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Test Report AA 60-0087
25 August 1960

ENGINEERING CORRESPONDENCE
CONVAIR ASTRONAUTICS
POST OFFICE BOX 1128
SAN DIEGO 12, CALIFORNIA

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WS 107A-1 FLIGHT TEST WORKING GROUP

FLIGHT TEST REPORT

ATLAS MISSILE 66 D

12 AUGUST 1960

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FOREWORD

This report has been prepared to present preliminary information relative to the flight of Atlas Missile No. 66D. 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.

Prepared by: Data Operations, Convair Astronautics, AMR.

R. E. Payne
Head of WS 107A-1 Project Office
Space Technology Laboratories, Inc.
AMR, Florida

K. E. Newton
Chief Test Conductor, AMR
Convair (Astronautics) Division
General Dynamics Corporation

R. W. Taylor
Responsible Representative
WS 107A-1
Rocketdyne, AMR, Florida

F. R. Radcliffe
Chief Test Conductor
General Electric, (DSD)
AMR, Florida

W. H. Caldwell
Manager, Test Operations
Ballistic Missile Division
Burroughs

Howard R. Sloan
Resident Senior Engineer
Acoustica Associates

J. N. Farrentine
WS 107A-1 Flight Test Engineer
GE (MSVD)

M. H. Allen
Test Operations Section Head
American Bosch ARMA Corp.

R. R. Wignall
Colonel, USAF
Commander

[redacted]

SUMMARY

Atlas Missile 66D was launched at 0800 EST, on 12 August 1960, from Complex 11, at AMR. The range for this flight was 4387 nautical miles. This was the first Atlas using the all inertial guidance system with impact programmed for the MILS net at AMR Station 12. Guidance System operation was satisfactory and impact was less than two nautical miles from the target.

Recovery of the RVX-2A Re-entry Vehicle was planned, however, this was not accomplished. The vehicle sank after impact. The parachute was deployed and impact was observed near the recovery ship, but the vehicle was not sighted after impact.

Discrepancies were apparent in the flight control, re-entry vehicle, and propellant utilization systems, however they did not compromise the flight and the primary test objectives were satisfied.

A special study of thrust section temperatures revealed only localized heating at the fireshield and no general temperature rise was observed.

Due to the spurious re-pressurizations of the engine LO2 and fuel tanks during the flight of Missile 60D and one spurious re-pressurization following an attempted launch on Missile 66D, the normal re-pressurizing circuit was by-passed and the booster cutoff relay output was used to initiate re-pressurization on this flight. The normal re-pressurization circuit was instrumented in an effort to localize any spurious signals. None were observed and re-pressurization was normal.

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FLIGHT TEST OBJECTIVES

The primary objective for 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. This objective was satisfied.

Detailed objectives are listed on the following pages along with comments relative to the degree of satisfaction.

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
1 - First Order					
2 - Second Order					
3 - Third Order					
Weapon System Objective					
1. Demonstrate ARMA Inertial Guidance System compatibility with all associated missile sub-systems.	2	X			
2. Evaluate ARMA Inertial Guidance System performance (pre-flight and flight environment).	1	X			
3. Evaluate ARMA Inertial Guidance System's platform (IMU) performance (accelerometers, gyros, and servos and pitch and roll steering commands).	1	X			
4. Demonstrate ARMA Inertial Guidance System instrumentation and airborne and ground telemetry performance (analog and digital signal converters).	2	X			
5. Evaluate ARMA Inertial Guidance Systems digital guidance computer performance (generation of discrete signals, yaw steering commands).	1	X			

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
6. Determine ARMA GSE performance (alignment countdown set A-CS Lot II_m and associated equipment).	2	X			
7. Obtain data on ARMA system accuracy.	2	X			
8. Evaluate flight control system performance (missile stability and execution of roll programs, steering commands and discrete signals).	2	X			
9. Obtain data on blockhouse and launch control equipment performance.	2	X			
10. Obtain data on missile systems and GSE system to establish repeatibility of performance.	2	X			
11. Determine re-entry vehicle dynamic pressure distribution, vehicle loadings and vehicle motions.	2			X	
12. Determine re-entry vehicle heat shield performance with emphasis on ablation materials and design.	1			X	
13. Evaluate the missile system with regard to engine start and potential causes for combustion instability.	2	X			

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
14. Obtain data relative to causes of engine compartment abnormal heat condition.	2	X			
Non-Weapon System					
1. Obtain data on ARW-62 range safety command system performance.	3	X			
2. Obtain data on the special experiments incorporated in the re-entry vehicle.	3			X	

FLIGHT TRAJECTORY

The flight of Missile 66D was planned for a range of 4387 nautical miles. This was the first AIG missile with impact planned for the missile impact location systems (MILS) splash net area. Results indicate that impact was within 2 nautical miles of the target. A tabulation of miss distances is presented below.

	Miss Distance*	Confidence
Mod III IP	1.8 Long	Downrange 0.13 nm (1)
	1.2 Left	Crossrange 0.14 nm
SOFAR # 1	1.2 Long	± 0.1
	1.2 Left	± 0.1
Azusa	2.4 Long	Major Axis 1.82 nm (2)
	3.1 Right	Minor Axis 1.11 nm, Azimuth of Major Axis 129°

* Due to nose cone changes after fabrication of the ARMA Flight Target Constants Board, GSE target offsets were required for impact on the target called out in flight trajectory simulation case 46603. By STL directive these offsets were not inserted, and therefore a miss of approximately 0.9 nm downrange from target 46603 was expected. The impact points as presented are referenced to the target in case 46603, therefore, the ARMA system accuracy is better than indicated by 0.9 nm.

(1) Deviation of the mean.

(2) Ellipse of 95 percent confidence.

Figure I graphically represents impact points as determined from several source

A comparison of nominal flight performance parameters from flight trajectory simulation case 46603, and measured test values from Azusa and telemetry data at significant times along the trajectory are presented below:

NOTE: All times in this report are based on range zero time which occurred at 0800:10 EST.

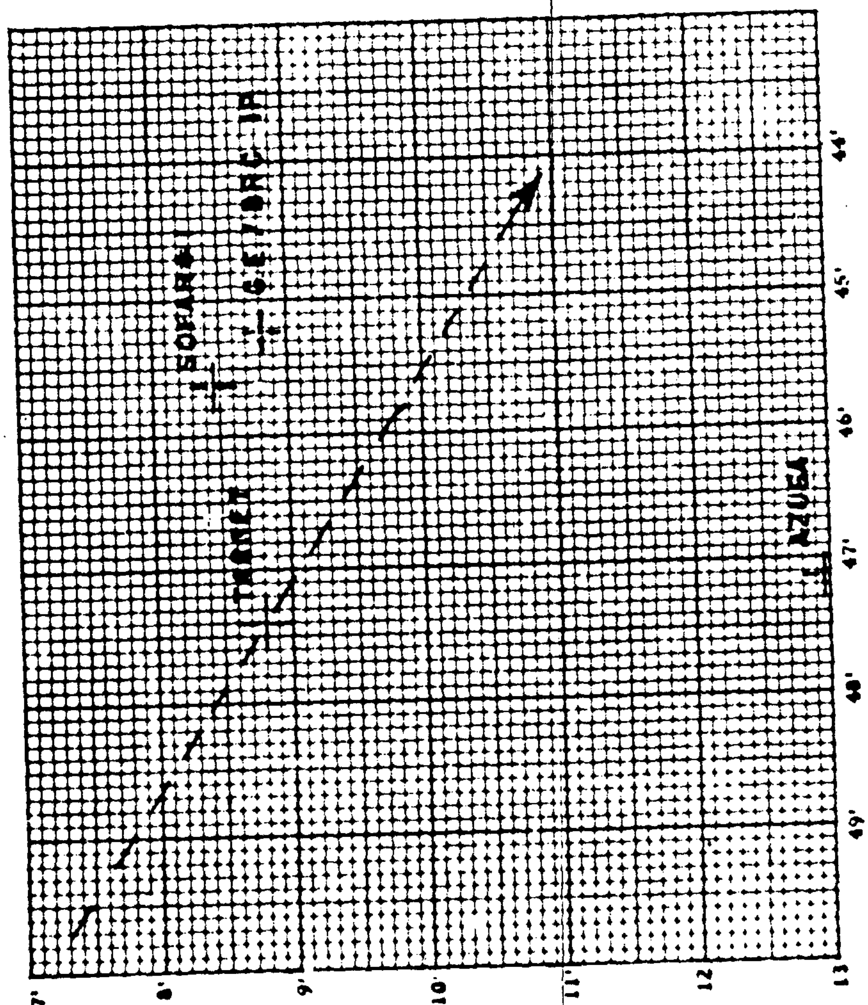
Item	Unit	Nominal	Measured
Liftoff Weight	lbs	262,953	260,395
Pitch Plane Azimuth	deg	106	106
BCO Velocity	ft/sec	10,164	10,525

