electrical Connection of Red Destruct Boxes.
	T-122		Electrical Connection of Red Destruct Boxes Completed.
		T-138	Electrical Connection of Retro-Rockets Started.
	T-119		Electrical Connection of Retro-Rockets Completed.
	T-95	T-95	Service Tower Removal and Securing Started.
0030	T-90	T-90	Nose Cone Telemetry and Beacon Check Started.
	T-85	T-85	Helium Pressure Storage Preparations Started.
	T-83	T-100	Flight Control System Test Started. These Tests Were Delayed Due to Waiting for Clearing of the Thrust Section.
0050	T-70	T-70	Helium Storage Started.
	T-65	T-65	GAP Test Preparations Started.

EST	Countdown Time	Countdown Procedure	Event
0055	T-65	T-65	Nose Cone Beacon and Telemetry Checks Finished.
	T-62	T-62	GAP Test Started.
0105	T-55	T-55	GAP Test Completed Satisfactorily.
	T-45	T-45	LO2 Tanking Started.
0130	T-30	T-35	Azusa Check Started.
	T-30	T-30	Autopilot System Final Check Started.
	T-26		Telemetry ELSSE Generator Out. Will Hold at -7 Minutes if Necessary.
	T-21	T-22	Range Safety Command Test Started. ELSSE Estimates 30 Minute Hold Will be Required.
	T-17	T-20	Start Telemetry Final Warm Up.
0153	T-7	T-7	Holding For Range to Change a Generator.
0155	T-7H		Telemetry Commutators "ON".
0217			Will Pick Up the Count in 10 Minutes.
0224	T-7H		Autopilot Final Systems Check Completed.
0225	T-7H		Range Ready to Pick Up the Count in 2 Minutes; However, ARMA is Having Trouble With One Accelerometer and Expects an Additional 5 Minute Hold.
0230	T-7H		Range Reports Link One 7.35KC Master Pulse is Breaking Up.
0235	T-70H		Recycled to -70 Minutes and Holding to Recarbon Searchlights. Estimate 90 Minute Hold. Will Have to Retank LO2 Storage Tank.
0350	T-45H		Will Run GAP Test No. 2 While Preparing to Pick Up the Count.
0355			Start GAP Test.

EST	Countdown Time	Countdown Procedure	Event
0401	T-45H		GAP Test Completed Satisfactorily.
0404	T-45	T-45	Picked Up the Count at -45 Minutes.
	T-45	T-45	LO2 Tanking Preparations Started.
	T-38	T-35	Insert X Offset Checks Started.
0414	T-35	T-35	Azusa Check Started.
	T-35	T-35	LO2 Tanking Started.
0419	T-30	T-30	Autopilot System Final Check Started.
	T-26	T-26	Final Computer Check Started.
0429	T-20	T-20	Start Telemetry Final Warm Up.
	T-18	T-18	Accelerometer Adjustment Check.
	T-17	T-17	Telemetry Commutators "ON".
	T-14	T-14	Nose Cone Telemetry "ON".
	T-13	T-13	Azusa is "GO".
	T-12	T-12	Nose Cone Beacon "ON".
0439	T-10	T-10	Telemetry Final Check Started.
	T-7	T-7	Start Guidance Final Checks.
	T-3:50	T-3:50	Status Check - All Systems "GO".
	T-3:30	T-3:30	Telemetry to "INTERNAL". Timer Off-Ready Switch to "READY".
0446	T-2:40	T-2:40	Nose Cone Switch to "INTERNAL".

EST	Countdown Time	Countdown Procedure	Event
0446	T-2:30	T-2:30	Recycled to -7 Minutes and Holding Because the B1A RCC Test Switch was Switched Inadvertently and Gave a Cutoff.
0450	T-7H	T-7H	Nose Cone Reports Loss of Modulation on Link 4.
0453			Test Terminated Because of the Nose Cone Problem.