Item	Unit	Nominal	Measured
BCO Altitude	ft	---	259,354
BCO Range	nm	---	50.9
BCO Time	sec	138.7	136.2
SCO Velocity	ft/sec	20,380	20,192
SCO Altitude	ft	---	911,327
SCO Range	nm	---	317.3
SCO Time	sec	271.6	259.2
VCO Velocity	ft/sec	20,314	20,175
VCO Altitude	ft	---	1,005,451
VCO Range	nm	---	365.5
VCO Time	sec	284.1	274.2
Impact Time	sec	1864**	1919.87
Impact Range	nm	4387	4388
Impact Latitude (Geodetic)	deg S	8^{o} 8.8'	8^{o} 8.4'
Impact Longitude (Geodetic)	deg W	14^{o} 47.4'	14^{o} 45.6'

NOTE: Nominal times are corrected for the difference between range zero and 2 inch motion. Measured velocity, altitude, range and impact time are taken from Azusa data. Measured impact coordinates are taken from GE/BRC impact prediction data. Measured cutoff times are taken from telemetry recordings of discrete generation. Altitude is height above launch horizontal. Velocity is speed relative to the earths surface. Range is horizontal range from the launch pad with the exception of impact range which is surface range.

** Nominal without parachute deployment.

IMPACT POINT COMPARISON



14° WEST LONGITUDE

3° SOUTH LATITUDE

FIGURE 1

SYSTEM PERFORMANCE

AIRFRAME

Structural integrity of the Airframe was maintained throughout powered flight and well beyond re-entry vehicle separation.

Booster staging and separation of the RVX-2A Re-entry Vehicle appeared to be satisfactory as indicated by autopilot rate gyro data and Jettison Section Separation, M 26 D.

Measurement A 622 I, Thrust Section Light Quad IV, rose to 5 percent at engine start and varied between 5 and 10 percent until 137.4 seconds when it rose to 40 percent IBW. The indication had then decayed to 20 percent IBW by staging. The thrust section temperature measurements usually carried on "D" Series missiles indicated no abnormal rises in temperature during the flight.

Extensive additional instrumentation was installed on this missile to further investigate the temperature environment of the thrust section and the area around the nacelles. Fifteen thermocouples were utilized for this purpose. There were also four measurements utilizing microswitches which monitored the position of the B2 upper nacelle doors. Twelve of the 15 temperature measurements remained near zero percent IBW throughout the flight. The zero percent IBW value for these measurements is 83°F.

The remaining three temperature measurements indicated temperature rises during the flight. These three measurements were located on the forward side of the heat radiation shield and immediately adjacent to the doors in Quad I for the thrust section heater and the firex nozzle, and the door in Quad II for the firex nozzle.

Measurement A 819 T, Ambient at Heater Door, began increasing at 35 seconds and reached a peak of 563°F at 48 seconds. After this time the temperature decreased slowly and had reached 126°F by booster jettison. A 820 T, Ambient at Quad I Firex Door, began increasing at 38 seconds and reached a peak of 169°F at 48 seconds. After this time the temperature decreased slowly and reached a stable 83°F at approximately 104 seconds, where it remained until staging. A 821 T, Ambient at Quad II Firex Door, began increasing at 25 seconds, and reached 373°F by 50 seconds. The temperature then decreased to 254°F at 66 seconds. An increase began again and by 82 seconds the temperature had reached 510°F. The temperature then decreased slowly to 357°F at booster jettison.

Data from the four microswitches on the two B2 upper nacelle doors appeared to be inadequate to analyze door movements during flight. Only one of the four measurements, A 813 X, Quad II Door Aft Msw, indicated the expected door position during flight.

Data from the Quad II door forward microswitch did not indicate a proper closed position at any time throughout the flight. From liftoff to 55 seconds the measurement reflected chattering and after 55 seconds indicated that the door was not contacting the microswitch.

The Quad III door forward microswitch data indicated a proper door position until approximately 30 seconds. At this time the switch started chattering and indicated a door opening far enough to deactivate the switch. These indications ceased at 85 seconds and the data then indicated that the door remained closed until staging. Data from the Quad III door aft microswitch appeared to be invalid.

The new suit case type booster boot cable clamps were utilized on this missile.

PROPULSION SYSTEM

Performance of the MA-2 Propulsion System was satisfactory.

The engine start sequence was normal and all valve and timer operating times were within specifications with the exception of the holddown timer. Release of the missile was delayed an additional 2.76 seconds after main engines complete by means of this holddown timer. Planned delay was 2.375 to 2.625 seconds. The rough combustion cutoff (RCC) systems were active during this additional time.

RCC accelerometer data recorded on the FM landline system indicated levels varying between 5 and .5 G's RMS for the 5 RCC systems on the booster and sustainer chambers during mainstage. All booster accelerometers indicated a brief disturbance during thrust buildup, occurring between -3.2 and -3.15 seconds on the B1 accelerometers and between -3.16 and -3.10 seconds on the B2 accelerometers. The acceleration level varied during these 30 G's RMS for the B2 backup RCC system, and between 25 and 40 G's RMS for the B2 primary RCC system. These levels were substantiated by oscillographic binary count data as no count was observed on the sustainer, B1 primary, and B1 backup systems. Approximately 0.5 milliseconds of count on the B2 primary system and 1.5 milliseconds of count on the B2 backup system.

Accelerometers on the booster LO2 high pressure ducting indicated levels varying between 20 and 40 G's RMS during mainstage. These data were erratic prior to and during thrust buildup and further evaluation will be required to determine the data validity. The fuel high pressure ducting accelerometers yielded invalid data. LO2 and fuel low pressure ducting accelerometer data indicated levels varying between 15 and 40 G's RMS.

Characteristics of the sustainer turbine inlet temperature as recorded on land-line were different than has been noted before. A maximum temperature of 1240°F was reached approximately 0.85 seconds after the start of the temperature rise. The temperature remained at this level for about 0.2 seconds and then slowly began to decay reaching a steady level of approximately 890°F 3 seconds later where it remained until liftoff. This is a greater change in temperature than has been observed on previous tests. Although the indicated temperature at liftoff was lower than normal (1000-1100°F) engine performance did not appear to be affected.

Missile axial thrust levels during flight were as follows:

Engine	Units	L/L At Liftoff	After Liftoff	Prior To BCO	Prior To SCO	Prior To VCO
Vernier No. 1	lbs	---	840	935	730	650
Vernier No. 2	lbs	---	835	925	725	640
Booster No. 1	lbs	152,570	155,840	182,950	---	---
Booster No. 2	lbs	152,650	153,360	181,840	---	---
Sustainer	lbs	52,720	53,875	78,725	78,550	---

Equations used for computing thrusts were:

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

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

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

Where P_o = Ambient Pressure
P_c = Combustion Chamber Pressure
ϵ = Expansion Ratio (Vernier = 5, Sustainer = 24.7, B1 = 7.9, B2 = 8.0)
A_t = Throat Area (Verniers = 2.10 in^2, B1 = 205.62 in^2, B2 = 205.47 in^2, Sustainer = 67.18 in^2)
θ = Angle of verniers from missile longitudinal axis in pitch plane.

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 re-pressurize the tanks. Pressurization at booster cutoff was normal. Instrumentation throughout the normal re-pressurizing circuit showed no spurious signals.

TIMERS AND VALVE OPERATING TIMES

(all times in seconds)

	Sequence		Test Value	Specifications
1.	BGG valve opening control signal until valve reaches full open		0.48	0.330 to 0.590
2.	Main LO2 valves opening control signal until valve reaches full open	B1	0.37	0.330 to 0.470
		B2	0.34	0.340 to 0.480
3.	Main fuel valve opening control signal until valve reaches full open	B1	0.13	0.090 to 0.170
		B2	0.13	0.090 to 0.190
4.	S HS valve opening control signal until valve reaches full open		0.65	0.480 to 0.780
5.	S PU valve opening control signal until valve reaches full open		0.59	0.480 to 0.770
6.	SGG valve opening control signal until valve reaches full open		0.44	0.340 to 0.490
7.	V Engine valve opening control signal until valve reaches full open	V1	0.49	1.500 Maximum
		V2	0.51	1.500 Maximum
8.	Ignition Stage Limiter opening control signal		2.40	2.16 to 2.64
9.	Holddown Timer		(2.76)	2.375 to 2.625

NOTE: Circled value out of specifications.