A brief compilation of significant difficulties encountered in system perparation at AMR follows:

Propulsion System

The V2 engine and the propellant valve on V1 engine were replaced and the vernier LO2 lines were cleaned due to contamination.

After Fuel Tanking, a fuel leak was discovered at the fuel fill and check valve attachment to the booster gas generator. It was observed that the valve flange face was cocked slightly with reference to the BGG flange. After ascertaining that the sealing surfaces were smooth, the gasket was replaced, and a leak check at start tank pressure revealed no leakage. After the X-1 Day Fuel Tanking, however, the leak was again detected. The fuel lines involved were replaced and a bulkhead fitting was turned around which aided in aligning the line. All subsequent checks proved successful.

During the first LO2 Tanking, neither vernier LO2 bleed was observed to open. Investigation revealed that the vernier bleed valve close line was connected to the wrong part. This was corrected.

It was necessary to decontaminate the V1 Engine because the V1 fuel purge check valve had been installed backward during vernier leak checks.

Hydraulic System

On X Day of the second launch operation, it was observed that the booster hydraulic system had accumulated air since the last check; a period of twelve hours. A bleed was performed prior to precount and the system was again found to contain air. This was attributed to incorrect procedure during the check itself. Another check performed during pre-count proved satisfactory.

Azusa System

The Azusa System was checked in accordance with FTP-Z-001A. A signal strength of -117 DBW was observed by the Azusa Ground Station. The system was acceptable and operated satisfactorily during all tests.

Optical Beacon System

The Optical Beacon System was checked in accordance with FTP-E-049 and was found to be acceptable. Leak checks were performed and were satisfactory. The Optical Beacon System functioned properly during all tests.

Missile Electrical System

All missile electrical tests performed during preparation for flight were satisfactory.

Range Safety Command System

The Range Safety Command System was acceptable in all tests performed in preparation for flight.

Acoustica PU System

All tests on the Acoustica PU System were satisfactory.

Re-Entry Vehicle

On -1 day for the attempted launch, the multiplexer (90 x 10) would not start switching until the ground power voltage (at the console meter) was increased to 30 volts. A comparison of the telemetry voltage monitor and console meter reading revealed that the console meter was reading approximately 3V higher than the voltage at the re-entry vehicle. The console meter was calibrated for this condition and the multiplexer was considered satisfactory.

During the countdown for the launch attempt, the tape recorder jammed when the re-entry vehicle battery was being preloaded. The preload operation introduced a 2 volt rise in ground power voltage. The ground power, console meter, and preload returns were isolated and the condition was eliminated. The recorder was changed. A back-up recorder was added which was programmed to start at separation and stop at -25g decreasing. This would enable recovering the data after vehicle recovery in the event of play-back recorder failure during flight.

Telemetry System

Several measurements were bad due to an incorrectly worked engineering change. This caused the continuous measurements on RF No. 1 to read improperly. Plug 3P1 into the Acoustica Canister was improperly keyed which caused the PU measurements not to function.

During the FAC Test, the sustainer yaw transducer shorted out when the engine was moved hard over. The plug was left out for the remainder of the FAC Test and the transducer was later replaced. A guidance servo error signal was not received by telemetry and the difficulty was traced to be an open wire in 100P3. This was resolved by using a spare wire.

During the launch attempt on 8 October, the master pulse on RF No. 1, Channel 11 began breaking up intermittently. A run and record was made with both RF No. 1 cans to prove that a variation in deviation and a drop-out in signal is caused by the doors being opened and people walking around the antenna. RF No. 1, Serial Number 903, was found to be affected less than RF No. 1, Serial Number 956 and consequently RF No. 1 Serial Number 903, was used during flight.

Flight Control

The sustainer engine alignment check on 27 September gave 1/8 inch out of tolerance indicating in both pitch and yaw. This was ascertained to be acceptable for flight and no corrective action was taken.

During a programmer run on 3 October, it was discovered that a SECO discrete sent through the programmer would not cut off the propulsion system. The system wiring was checked out and no errors or breaks were found. Successive operation of the system could not produce the malfunction and the trouble never repeated. It is believed that U3P2 on the programmer may not have been connected securely causing the malfunction. On 4 October programmer Serial Number 17 was removed and sent to the Gyro Laboratory to check for a mechanical clearance problem within the programmer. Serial Number 18 became the flight programmer.

Guidance System

During initial MGS checkout, the ASC output for the 601 gyro temperature was faulty and the computer failed to operate reliably. ASC Serial Number 7150015 was replaced by Serial Number 7150022 and Computer Serial Number 7130013 was replaced by Serial Number 7130011. The Azimuth servo error output from the ASC was in error during the FAC Test and ASC, Serial Number 7150022, was replaced by Serial Number 025. Computer Serial Number 7130011 was replaced with Computer Serial Number 7130015 due to a suspected problem which was resolved to be a GSE problem. After the launch attempt, computer, Serial Number 7130015, was replaced by Serial Number 7130011 because the unit exhibited yaw steering dropouts. ASC, Serial Number 125, failed to provide string output and was replaced by Serial Number 715022. At STL direction the DC marginal computer power supplies were replaced by an AC marginal power source.

MOD III E Instrumentation Beacon System

In attempting the pressure test on the waveguide and antenna on 29 September, two leaks were found. The leaks were repaired with epoxy resin.

The blockhouse compatibility test was attempted on 30 September but could not be completed due to test equipment malfunction. The test was completed on 3 October.

Complex Electrical System

On 23 September the 90 percent and overfill PLCU fuel probe coaxes were found to be shorted in the transfer room. New cables were spliced in as required. The 100 percent PLCM fuel probe was inoperative on 29 September due to open stillwell wiring. The trouble was not repaired and the system was used in that status.

During propulsion checkout on 30 September the purges would not turn off and therefore it was necessary to turn off the panel power. Severe burning was sustained on the purge panels in the transfer room. Investigation of the purge system disclosed a short caused by a pinched cable in the junction box.

Trouble was encountered with the umbilical control on the FAC Test in that there was no voltage to the two inch rise switch. It was found that a jumper from H to N for system safety circuit was not installed. This was corrected.

Landline Instrumentation System

Failure to record the serial numbers of 15 transducers installed in San Diego presented difficulties on the day of the first launch attempt. On X-1 Day the serial numbers of these transducers were checked. Calibration curves were not available for three of these transducers. They were replaced.

Pneumatic System

The High Pressure Leak Check and Airborne Regulator Lockup Checkout, was first attempted on 27 September 1960. Upon stepping from "Sequence III" to "Internal", the fuel ullage tank pressure rose rapidly to 70 psid before restep could be initiated. The fuel airborne relief valve was checked and found to be apparently working satisfactorily. It was then decided to remove and replace the fuel airborne regulator.

On 28 September 1960, the same test was attempted. Upon stepping from "Sequence III" to "Internal" the fuel ullage tank pressure rose to 80 psig before "restep" could be initiated. The Airborne System was carefully inspected and checked. It was then discovered that when the fuel ullage tank pressure read 60 psig, the sensing pressure to the fuel airborne regulator only read 44 psig. A further check revealed that the fuel airborne relief valve was experiencing a sensing pressure leak, which in turn was depleting the sensing pressure to the fuel airborne regulator. The troubles were corrected by replacing the fuel airborne relief valve.

Complex Mechanical

Fuel and LO2 dual tankings were performed on 30 September 1960. Due to the inoperative 100 percent PLCM probe standard fuel tanking procedure could not be followed. Accordingly, fuel was tanked until the 100.2 percent PLCM probe was reached in order to verify that the proper fuel leve could be attained using the PLCM overfill probe and the load cells. Prior to placing fuel into the missile, an excessive leak was found at the fuel flex duct. The adapter "O" ring had not been installed. After installation of this item, no further problems were encountered and Fuel and LO2 Tanking was successfully completed.