Measure-ment 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 Press								
F 1288 P	ISS Pneu Reg Out	psia	615	628	610	585	675	585
P 27 P	Engine Fuel Tank Press	psia	610	---	204	323	709	580
P 30 P	Engine LO2 Tank Press	psia	610	---	22	27	677	580
Verniers								
P 28 P	V1 Thrust Chm Press	psia	355	---	349	335	351	312
F 29 P	V2 Thrust Chm Press	psia	355	---	347	331	347	307
Boosters								
F 1125 P	B Ctl Pneu Reg Out	psia	765	764	789**	780**	---	---
F 1026 P	B LO2 Reg Ref Press	psia	572	576	555	545	---	---
F 1100 P	BGG Chamber Press	psia	441	*	468	456	---	---
F 1017 P	B2 Turbine Inlet Temp	dgf	1200	1210	---	---	---	---
F 1001 P	B1 LO2 Pump Inlet	psia	---	62	---	---	---	---
F 1003 P	B2 LO2 Pump Inlet	psia	---	58	---	---	---	---
F 1002 P	B1 Fuel Pump Inlet	psia	---	61	---	---	---	---
P 1004 P	B2 Fuel Pump Inlet	psia	---	61	---	---	---	---
P 1020 T	B1 LO2 Pump Inlet	dgf	---	***	---	---	---	---

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	dgf	---	***	---	---	---	---
P 84 B	B1 Turbopump Speed	rpm	6169	---	6138	6075	---	---
P 83 B	B2 Turbopump Speed	rpm	6189	---	6094	6040	---	---
P 1039 P	B1 Fuel Pump Outlet	psia	788	702	---	---	---	---
P 1038 P	B2 Fuel Pump Outlet	psia	820	*	---	---	---	---
P 1487 P	B1 Ign Fuel Inj	psia	---	686	---	---	---	---
P 1488 P	B2 Ign Fuel Inj	psia	---	681	---	---	---	---
P 1093 P	B1 Fuel Inj Man	psia	658	720	---	---	---	---
P 1094 P	B2 Fuel Inj Man	psia	658	717	---	---	---	---
P 1091 P	B1 LO2 Inj Man	psia	649	***	---	---	---	---
F 1092 P	B2 LO2 Inj Man	psia	649	619	---	---	---	---
F 1060 P	B1 Thrust Chm Press	psia	544	542	552	561	---	---
F 1059 P	B2 Thrust Chm Press	psia	544	544	546	558	---	---
Sustainer								
I 1344 P	Sus LO2 Reg Ref Press	psia	807	787	800	800	800	800
I 339 P	SGG Discharge Press	psia	589	---	616	592	592	---
I 530 T	S LO2 Pump Inlet	dgf	---	---	-292	-288	-289	-289

Measure-ment 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	53	---	59	114	68	23
P 1326 T	S Turbine Inlet	dgf	1100	890	---	---	---	---
P 349 B	S Turbopump Speed	rpm	9970	---	10,080	10,125	10,100	---
P 330 P	S Fuel Pump Discharge	psia	974	---	930	900	900	---
P 830 D	S Main Fuel Valve Pos	deg	29.6	---	23.4	45.1	23.4	0
P 529 D	S Main LO2 Valve Pos	Deg	---	---	39.9	29.4	34.0	0
P 351 P	S LO2 Inj Man	psia	814	---	789	784	779	
P 1006 P	S Thrust Chm Press	psia	693	660	670	670	660	---
Miscellaneous								
P 1021 T	LO2 At Breakaway Vlv	dgf	-294	-293	---	---	---	---
P 671 T	Thrust Section Amb Quad 4	dgf	---	---	64	169	53	53
P 1673 T	B1 Ign Fuel Vlv Amb	dgf	---	68	---	---	---	---
P 1674 T	B2 Ign Fuel Vlv Amb	dgf	---	70	---	---	---	---
P 1675 T	Eng Ctl Pneu Man	dgf	---	75	---	---	---	---
P 14 T	Eng Compartment Amb	dgf	---	---	58	27	36	36

* Instrumentation Malfunction ** Qualitative Only *** No Calibration

NOTE: Expected values are from Rocketdyne Design Information Manual. Individual parameters may vary from engine to engine.

PNEUMATIC SYSTEM

Performance of the Pneumatic System was satisfactory. A minor discrepancy was noted in the operation of the ISS pneumatic regulator in that the regulator locked up at a higher pressure than the normal setting after in-flight repressurization of the vernier tanks.

Missile tanks and helium bottle pressures were satisfactory prior to engine start and were satisfactorily maintained during flight.

Tank Pressurization System

Performance of the LO2 and fuel Hadley "D" Series pneumatic regulators was satisfactory as indicated by the missile main tank pressure measurements. LO2 tank pressure during the ground run cycled between 40.0 psia and 39.0 psia, and was satisfactorily maintained during flight. Fuel tank pressure during the ground run cycled between 74.1 psia and 73.5 psia, and was satisfactorily maintained during flight.

Booster tank helium bottle pressure decayed from 2927 psia at liftoff to 671 psia at booster cutoff and was adequate for tank pressurization purposes.

Engine Control Pressurization System

The ISS pneumatic regulator locked up at approximately 100 psi higher than the normal regulator setting after in-flight repressurization of the vernier tanks. The regulator outlet pressure returned to the normal regulator setting at the beginning of the vernier solo phase. This type regulator has experienced similar lockups on previous flights and this condition is prevalent during the times when a low flow rate through the regulator exists. No adverse effects were noted on this flight or on previous flights and this condition is not considered detrimental to propulsion or pneumatic system performance.

Booster control pneumatic regulator output pressure was apparently satisfactory throughout booster phase since no peculiarities were noted on other related data. Telemetry data of this measurement were considered qualitative only.

Engine control helium bottle pressure decayed from 2996 psia at liftoff to 1635 psia at vernier cutoff and was adequate for all engine control functions throughout flight.

Values taken from landline and telemetry data, at the times specified, are listed on the following page.

PNEUMATIC SYSTEMS TIME SLICE DATA

Measurement No.	Description	Units	L/L At Liftoff	After Liftoff	Prior To BCO	Prior To SCO	Prior To VCO
F 1001 P	LO2 Tank Helium	psia	40.0-39.0	39.3	24.8	22.3	22.3
F 1003 P	Fuel Tank Helium	psia	74.1-73.5	76.2	61.8	51.4	51.4
F 1246 P	B Tk Helium Btl Hi	psia	2927	2684	671	---	---
F 1291 P	S Ctl Helium Btl	psia	2996	2929	2667	2404	1635
F 304 P	Separation Btl Disch	psia	----	3098	2940	---	---
F 1125 P	B Ctl Pneu Reg Out	psia	764	780*	780*	---	---
F 1258 P	ISS Pneu Reg Out	psia	632	609	585	612	585
F 1194 P	Facility GN2 Supply	psia	1846	---	---	---	---

* Qualitative Only

HYDRAULIC SYSTEMS

Performance of the Hydraulic Systems was satisfactory. The booster hydraulic system maintained an airborne pressure of 3069 psia until booster cutoff. The sustainer hydraulic system maintained an airborne pressure of 3150 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 3150 psia. This pressure had decreased to 875 psia by vernier cutoff. The accumulator bottomed out when the pressure reached 805 psia, 2 seconds after vernier cutoff, and 17 seconds after sustainer cutoff. The accumulator gas precharge was 1000 psig.

MISSILE ELECTRICAL SYSTEM

Missile Electrical System performance was satisfactory. Telemetered data indicated that satisfactory a-c and d-c electrical power were supplied until re-entry vehicle separation. System parameters remained within specifications at all times. The changeover from complex external power to missile internal power was accomplished without incident.

Missile main battery voltage remained between 26.73 and 27.95 vdc, and inverter phase A and phase C voltage remained between 114.45 and 115.06 vac and 114.75 and 115.16 vac, respectively, over the time interval from engine start to re-entry vehicle separation. Inverter frequency remained between 400.00 and 401.20 cps during this interval. Minor inverter frequency transients occurred at engine start, booster, sustainer and vernier engine cutoff, re-entry vehicle separation and retro-rockets firing.

The 115 vac phase B voltage, as measured at the guidance system, showed several flucuations of as much as 2.5 volts coincident with ARMA steering functions. It is not known whether these are true reflections of the voltage level or are due to the method of instrumentation.