APPENDIX

FLUID CHEMICAL ANALYSIS

The fluid chemistry samples were taken for Missile 71D and the results were as follows:

Liquid Oxygen	Units	Sample	Specifications
Purity	Percent	99.4	99.5 Min.
Hydrocarbons			
As Methane	ppm	10	75.0 Total Max.
As Acetylene		None	0.5 Max.
Particle Count			
10 - 20	Microns	1440	No solid particles
20 - 40	Microns	600	greater than 175
40 - 80	Microns	240	microns. (Fibers
80 /	Microns	12	not defined).
Moisture Content		Not Required	
Appearance		Normal	

This item is nonacceptable.

Fuel - RP-1			
Initial Boiling	°F	363	Report
10 Percent	°F	389	365-410
50 Percent	°F	417	Report
90 Percent	°F	451	Report
End Point	°F	477	525 Max.
Residue	Percent	1.0	1.5 Max.
Loss	Percent	1.1	1.5 Max.
Gravity	°API	43.9	42.0 to 45.0
Flash Point	°F	140	110 Min.
Particle Count			
10 - 20	Microns	850	No solid particles
20 - 40	Microns	250	greater than 175
40 80	Microns	9	microns. (Fibers
80 /	Microns	9	not defined).
Fibers		25	

	Units	Sample	Specifications
Fuel - RP-1 Particle Count (Cont'd)			
175 ≠	Microns	1 (Appears to be Oxylube)	
Moisture Content		None	
This item is nonacceptable.			
Gaseous Helium			
Purity	Percent	99.9	99.9 ≠ Min.
Hydrocarbons		None	
Gaseous Nitrogen			
Purity	Percent	99.6	99.5 Min.
Hydrocarbons		None	
This item is acceptable.			
Lubricating Oil			
Viscosity	Centistokes @ 100°F	26	23.0 to 34.0
Flash Point	°F	371	280 Min.
Viscosity Index		93.8	80 Min.
This item is acceptable			
Trichloroethylene			
Appearance		Pass	Clear and Free
Color		Pass	Not red, blue, green, or purple dyed.
Odor		Pass	Characteristic
Specific Gravity	@68°/68°F	1.468	1.454 to 1.476
Distillation	°F	186	185.0 to 191.3
End Point	°F	185	199.4 Max.
Water Content		Pass	Cloudless @ ≠ 14°F
Non-volatile	Percent	.0008	0.002 Max.
This item is acceptable			

Hydraulic Fluid	Units	Sample	Specifications
Flash Point	°F	219	200 Min.
Color		Pass	Report
Viscosity	Centistokes @130°F	8.4	10.0 Min.
Water by Distillation	Percent	Cannot be measured by spec. method	0.005 Max.
Dye		Pass	
Particle Count			
10 - 20	Microns	3780	4800 Max.
21 - 40	Microns	1680	2400 Max.
41 - 65	Microns	800	800 Max.
65 - 100	Microns	100	160 Max.
100 +	Microns	10 Particles 13 Fibers 1 Particle 300 Microns	0 Max.

This item is nonacceptable.

It was decided to launch with these conditions existing.

REFERENCE DOCUMENTS

Flight Test Plan - Missile No. 71D	AZC-27-091
Detailed Test Objectives (AFBMD/STL)	STL/OR-60-0000-09013
Flight Test Directive (FTWG)	AA 60-0064

Additional reports which may be referenced for further information regarding this missile are listed below:

Reports	Approximate Issue Date (time after test)
Convair - Astronautics, San Diego, Calif.	
Flight Test Evaluation Report	14 Days
AFBMD/STL, Inglewood, Calif.	
Flight Summary Report	8 - 12 Weeks
ARMA, CCO	
CCO Quick Look Report	7 - 10 Days
American BOSCH ARMA Co., Garden City, N. Y.	
Flight Test Evaluation Report	30 Days
General Electric, Philadelphia, Pa.	
Evaluation Report	30 Days
General Electric Syracuse, N. Y.	
Evaluation Report of Mod III Instrumentation System With Missile 71D	6 - 10 Weeks
Acoustica Associates, Los Angeles, Calif.	
Final Test Report	30 Days

SERIAL NUMBERS OF SYSTEM COMPONENTS

AZUSA TRANSPONDER, Serial No. 731-0020

REENTRY VEHICLE, Serial No. 423

RANGE SAFETY COMMAND SYSTEM

Range Safety Command Receiver No. 1, Serial No. AF 58-165

Range Safety Command Receiver No. 2, Serial No. AF 58-169

Range Safety Command Receiver, No. 1, Battery, Serial No. 009-0051

Range Safety Command Receiver No. 2, Battery, Serial No. 009-0052

Range Safety Command Power and Signal Control Unit, Serial No. 9

PROPULSION SYSTEM

Sustainer, Serial No. 222109

Booster, Serial No. 112109

Vernier No. 1, Serial No. 332218

Vernier No. 2, Serial No. 332083

ELECTRICAL SYSTEM

Missile Main Battery, Serial No. 001-0462

Inverter, Serial No. 907-0044

Power Changeover Switch, Serial No. 003-0001

MODULE INSTRUMENTATION BEACON SYSTEM

Rate Beacon, Serial No. 4E1072

Pulse Beacon, Serial No. 6E1015

TELEMETRY SYSTEM

Telemeter RF No. 1, Serial No. 9030

Telemeter RF No. 2, Serial No. 9925

Telemeter RF No. 3, Serial No. 9929

Telemeter RF No. 1, Battery, Serial No. 002-0191

Telemeter RF No. 2, Battery, Serial No. 002-0197

Telemeter RF No. 3, Battery, Serial No. 002-0192

Accessory Package, Serial No. 9

FLIGHT CONTROL SYSTEM

Gyro Canister, Serial No. 4

Filter-Servo Amplifier Canister, Serial No. 7

Programmer, Serial No. 18

PROPELLANT UTILIZATION SYSTEM

Canister, Serial No. 043

INERTIAL GUIDANCE SYSTEM

Platform, Serial No. 7110017

Control, Serial No. 7120010

Computer, Serial No. 7130011

Analog Signal Converter, Serial No. 7150022

Digital Signal Converter, Serial No. 7140033

OPTICAL BEACON SYSTEM

Unit, Serial No. 006-0019

Battery, Serial No. 001-0002

SIGNIFICANT DATES DURING TESTING OF "A" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
4A	12-8-56	14	3-22-57	6-3-57	6-11-57	895	Engine shut down at 29.9 seconds of flight. Missile destroyed at 50.1 seconds.
6A	4-4-57	14	8-2-57	9-20-57	9-25-57	1422	Engine shut down at 47.7 seconds of flight. Missile destroyed at 74 seconds.
12A	11-1-57	14	11-20-57	12-11-57	12-17-57	2148	Successful flight. Impacted approximately 490 nm downrange.
10A	7-18-57	12	9-27-57 10-27-57 11-6-57	*11-27-57 **12-10-57 1-4-58	1-10-58	10	Successful flight. Impacted approximately 542 nm downrange.
13A	12-4-57	14	1-17-58	***1-31-58	2-7-58	222	Engine shut down prematurely at 117.8 seconds of flight due to flight control system failure. Missile broke up at 167 seconds.
11A	12-28-57	12	1-25-58	2-8-58	2-20-58	449	Engine shut down prematurely at 124 seconds of flight due to flight control system failure. Missile broke up at 126.5 seconds.
15A	1-6-58	14	2-26-58	3-22-58	4-5-58	634	Engine shut down prematurely at 105 seconds of flight due to B1 turbopump failure. Missile remained intact and impacted approximately 200 miles downrange.
16A	2-5-58	12	3-17-58	****4-18-58 5-22-58	6-3-58	1261	Successful flight. Impacted approximately 480 nm downrange.