RANGE SAFETY COMMAND SYSTEM

Performance of the Range Safety Command System was satisfactory. Automatic and manual fuel cutoff command signals were received and properly decoded during the flight. Telemetered r-f input/agc data indicated that the received signal strength was adequate to maintain proper system operation from launch until after re-entry vehicle separation.

The automatic sustainer cutoff signal was generated correctly by Station 1 (GMCF No. 1) A-1 computer as a backup sustainer cutoff signal at 259.563 seconds and initiated sustainer cutoff. This signal was decoded by the air-borne system at 259.639 seconds. The manual fuel cutoff signal was planned for 320 seconds and was decoded at 320.056 seconds.

AZUSA SYSTEM

Performance of the Azusa System was satisfactory. A type B-1A coherent carrier transponder and a tripod antenna were carried on this flight. Real time impact prediction plots were obtained during powered flight and trajectory information was obtained until 360 seconds.

Solid r-f lock was acquired at 22 seconds and all ambiguities in the fine cosine channels were resolved by 48 seconds. No further resolutions were required for the remainder of the flight.

During the countdown AMR reported a "GO" transponder. Recovery, modulation, and coherency were satisfactory. Telemetry data indicated that the Klystron power output, Klystron Beam Voltage and RF Input/AGC were within specifications and transponder can gas temperature was normal during flight.

Azusa Mark II tracked passively during this flight.

FLIGHT CONTROL SYSTEM

Flight Control System operation was adequate to maintain missile stability and to perform the required control functions. However, a 5 cps bending oscillation occurred in the yaw plane during booster phase which is unexplained at this time. The bending started at 80 seconds and was evident until 130 seconds. Thrust chamber displacements at engine start were within the applicable tolerance of ≠ 0.6 degrees. Satisfactory pitch and roll programs were accomplished. Propellant slosh during booster phase and engine movements at booster cutoff and during staging were normal. Response to guidance steering commands during sustainer phase was satisfactory. Programmer recycling after retro-rockets firing was again evident and was similar to that observed on Missile 54D.

Thrust chamber displacements at engine start were within the applicable tolerance of ≠ 0.6 degrees. It was planned for the autopilot programmer to generate a roll program of 93.98 degrees to roll the missile to an azimuth of 101.27 degrees true. Following this the guidance system was to generate a five degree roll correction to give a true flignt azimuth of 106.27 degrees. Flight control system data and radar plots indicated satisfactory accomplishment of the roll and pitch programs. The short duration high frequency vibration which has been observed on previous D-AIG missiles at approximately 35 seconds, was evident at 34 seconds with the largest disturbance occurring in roll, as has been the case on the previous flights.

The excessive missile bending in yaw observed during the booster phase began building up at approximately 80 seconds at a frequency of 4.6 cps. At 112 seconds it reached a maximum value, as indicated by the yaw rate gyro output, of 7.9 degrees per second, peak-to-peak, with a frequency of 4.8 cps. This bending was accompanied by booster and sustainer thrust chamber movement in yaw which reached peak-to-peak values of 2.2 degrees and 0.60 degrees respectively. At 113 seconds the rate gyro data indicated a shock with an abrupt reduction in yaw rate gyro output to 1.8 degrees per second, peak-to-peak, at the same time the experiments in the re-entry vehicle were energized. Following the reduction in yaw rate output an oscillation in pitch developed which was reflected by a pitch rate gyro output of 0.60 degree per second, peak-to-peak, at a frequency of 4.8 cps. This bending decayed to zero in eight seconds. Following the shock, the yaw bending again diverged with a maximum rate gyro output of 3.1 degrees per second, peak-to-peak, at 121 seconds. This bending was damped out by 130 seconds.

The bending instability is presently under investigation. A 5 cps bending mode during the booster phase was noted on the flights of Missiles 44D, 49D and 56D. However, on these flights maximum rate gyro output was less than 2.8 degrees per second, peak-to-peak.

Failure of the pitch displacement gyro telemetry measurement was evident at approximately 106 seconds, however, proper gyro operation was substantiated by other flight data.

Re-entry vehicle separation was not readily discernible on the rate gyro traces on this flight as this vehicle does not utilize a torsion bar to impart spin at separation. Measurement S 248 X, which normally monitors the vehicle separation signal monitored the umbilical disconnect signal on this missile, and indicated a signal was correctly sent at 289.80 seconds, or 14.6 seconds after vernier cutoff. At 290.74 seconds a slight disturbance occurred on the rate gyro traces which was apparently re-entry vehicle separation. Retro-rocket firing was evident at 291.70 seconds indicating satisfactory completion of the separation sequence.

At 292.76 seconds (1.06 seconds after retro-rockets firing was initiated) a 28 volt short apparently occurred. The 28 volt DC power within the programmer was lost at this time, as evidenced by the dropout of the high power switches and by recycling of the programmer every 24 seconds. A similar malfunction occurred following retro-rockets firing on Missile 54D. This did not have any effect on flight performance, since all flight programmer switching was completed.

INERTIAL GUIDANCE SYSTEM

Inertial Guidance System (IGS) operation was completely successful. All discrete commands and steering commands were properly supplied. All planned data were obtained and all IGS test objectives were satisfied.

System Accuracy

1. The Mod III instrumentation system IP at the time of vernier cutoff discrete generation was 0.52 nautical miles short and 1.32 nautical miles to the left. The guidance system computer is programmed to issue the vernier cutoff discrete 0.8 nautical miles short of the target to allow for expected thrust decay. Adding this 0.8 miles to the IP at discrete generation results in apparent system miss distances at vernier cutoff of 0.18 nautical miles long and 1.32 nautical miles left.

2. Mod III system data indicate that the impact point moved 2.4 nautical miles downrange between generation of the vernier cutoff discrete and retro-rocket firing.

3. The ARMA and Burroughs data were checked for time correlation and the errors were found to be negligible. Velocity and position errors converted to target misses indicate miss distances of 2.1 nautical miles long and 1.75 nautical miles left.

Trajectory

Missile acceleration was above nominal. Sustainer cutoff occurred 11 seconds before the nominal time, and vernier cutoff 9 seconds before the nominal time. The flight path before staging was high in elevation and to the right in azimuth which is usually the case.

At staging, Z velocity was 784 feet/sec. high and Z position was 24,768 feet high with respect to the nominal trajectory. The actual values were:

	Velocities			Positions		
Function	$\dot{X}$	$\dot{Y}$	$\dot{Z}$	X	Y	Z
Nominal*	10,537	456.75	4361	518,464	61,528	234,944
Actual	10,524	412.75	5145	505,024	59,840	259,712

Discretes were issued at the following times:

Discrete	Staging	SECO	VECO	Prearm
Nominal*	138.25	271.0	283.7	
Measured	136.8	259.76	274.80	275.95

Platform and Control

The autopilot roll program for this flight produced a roll beyond the 0 degree azimuth resolver position. At 15 seconds when roll trim is supplied by the Missile Guidance Set (MGS) the azimuth resolver indicated 2 degrees left with a roll rate of 5.5°/sec. The maximum roll excursion was 3.8 degrees left from which point the roll trim returned to zero degrees without any overshoot. The roll trim was completed within the 4 seconds the MGS was in control.

Pitch steering was satisfactory. At staging the pitch resolver indicated 4 degrees high and at guidance enable 4.2 degrees high. From this point the MGS completed the pitchover to zero error in 13 seconds. The pitch resolver indicated zero error for the remainder of the powered flight.

Servo errors were all within one minute throughout powered flight which is satisfactory.

The performance of the gyros was satisfactory and consistent with previous history. The gross gyro drifts, which were measured prior to launch were:

Azimuth	+ 1.47°/hr	(Precount)
Pitch	- 0.598°/hr	(X-1 Day)
Roll	+ 0.042°/hr	(X-1 Day)

The roll-azimuth gyro 602 temperature at the time of the azimuth gross drift measurement was 0.92°C below buoyant temperature. Gyro temperatures during flight were:

Gyro	Buoyant Temp.	Temperature Variation From Buoyancy -10 min	-10 sec	Veco
601 Pitch	66.53°C	+1.22	+1.35	+1.35
602 Roll-Az	70.3°C	-0.95	-0.70	-0.95

* From Trajectory simulation case 46603

Redundant gyro torquing current was maximum between 90 to 105 seconds and at staging, with peak amplitudes of $+47^{\circ}$/hr to -44°/hr. The torquing current after vernier cutoff was below the inhibit level.

The performance of the accelerometers was satisfactory. Scaling measurements made during the tests prior to and on the launch day were very consistent. Scale factors which were measured during the precount and countdown operation were as follows:

Accelerometer	X	Y	Z
Scale Factor cps/ft/sec^2	1.99981	2.00129	1.99944

Temperature control was satisfactory. From liftoff to 10 seconds the mag amp output was maximum. From 12 to 52 seconds the mag amp was off indicating that the platform was over temperature. For the remainder of powered flight the mag amp was in control.

Telemetered information indicated there was no change in binnacle pressure. However, the range and calibration of the pressure transducer on this missile was not known.

MGS Voltages were satisfactory. The oscillator amplifier power supply voltage (-22.5 VDC) was constant at 21.9 volts from AIM to 113 seconds. At this time a small transient occurred which was also present on all other voltages. The voltage returned to its original level for the remainder of powered flight. The 115 volt phase A output was constant at 114.7 volts except for a 1 volt rise and return at 113 seconds. The 115 volt phase C output was constant throughout the flight. The 115 volt phase B output had some variation from a nominal 115V throughout the flight. The largest excursion, a 2.5 volt drop, occurred from 135 to 155 seconds.

There were no vibration pickups installed on this flight. However, an examination of the double discriminated accelerometer strings gave an indication of platform vibration. At liftoff there was a 5 cps 1.5g p-p vibration in Z axis. From 85 to 130 seconds an oscillation in Y and Z axis occurred with a maximum at 110 seconds of approximately 1.5g. The X accelerometer indicated a short 2g vibration at staging and 3g at sustainer cutoff.

Computer

Computer operation was satisfactory and there were no computer malfunctions.

All discretes were properly issued. Booster cutoff was issued properly by the MGS computer. The computer issued a sustainer cutoff discrete, but the Automatic Sustainer Cutoff (ASCO) signal was received at the missile 120 milliseconds before the MGS cutoff signal was generated, and ASCO effected sustainer cutoff.

ASCO occurred when the Instantaneous Impact Point was 100 nm uprange. Sustainer cutoff was programmed to (and did) occur at 90 nm uprange. Slightly early ASCO has no effect on the computations. Vernier cutoff and prearm were issued properly by the MGS computer.

Yaw steering, as in prior flights, consisted essentially of just two commands. At guidance enable the missile was turned left approximately six degrees. After 12 seconds a six degree right turn was made and with one overshoot the missile was on course with CEF zero.

The computer power supply voltages as measured during flight were as follows

Power Supply

Time	-10V	-16.5V	-50V	+38	+4
Before Computer Start	-10.0	-17.18	49.0	37.3	4.2
After Computer Start	-10.12	-16.80	49.0	37.3	4.0
+2.0 sec. (Vernier ph)	-9.64	-16.80	48.6	37.3	4.0

At 113 seconds all voltages except the -10V shifted in accordance with the change in the 115V 400 cycle phase A. All variations were within specifications.

The computer temperature was 31.2°C at the start of the flight test, slowly increasing to 36°C at vernier cutoff. This variation is satisfactory.

Correct operation of the computer was established by means of Data Checker tests using tape recorded accelerometer and digital signals. These tests indicated that the computer performed its calculations correctly.

Alignment-Countdown Set

Alignment-Countdown Set (A-CS) performance was satisfactory. No difficulties were experienced during precountdown or countdown operations.

The blockhouse Sanborn recorder idicated the alignment errors shown below existed at launch. The magnitude of these errors is considered satisfactory.

		Measured	Specified Tolerance
Azimuth Alignment		4.8 sec	± 20 sec
Tilt:	Roll pendulum	1.0 sec	± 15 sec
	Pitch pendulum	0.9 sec	± 15 sec

The A-CS satisfactorily maintained the accelerometer zeros to the required ± 0.002 cps. as shown below. All figures are in cps.

Function	Nominal	Compensated Nominal	Measured	Error
X offset	0.667	0.69387	0.69303	-0.00084
X	1.000	---	0.99971	-0.00029
Y	1.000	---	1.00176	+0.00176
Z	65.254014	65.23634	65.23808	+0.00174

The compensated nominal is the value calculated during the countdown to compensate for measured system variations. Of the error shown in Z, the portion due to missetting of the A-CS is 0.00023 cps.

Instrumentation

The Analog Signal Converter (ASC) performance for this flight was satisfactory. All 31 channels functioned normally.

ASC temperature increased from 17.5°C at launch to 18°C at vernier cutoff.

Digital data transmission was satisfactory during the entire flight (guidance phase) and indicated normal functioning of the Digital Signal Converter (DSC).

MOD III E INSTRUMENTATION BEACON SYSTEM

Performance of the Mod III E Instrumentation Beacon System was satisfactory. The missile was tracked off the pad in the automatic monopulse mode and tracking was continous until 353 seconds.

The A-1 computer performance was satisfactory throughout the flight. Preliminary evaluation indicates that the Automatic Sustainer Cutoff (ASCO) signal was received at the missile before the guidance discrete signal.

Performance of the individual subsystems was as follows:

Track Subsystem

Track Subsystem performance was satisfactory. The missile was tracked off the pad in monopulse mode and tracking was continuous until 78 seconds after vernier cutoff. At this time (352.8 sec.) track went into memory for 11 seconds and then re-acquired the beacon. The low signal experienced during this memory period is associated with missile attitude change after nose cone separation. After the memory period, tracking in monopulse was maintained to the limit of range at 398.8 seconds.

The tracking characteristics for the first 60 seconds were typical with monopulse errors of 1.0 mils, peak-to-peak. After this the monopulse errors decreased to 0.10 mil, peak-to-peak, and except for the memory periods, remained at 0.10 mil until the end of the test. The received signal varied from -58 dbm early in sustainer period to -66 dbm near the end of guidance. The average was -62 dbm.

Rate Subsystem

The performance of the rate subsystem was satisfactory. Rate lock was typically intermittent for the first 19 seconds of flight. Except for a short period of a few seconds following booster cutoff, rate was solidly locked until 73 seconds after vernier cutoff. The agc's averaged -85 dbm at first and gradually went down to -92 dbm at 347 seconds. During the last 53 seconds of tracking rate was solidly locked except for two ten-second intervals starting at 347.5 and 378.2. The signal level in the last period was quite low, averaging between -100 and -105 dbm for the locked portions of the period.

A-1 Computer

The computing system functioned satisfactorily during the countdown and flight periods. There were no known equipment malfunctions.

The following impact position data are based on nominal re-entry effects:

	Mean Miss Distance	Standard Deviation	Standard Deviation of the Mean
Downrange	1.81 nm Long	0.51 nm	0.13 nm
Crossrange	1.18 nm Left	0.57 nm	0.14 nm

The Automatic Sustainer Cutoff signal was generated and transmitted to the AMR lines at 0804:29.563 EST or at 259.563 seconds Range Time. The instaneuous IP was approximately 38 nm uprange from target when ASC was effective (sustainer thrust was zero).

RE-ENTRY VEHICLE

An RVX-2A Re-entry Vehicle, Serial Number 421, was flown on Missile 66D. The vehicle was not recovered. Nearly all re-entry data were lost due to a failure of the playback link about 4 seconds after the end of the re-entry blackout. A premature ground on the separation ground bus turned on four of the experiments early. The 5 volt power supply was shorted shortly after re-entry. Intermittent telemetry reception was recorded by the aircraft for approximately 11 seconds after impact. The C-band beacon was tracked by Stations 1, 3, 4, and 12.

Powered Flight and Separation

All on board equipment which was monitored in the blockhouse or via telemetry was functioning properly at liftoff with the exception of J-29 (fuel cell). The fuel cell could not be charged prior to liftoff due to a short in the fuel cell or harness wiring. Coincident with the sudden decay in yaw bending at 113 seconds J-30-1, J-30-2, J-22, and J-43 were energized. These are normally energized by the closing of the separation switch which supplies a ground to a relay which then is electrically held in. An intermittent ground on any of these experiments, or in the harness, or an intermittent closing of the separation switch would account for this failure.

The separation switch closed approximately 7 seconds before the inflight connector was released. The time of separation switch monitor is prior to sending of the release payload signal by the airframe. The inflight disconnect monitor matches the time when the signal was sent by the autopilot.

The following is a list of events and times of reception.

Experiments energized	113.0 seconds
Separation Switch Monitor	282.5 seconds
Inflight Connector Separation	289.8 seconds

Telemetry

The telemetry system appeared to function properly until after re-entry blackout. The playback transmitter signal strength did not return to normal after blackout and dropped to zero approximately 4 seconds after the end of blackout.

During re-entry the programmer switched the sensors from fine to coarse. This is programmed by a lateral 5g switch. The sensors did not switch back to fine and the telemetry system was not turned off at impact. Subsequent to the flight it was discovered that the programmer was mounted in the vehicle backwards. These latter events are programmed by 15g and 25g deceleration switches.