* Premature cutoff at 8 seconds. Both booster chambers damaged, necessitating replacement.

** Full duration, but damaged B1 chamber, necessitating replacement.

*** FRF terminated prematurely, but considered satisfactory.

**** Prematurely terminated due to APS shutdown.

SIGNIFICANT DATES DURING TESTING OF "B" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3B	4-12-58	11	5-29-58	*6-23-58 **6-27-58 7-8-58	***7-12-58 7-19-58	1564	Missile broke up at 42 seconds of flight. Due to failure of the yaw rate gyro.
4B	5-31-58	13	6-13-58	7-15-58	8-2-58	1382	Successful flight. Impacted approximately 2345 nm downrange.
5B	5-30-58	11	7-22-58	8-20-58	8-28-58	1383	Successful flight. Impacted approximately 2853 nm downrange. First completely closed loop guidance system flight.
8B	7-31-58	14	8-4-58	9-6-58	9-14-58	1511	Successful flight. Impacted approximately 3151 nm downrange.
6B	7-17-58	13	8-14-58	9-10-58	9-18-58	1512	B1 turbopump failed at 80.8 seconds after lift-off. Missile exploded two seconds later.
9B	8-7-58	11	9-12-58 #9-30-58	#10-4-58 ##10-24-58 ###10-27-58	11-17-58	1513	Depletion of fuel supply caused simultaneous premature sustainer and vernier shutdown. Missile impacted 800 to 900 nm short of intended impact point. First flight of modified booster turbopumps.
12B	9-4-58	14	11-8-58	11-24-58	11-28-58	1730	Successful flight. Impacted approximately 5506 nm downrange.
10B	10-22-58	11	11-20-58	****11-9-58 ****12-10-58 12-12-58	12-18-58	1729	Successful flight. Missile placed into orbit.
13B	12-4-58	14	12-5-58	12-22-58	1-15-59	30	Flight prematurely terminated due to unexplained difficulties starting at 100 seconds after liftoff. Missile impacted 170 nm downrange. There was no telemetry system aboard this missile.
11B	8-22-58	11	12-23-58	1-20-59	2-4-59	29	Successful flight. Impacted approximately 3122 nm downrange.

* Automatic cutoff initiated by sustainer overspeed/underspeed trip 1.96 seconds after BGG links break.

** Automatic cutoff initiated by sustainer overspeed/underspeed trip 1.08 seconds after BGG links break.

*** Prematurely terminated by an automatic cutoff 4.98 seconds after BGG links break.

**** Vernier ignition only.

Manual cutoff at 6.69 seconds.

After installation of "C" Series power pack in Hangar "J".

Automatic cutoff initiated by sustainer overspeed/underspeed trip 1.0 seconds after BGG links break.

Full duration, but engine compartment fire delayed schedule approximately 10 days.

SIGNIFICANT DATES DURING TESTING OF "C" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3C	10-31-58	12	11-4-58 *11-25-58	12-17-58	12-23-58	2501	Successful flight. Impacted approximately 3803 nm downrange.
4C	11-9-58	12	1-6-59	1-19-59	1-27-59	10	Although impact was close to intended point, the guidance system did not function.
5C	1-31-59	12	2-4-59	None	2-20-59	251	Missile exploded at 174 seconds due to a malfunction at staging. Probable cause was improper operation of the fuel staging valve.
7C	2-12-59	12	2-23-59	None	3-18-59	761	Booster engine shut down prematurely at 131 seconds of flight. Missile was unstable for remainder of flight.
8C	5-7-59	12	5-11-59	**5-22-59 **7-9-59	#7-15-59 7-21-59	2103	Successful flight. Impacted in target area 4385 nm downrange. RVX-2 Re-entry Vehicle recovered.
11C	7-15-59	12	7-25-59	8-14-59	8-24-59	2121	Successful flight. Impacted almost 5 miles long in MILS net due to residual thrust after vernier cutoff. Re-entry Vehicle was recovered.
9C	4-4-59	12	4-15-59 ##8-17-59	***9-24-59		2944	

* After power pack modification.