Approximately 9 seconds after the end of blackout the 5 volt power supply failed due to a short across its output. This caused the loss of the rate gyros, and the pressure and temperature monitors that used the 5 volts as excitation voltage. It is believed that the short was caused by a greater than expected ablation of the transmissibility sensor.

Recovery Sequence and Search

Two aircraft and one ship were stationed in the impact area for the recovery operation. Only one aircraft had telemetry reception capability. The following are the positions of the aircraft and ship at impact. The sky was clear and the sea state was a code 4.

ORV Lima	A/C No. 1	C-130
08°05'S	07°56'S	08°21'S
14°50'W	14°39'W	15°51'W

The aircraft and ship reported seeing re-entry and observing the vehicle with the chute deployed. Both Station 12 and the ship reported 400 cps tone reception which indicated recovery basket separation. Telemetry indicated correct sequencing of the recovery system events up to recovery basket separation. All monitoring of the recovery systems ceases at this time because electrical connections between the recovery system and the vehicle are broken. Station 12 reported radar chaff reception with the Mod II radar.

At loss of telemetry signal the search was commenced with no sighting of the balloon, fluourescent dye marker, aluminum dye marker or reception of the SARAH beacon reported. The first SOFAR bomb detonation was reported as occurring at 0350 EST. This would be the bomb that is ejected after recovery basket separation. At 0901 EST a second SOFAR bomb detonation was recorded. This would be the bomb that remains in the vehicle and indicates that the vehicle sank.

Preliminary evaluation of the recovery sequence operation as recorded on telemetry indicates proper operation of the portions of the recovery system that are telemetered It definitely shows chute ejection, chute de-reefing and basket separation. Sighting of chaff and the time of the first bomb detonation are also indications that the recovery basket separated from the vehicle. No monitors of balloon inflation or balloon tether line cutting are made.

After the re-entry vehicle impacted, as indicated by almost simultaneous loss of telemetry signal at Station 12, ORV Lima and A/C No. 1, the aircraft reacquired intermittent telemetry for 11 seconds. This indicates that the vehicle floated for at least 11 seconds before sinking.

The following is a list of re-entry and recovery events as recorded on telemetry or as reported by the Range.

End of Blackout	1908.3 seconds
Loss of Playback Link	1912.0 seconds
Recovery Timer Start	1922.0 seconds
Rear Cover Off	1927.8 seconds
Chute Eject (Monitor)	1929.5 seconds
Chute Out (Long. Accel.)	1930.4 seconds
Chute De-reefed (Long. Accel.)	1934.5 seconds
Recovery Basket Separation	1945.0 seconds
Loss of T/M (ORV Lima)	1993.8 seconds
Loss of T/M (Station 12)	1994.2 seconds
Loss of T/M (Aircraft)	1994.8 seconds
Telemetry Blip (Aircraft)	1998.5 seconds
Telemetry Reacquisition (Aircraft)	1999.8 seconds
Telemetry Loss Of Signal (Aircraft)	2003.2 seconds
Telemetry Reacquisition (Aircraft)	2005.0 seconds
Final Loss of Telemetry (Aircraft)	2006.0 seconds
SOFAR No. 1	2990.0 seconds
SOFAR No. 2	3650.0 seconds

CONVAIR PROPELLANT UTILIZATION SYSTEM

Performance of the Convair Propellant Utilization (PU) System was adequate, however, two pecularities were noted in the Error Demodulator Output (EDO) data. PU valve response to the EDO signal was correct in direction throughout the flight.

During booster phase the general trend of the EDO was a change from a 1.4 percent LO2 rich error at 1.5 seconds to a greater than 5.8 percent fuel rich error at 116 seconds. The EDO was essentially at null between 36 seconds and 72 seconds. Between 116 seconds and 193 seconds EDO data were beyond the instrumentation limit of 5.8 percent fuel rich.

A peculiarity was noted between 50 and 56 seconds in that the EDO signal indicated a momentary 4.6 percent fuel rich error for unknown reasons. The PU valve responded by opening to 42 degrees.

At booster separation LO2 and fuel tank head pressures indicated the transient conditions usually observed at this time, however, LO2 tank head pressure (which is normally beyond the instrumentation limit during booster phase) returned to 100 percent IBW momentarily. At a corresponding time the EDO signal momentarily surged from its saturated fuel rich error to a saturated LO2 rich error. Immediately following this transient the PU valve responded by moving momentarily from the open electrical limit towards a closing position.

The general trend of the EDO signal during sustainer phase was a change from the excessive fuel rich error, which was created during booster phase, to a LO2 rich error with the signal crossing null at 212 seconds. The EDO during the last 36 seconds of sustainer operation oscillated with a mean error of approximately 2.4 percent LO2 rich. These oscillations were attributed to propellant sloshing since LO2 and fuel tank head pressure data had similar characteristics. PU valve response during sustainer phase was proper. During the last 35 seconds of sustainer operation the PU valve was intermittently against the mechanical stop due to EDO oscillations.

Neither the LO2 nor fuel head sensing port uncovered prior to sustainer cutoff. Head pressure data indicated the remaining burnable propellants were approximately 2690 pounds of LO2 and 1270 pounds of fuel at sustainer cutoff. This is equivalent to approximately 14 seconds of additional sustainer operation.

Missile 66D utilized Matched Set Number 305.

The following constants were applicable:

PU Valve Control Limits

Open Electrical Limit	48.8 Degrees
Nominal Angle	29.6 Degrees
Closed Mechanical Limit	23.4 Degrees
Closed Electrical Limit	23.4 Degrees
EDO Sensitivity	0.870 VDC/ 1 Percent

PROPELLANT TANKING

The missile was satisfactorily tanked utilizing the Acoustica Propellant Loading Control Monitor (PLCM) as the primary tanking system.

Fuel tanking was accomplished on 10 August 1960, X-1 Day for the scheduled launch. The launch was rescheduled for 12 August 1960 and the fuel was left aboard in the missile. Flight level was obtained by tanking midway between the 100 and 100.2 percent PLCM probes. The Propellant Loading Control Unit (PLCU), load cells, and flow totalizer served as backup systems. Flow totalizer data were invalid with excessive error. Correlation among the other weight indicating systems was satisfactory. Changing fuel density between the tanking and X-Day dropped the fuel level below the 100 percent PLCM probe, however it was decided not to retop the fuel to flight level.

LO2 tanking was accomplished during the countdown. Flight level was obtained by tanking to the 100.2 percent PLCM probe plus 550 pounds. The PLCU and load cells served as backup systems. The load cells indicated a loss of only 50 pounds from the time tanking was secured to ignition. The normal loss of weight during this time is approximately 400 pounds. The Error Demodulator Output (EDO) indication was very high at ignition (2.77 percent LO2 rich) and is considered invalid. Conversion from the EDO signal to weight could not be made.

The following tabulated data reflect the correlation between the desired and measured weights as indicated by the various systems for both loading operations.

	Units	Desired[1]	PLCM	PLCU	Load Cells
LO2 at Ignition	lbs.	174,481	174,831	----	174,976
Fuel at Ignition	lbs.	75,777	75,777	75,777	75,551
Missile Wet Weight[2]	lbs.	15,727	15,727	----	15,727
Ignition Weight	lbs.	265,985	266,335	----	266,254
Ground Run Consumption[3]	lbs.	6,263	6,263	----	6,263
Liftoff Weight	lbs.	259,722	260,072	----	259,991

1. Desired Weights are based on desired propellant weights and actual missile weight.

2. Based on the AMR weighing.

3. Based on actual ground run time and nominal flow rates.

WEATHER DATA

	Fuel Tanking	Ignition
Ambient Temperature	82.9°F	83.7°F
Barometric Pressure	30.070 In. Hg	30.020 In. Hg
Relative Humidity	80 Percent	70 Percent
Wind-Velocity and Direction	4 Knots, SSW	10 Knots, SSW
Cloud Coverage	4/10	7/10

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 values taken from the holddown cylinder pressure decay curves were within specifications. Residual pressure data were based upon zero pressures taken 5 seconds after the blowdown. This was necessary since holddown cylinder pressure data after liftoff were affected by engine blast and were erratic. Values obtained were as follows:

Event	Unit	Specification	Test Value
Release signal to 2550 psig	sec	0.5 max	0.388
Time difference between start of B1 and B2 cylinder pressure decay	sec	0.010 max	0.004
Time intercept of tangent at 2550 psig	sec	0.110 min	B1 = 0.148 B2 = 0.134
Residual pressure 0.5 seconds after 2550 psig	psig	350 max	B1 = 193 B2 = 216
Maximum differential cylinder pressure after 2550 psig	psid	400 max	240 @ B2 = 2550

EXTERNAL INSTRUMENTATION

This section describes the coverage obtained by data recording systems other than telemetry and Convair acquired landline instrumentation as reported in item 1.0-10, Preliminary Estimate of Data Coverage.