** Two successful Flight Readiness Firings performed.

*** Destroyed by fire and explosion following premature cutoff.

\# Ignition achieved twice. Manual cutoff for 1st. attempt in vernier ignition phase. Second attempt terminated by release timer.

\## Erected twice due to cancellation of test and subsequent return to hangar for storage.

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3D	2-25-59	13	2-27-59	3-27-59	4-14-59	1002	Booster section exploded 27 seconds after liftoff due to failure to close airborne LO2 fill and drain valve. Missile destroyed at 37 seconds.
7D	3-28-59	14	4-13-59	5-8-59	*5-15-59 5-18-59	1754	Missile exploded at 65 seconds due to improper launcher operation which resulted in loss of fuel tank pressure.
5D	3-8-59	13	4-28-59	5-15-59	6-6-59	1753	Missile exploded at 160 seconds due to a malfunction at staging. Probable cause was improper operation of the fuel staging valve.
11D	4-10-59	11	5-11-59	**7-14-59 7-22-59	7-28-59	2002	Successful flight. Impacted 4384 nm downrange less than 1/2 mile from target in MILS net.
14D	5-7-59	13	6-10-59	7-28-59	8-11-59	2003	Successful flight. Impacted in MILS net less than 1 mile from target.
10D	4-10-59	14	6-2-59 **7-22-59	9-3-59	9-9-59	2119	Successful flight although booster section failed to jettison. Project Mercury Capsule recovered.
17D	5-27-59	13	8-17-59	9-9-59	9-16-59	2106	Successful flight. Impacted 2 miles short of target in MILS net due to failure of vernier solo hydraulic package.
18D	5-27-59	11	9-2-59	None	10-6-59	2120	Successful flight. Impacted in MILS net less than 1/2 mile from target.
22D	8-26-59	13	9-21-59	None	10-9-59	3505	Successful flight. Impacted in MILS net less than 1 1/2 miles from target.
26D	9-18-59	11	10-8-59	None	10-29-59	2344	Due to malfunction of V2 engine at staging, impacted approximately 14 miles short of target point.
28D	9-18-59	13	10-14-59	None	11-4-59	4203	Unsuccessful. A/B IP failure prevented Station 5 IP system from acquiring the missile. Range safety cutoff caused R/V to impact approximately 260 miles short of target.
15D	5-9-59	11 ~~14~~ ~~13~~	7-11-59 9-23-59 11-7-59	None	11-24-59	2105	Successful although re-entry vehicle did not separate. Impacted in MILS net.

SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR (Cont'd)

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
28D	9-10-59	14	10-19-59	None	11-26-59	4122	Atlas/Able IV lunar probe. Atlas portion of flight was successful. Portions of Able failed at 47 sec.
31D	10-10-59	13	11-28-59	None	12-8-59	8285	Successful flight. Impacted 1/2 mile from target in MILS net.
40D	11-28-59	13	12-10-59	None	12-18-59	16	Successful flight. Delivered a Mk-2 Re-entry Vehicle within 3 nm of target point over a 5500 nm range.
43D	12-8-59	13	12-22-59	None	1-6-60	32	Successful flight. Delivered a Mk-3 Re-entry Vehicle within 3 miles of target point over a 5500 nm range.
44D	12-17-60	13	1-11-60	None	1-26-60	54	Successful flight. RVX4-A2 Re-entry Vehicle impacted approximately 1/2 mile from target in MILS net.
49D	1-5-60	13	1-28-60	None	2-11-60	320	Successful flight. Mk-3 Re-entry Vehicle impacted less than 1 1/2 nm from target over a 5500 nm range.
29D	10-10-59	14	1-18-60	None	2-26-60	304	MIDAS I Booster shot. Atlas portion of flight was successful.
42D	12-5-59	11	12-21-59	#2-4-60 2-23-60	##3-4-60 3-8-60	17	Successful flight. First missile to use all-inertial guidance system open loop.
51D	1-29-60	13	2-15-60	None	3-10-60	775	Destroyed by fire and explosion immediately after liftoff.
48D	2-19-60	11	3-10-60	None	4-7-60	301	Destroyed in the stand by fire and explosion during a launch attempt.
56D	3-3-60	12	4-11-60	None	###5-12-60 5-20-60	1885	Successful flight. Delivered Mk-3 Re-entry Vehicle within 4 nm of target point over an extended range of 7859 nm.
45D	1-26-60	14	3-2-60	None	5-24-60	619	MIDAS II Booster shot. Atlas portion of flight completely successful.
54D	2-25-60	11	5-13-60	None	6-11-60	615	Successful flight. Delivered Mk-3 Re-entry Vehicle 4306 nm downrange within 2.2 nm of target. First flight with AIG system providing active guidance functions.

SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR (Cont'd)

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comment
62D	4-19-60	14	5-26-60	None	6-22-60	801	Impacted approximately 18 nm long due to failure of the vernier engines to shut-down when the guidance cutoff discrete was received.
27D	5-27-60	12	6-4-60	None	6-27-60	1002	Successful flight. Impacted within 1 nm of target in MILS net 4388 nm downrange.
60D	4-5-60	11	6-14-60	None	7-2-60	803	Inadvertent pressurizations of the engine tanks caused premature depletion of control helium. Re-entry vehicle impacted 40 nm short.
50D	5-17-60	14	6-30-60	7-21-60	7-29-60	1505	Unsuccessful. Missile apparently destroyed after 60 seconds of flight. Mercury Capsule remained intact until impact.
32D	6-22-60	12	7-1-60	None	#####8-2-60 8-9-60	1003	Successful flight. Impacted within 4 nm of target in South Atlantic Ocean over the intermediate range of 6350 nm.
66D	6-14-60	11	7-7-60	None	8-12-60	1004	Successfully impacted re-entry vehicle within 2 nm of target. First Atlas to use AIG System with impact programmed for Station 12 MILS net.
76D	7-6-60	11	8-15-60	None	9-16-60	2817	Successfully placed RVX-2A Re-entry Vehicle within 5 nm of target. Second Atlas to use AIG System with impact in Station 12 MILS net.
79D	7-13-60	14	8-26-60	None	*****9-15-60 9-19-60	802	Successful flight. Second Atlas to deliver a Mark 3 Re-entry Vehicle to target over an extended range of 7863 nm.
80D	8-13-60	12	9-2-60	None	9-25-60	2801	Atlas/Able V lunar probe. Atlas portion of flight was successful. Second stage engine operation unsatisfactory.

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SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR (Cont'd)

* Launch aborted due to faulty release timer which initiated automatic cutoff.

** Test terminated by sustainer rough combustion cutoff circuitry.

*** Returned to hangar for booster power package replacement.

**** Launch aborted 5.45 seconds after sustainer flight lockin because no release signal was generated.

@ Return due to Guidance System difficulties.

Engine cutoff prior to release due to erroneous callout in blockhouse.

Terminated by erroneous output from B3 primary RCC accelerometer.

Terminated 1.53 seconds after sustainer flight lockin by the sustainer RCC system.

SIGNIFICANT DATES DURING TESTING OF "E" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3E	5-19-60	13	7-29-60	*9-23-60 10-3-60	10-11-60	1502	Malfunction in sustainer hydraulic system caused loss of missile after staging.

B2 lube oil pump shaft sheared. Test duration 14 seconds.