The operation of the external data system was satisfactory:

Instrumentation	66 D DTO Requirements	Test Results
Optical Coverage		
37 Engineering Sequential Cameras	4.1.5.1 and 4.1.5.2	Satisfactory with the exception of 1.2-30 which had zero coverage due to camera difficulties.
13 Metric Cameras	4.1.5.3 and 4.1.5.4	Satisfactory
Electronic Coverage		
FPS-16 (XN-1 at PAFB)	5.4.1.1	Tracked from 32 seconds to 295 seconds.
FPS-16 (XN-2 at GBI)	5.4.1.1	Tracked from 95 seconds to 320 seconds.
FPS 16 Sta. 12	5.4.1.1	Tracked from 1632 seconds to 1904 seconds.
Mod IV (X-Band)	5.4.1.2	Tracked from 7 seconds to 139 seconds.
Azusa	5.4.1.3	Tracked from 20 seconds to 370 seconds.

AIRFRAME INTERNAL INSTRUMENTATION

Satisfactory telemetered data were received throughout powered flight. Telemetry signals were received at Cape Canaveral for approximately 15 minutes. Six measurements were unsatisfactory as follows:

Measurement No.	Description	Comment
F 125 P	B Ctl Pneu Reg Out	Qualitive only.
A 813 X	Quad 2 Door Aft Msw	Data received from Quad III aft micro-switch appeared to be invalid. Instrumen tion for all four positions appeared inadeq for accurately determining door positions
A 812 X	Quad 3 Door Fwd Msw	
A 814 X	Quad 3 Door Aft Msw	
A 811 X	Quad 2 Door Fwd Msw	
M [illegible] A	Msl Axial Accel Fine	Did Not Activate.

Missile 66D 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	22[illegible].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, 9, 12, 13, A, C, E	11

Basic telemetry channel assignment is given in Convair Report AZC 2[illegible]-070-66. Included in that report are channel assignment, commutation information, frequenc response, and make and model of transducer.

LANDLINE INSTRUMENTATION

Although some difficulty was encountered with the landline instrumentation system, sufficient data were obtained to ascertain proper missile and complex systems operation prior to liftoff.

Due to a fluctuation of the power supply voltage for potentiometer type transducers at -4 seconds, large oscillations were noted in these measurements. Never the less, useable data were obtained.

Due to difficulty with the oscillograph recorder during the countdown there were no calibrations for the B1, B2 and sustainer chamber pressures and the B1 and B2 LO2 pump inlet temperature measurements. Chamber pressure data were obtained on the FM recording system. Also, the oscillograph traces were missing for the LO2 dome purge pressure, the B1 LO2 valve closed microswitch, the B2 fuel valve open microswitch, the sustainer fuel manifold pressure switch and the sustainer flight lockin signal. In addition, the B1 fuel manifold pressure switch trace on the oscillograph failed to activate. All of the switch activations were properly recorded on the sequence (EA) recorders.

The timing pens did not operate correctly on the strip chart recorders for the sustainer main fuel valve position, the transfer room temperature and the sustainer turbine inlet temperature. Satisfactory data were obtained from these measurements although time correlation was poor.

The transducers appeared open on the FM recordings of the B1 and B2 high pressure fuel line accelerometers and the B2 high pressure LO2 line accelerometer. In addition, the B2 fuel pump discharge pressure data were erratic, the BGG chamber pressure measurement subcarrier oscillator was out of band and there was no calibration for the B1 LO2 injection manifold pressure data. All other FM data appeared satisfactory.

FILM REVIEW

A review of quick process engineering sequential film indicated all missile 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. Tracking films were exceptional having the missile in clear view through staging and a portion of sustainer phase. No discrepancies were noted.

A tabulation of film items reviewed is presented below:

Item No.	Camera Pad	Frames Per/Sec	Size mm B & W or Color	Fixed or Tracking	Field of View
1.2-8	Ramp	400	16 Color	Fixed	Entire launcher and missile to above verniers. Views Quads I and II.
1.2-11	East "A" Frame	400	16 Color	Fixed	Views B2 high pressure propellant lines at bottom of clamshell doors.
1.2-12	West "A" Frame	400	16 Color	Fixed	Views B1 high pressure propellant lines at bottom of clamshell doors.
1.2-13	North Launcher	100	16 Color	Fixed	Views turbine exhaust duct.
1.2-14	U122L29	48	16 Color	Track	Views entire missile.
1.2-15	D17R39	48	16 Color	Track	Views entire missile.
1.2-16	U75R6	48	16 Color	Track	Views entire missile.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The flight was successful although the majority of the re-entry vehicle objectives were not met.

2. Excessive missile yaw oscillations were observed during the boost phase.

3. The re-entry vehicle playback telemetry link failed shortly after black-out.

4. Thrust after vernier cutoff was greater than the nominal.

Recommendations

1. Examine the ability of the autopilot to stabilize the missine in this configuration.

2. Investigate the re-entry vehicle telemetry transmitter reliability.

3. Investigate the cause of greater than nominal thrust after vernier cutoff.

COUNTDOWN TIME VERSUS EVENTS

This test was scheduled for a 150 minute countdown and started at 0530 EST as planned. The countdown was performed perfectly with no holds or recycles required.

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

EST	Countdown Time	Countdown Procedure	Event
0527	T-153		Holddown-Release Cylinders Pressurized to 6250 psig.
0528	T-152	T-150	Computer Warmup Test Started.
0530	T-150	T-150	Countdown Started.
0531	T-149	T-147	Telemetry Warmup Started.
0536	T-144	T-144	GAP Test Started.
0543	T-137		GAP Test Completed Satisfactorily.
0544	T-136	T-139	Telemetry Internal Power Check Completed Satisfactorily.
		T-135	Gyro Temperature Check Started.
0545	T-135	T-135	Range Safety Command Test Started. Gyro Temperature Check Completed Satisfactorily
		T-135	Zero Z, Scale X (Plus 1G Field) Accelerometer Checks Started.
0554	T-126		Range Safety Command Test Completed Satisfactor
		T-125	Electrical Connection Of Red Destruct Box And Retro-Rockets Started.
0559	T-121		Zero Z, Scale X (Plus 1G Field) Accelerometer Checks Completed Satisfactorily.

EST	Countdown Time	Countdown Procedure	Event
		T-120	Scale X (Minus IG Field) Accelerometer Check Started.
0602	T-118		Electrical Connection Of Red Destruct Box Completed.
0604	T-116		Electrical Connection Of Retro-Rockets Completed. Pod Doors Being Closed.
0612	T-108		Tower Floors Being Raised.
0614	T-106		AIG System Landline Umbilicals Being Removed.
0617	T-103		Scale X (Minus IG Field) Accelerometer Check Completed Satisfactorily.
		T-90	Normal Align-Scale Z Accelerometer Checks Started.
0620	T-100		Flight Control System Tests Delayed To Complete Sewing Of Sustainer Boot. GAP Test Was "GO" On Hangar "N" and AMR Tapes.
0622	T-98		Service Tower Moving Back.
0625	T-95	T-65	Mod III E Beacon Warmup Started.
0627	T-93		AIG System Landline Umbilicals Have Been Removed.
0630	T-90		Sewing Of Sustainer Boot Completed.
0634	T-86		Normal Align-Scale Z Accelerometer Checks Completed Satisfactorily.
		T-75	Computer DSC Test Started.
0635	T-85	T-85	Helium Storage Preparation Started.
		T-65	Landline Electrical Calibrations Started.

EST	Countdown Time	Countdown Procedure	Event
0637	T-83		Service Tower Secured In Maintenance Area.
		T-100	Flight Control System Test Started.
0640	T-80	T-70	Nose Cone Beacon And Telemetry Tests Started.
		T-70	Helium Storage Started.
0642	T-78		Computer DSC Test Completed Satisfactorily.
0644	T-76		Flight Control System Test Completed Satisfactorily.
0654	T-66	T-65	Telemetry Warmup Started.
0658	T-62	T-62	GAP Test Started.
0702	T-58		Nose Cone Beacon and Telemetry Checks Completed Satisfactorily.
0704	T-56		Mod III E Beacon Lockon Check Completed Satisfactorily. GAP Test Completed Satisfactorily.
0705	T-55	T-45	Insert Z (Minus IG) Bias Check Started.
0710	T-50		Landline Electrical Calibrations Completed.
0714	T-46		Insert Z (Minus IG) Bias Check Completed Satisfactorily.
		T-35	Insert X Offset Checks Started.
0715	T-45	T-45	Roll Gyro Torquing Ramp Test Started.
0719	T-41		Roll Gyro Torquing Ramp Test Completed - Roll Is Left 94 Degrees.
0720	T-40		LO2 System Ready For Tanking.
		T-35	Azusa Check Started.

EST	Countdown Time	Countdown Procedure	Event
		T-20	Autopilot System Final Check Started.
0726	T-34		Insert X Offset Checks Completed Satisfactorily.
0734	T-26	T-25	Final Computer Check Started.
0738	T-22	T-22	Range Safety Command Final Test Started.
0741	T-19	T-20	Telemetry Final Warmup Started.
0742	T-18		Final Computer Check Completed Satisfactorily.
		T-18	Accelerometer Adjustment Check Started.
0748	T-12	T-12	Nose Cone Beacon And Telemetry "ON".
0750	T-10		Range Safety Command Final Test Completed Satisfactorily.
0753	T-7	T-7	Guidance Final Checks Started.
		T-7	Forecast Final Range Clearance From AMR.
		T-7	RCC System Activated.
0756	T-4:00		Autopilot System Final Check Completed Satisfactorily.
	T-3:50	T-3:50	Status Check - All Reports "GO".
		T-3:30	Telemetry To Internal.
0757	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	Water Systems Turned "ON".
	T-2:10	T-2.10	LO2 Tanking Secured.
0758	T-2.00	T-2.00	Flight Pressurization Started.

EST	Countdown Time	Countdown Procedure	Event
		T-2:00	Commands To Internal.
	T-1:45	T-1:45	Arm Switch To "ARM".
		T-1:45	Engine Preparation Complete Light "ON".
	T-1:40	T-1:40	Missile To Internal Power.
	T-1:35	T-1:35	Nose Cone Report Switch To "READY".
	T-1:30	T-1:30	Arming Safety Pin Removed.
	T-1:25	T-1:25	Commands To "ARM".
	T-1:15	T-1:15	Status Check - All Reports "GO".
0759	T-0:60	T-0:60	Missile Helium To Internal.
		T-0:60	Autopilot To "ARM".
	T-0:55	T-0:55	Water Full Flow.
	T-0:40	T-0:40	Status Check - All Reports "GO".
		T-0:40	All Pre-Start Panel Lights Are Correct.
		T-0:40	Ready Light Is "ON".
	T-0:25	T-0:25	Oil Evacuate.
	T-0:21		Evacuation Lights "ON.
	T-0:18	T-0:18	All Recorders To Fast.
		T-0:18	T-18 Seconds And Counting.
		T-0:18	Engine Start.
0800:10			Range Zero Time.

MISSILE CONFIGURATION

The Atlas Missile consists of three basic sections: re-entry vehicle, body section, and propulsion system. There are no external aerodynamic control surfaces. The re-entry vehicle is releasable and carries instrumentation and ballast to simulate the operational re-entry vehicle. The body section of the missile consists 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 66D. 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.

Re-entry Vehicle

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

The vehicle was designed for high velocity re-entry into the atmosphere. New types of ablative materials were utilized for the heat shield; GE Series 100 and others. The RVX-2A differed from the RVX-2 flown on earlier Atlas Missiles in that its ablative material was cast rather than wound around the vehicle structure

The RVX-2A contained a recovery subsystem that decelerated the vehicle from its high re-entry velocity. A parachute decelerated it to approximately 100 ft/second, then after impact, a balloon was to be used for a flotation period of up to 36 hours. The recovery system also provided vehicle location by a salt-water-activated, battery-powered SARAH beacon, a light beacon, SOFAR bomb, radar chaff, dye marker and protection by 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 was to transmit real-time data from range zero to impact. The other was to continuously play back the signal from the storage recorder (which also operated from liftoff to impact).

This playback data were to be recorded on recoverable magnetic tape.

A flight programmer was used to switch the accelerometer and rate gyro from fine to coarse range.

The following "piggy-back" experiments were carried on board the RVX-2A flown with Missile 66D.

Experiment No.	Description
21	Ion Sheath
22	Ultraviolet Background
26	Hot Gas Radiation Spectrograph
28	Passive Transpiration Cooling
29	Fuel Cell
30	Cloud Coverage
32	"X" Band Propogation
*39	Nuclear
43	Sputtering
*46	Radiation
47-2	Counter
48	Intergrating Accelerometer

* Not Telemetered

Separation 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.

Hydraulic System

The hydraulic system is comprised of three independent hydraulic systems which provide pressure for the booster stage subsystems, the sustainer/vernier subsystem, and the vernier solo subsystem. The standard "D" series was modified with the use of a 25 inch accumulator to furnish vernier solo hydraulic power.

Electrical System

Remotely activated battery, rotary inverter, and magnetic amplifier regulator system.

Convair Propellant Utilization System

Convair 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.

Booster Staging System

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

Flight Control

Flight Control for Missile 66D was provided by ARMA all-inertial guidance (AIG) in conjunction with a Convair "square canister" autopilot.

1. Sensing Platform - contained three accelerometers, two gyros, three pendulums and an alignment prism.

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

3. The final component of the MG5 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)

The Convair autopilot package utilized in conjunction with 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 changed to electronic, rather than electro-mechanical.

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

4. An 8 cps filter was switched in at booster cutoff to give 4 and 8 cps filtering for the sustainer and vernier phase.

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 MK1), power and signal control unit, and destruct package.

GE Impact Predictor

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

Azusa Transponder

Type B-1A coherent carrier transponder.

HISTORY OF XSM-65D MISSILE NO. 66

Atlas Missile 66D arrived at AMR by air transport (C-133) on 14 June 1960. Transfer from the IOC trailer to the R and D trailer and completion of receiving inspection was effected the next day. The missile was then positioned in the north bay of Hangar "K". Systems checkout was initiated on 16 June 1960 and completed on 6 July 1960.

Missile 66D remained at AMR for a period of approximately nine weeks before being launched. This time was utilized in performing system tests and in readying the missile and launching complex for the flight test. Preflight testing of the missile was accomplished in accordance with planning documented in Report AA 60-0034, Flight Test Directive, Series "D" Missile No. 66. Unplanned operations were performed on an "as required" basis.

Three launch attempts were made on this missile with cancellation of each attempt being ascribed to a different problem. The first attempt was terminated at -70 minutes due to a discrepancy in the sustainer RCC accelerometer circuitry. Test number two was terminated because of a spurious vernier tanks re-pressurization during a recycle and hold. The third launch attempt was terminated due to loss of modulation on nose cone telemetry link 4. A complete description of these launch attempts is presented immediately following the significant events resume.

Date	Event
14 June 1960	Arrived at AMR.
15 June 1960	Positioned in north bay of Hangar "K".
16 June 1960	Receiving inspection completed. System checkout initiated.
7 July 1960	Weighed, transferred to Complex 11 and erected.
14 July 1960	Successful fuel and LO2 tanking.
15 July 1960	Successful Flight Acceptance Composite Test.
21 July 1960	X-1 Day operations.

Date	Event
22 July 1960	Attempted launch. Terminated because of a discrepancy in the RCC accelerometer circuitry.
24 July 1960	X-1 Day operations.
25 July 1960	Attempted launch. Terminated because of a spurious vernier tanks re-pressurization.
1 August 1960	Successful Flight Acceptance Composite Test
7 August 1960	X-1 Day operations.
8 August 1960	Attempted launch. Terminated because of loss of modulation on nose cone telemetry link 4.
11 August 1960	X-1 Day operations.
12 August 1960	Flight.

Attempted Launch Results

The initial launch countdown was terminated at 1105 EST due to the presence of water in the plugs of the coaxial cable between plug 600P5 and the RCC accelerometer.

It was planned to start the count at -150 minutes at 0630 EST, but due to an ARMA platform cooling problem and a discrepancy in the sustainer RCC accelerometer circuitry the countdown was not started until 0930 EST.

During the Guidance/Autopilot/Propulsion test at -144 it was discovered that the pitch program output voltage failed to step from 1.7 to 1.9 volts at 39 seconds of programmer run time. The spare programmer was installed on the missile replacing the flight programmer and checked satisfactorily.

The countdown then proceeded normally until -70 minutes (1050 EST) when a hold was called to check out a newly installed sustainer RCC coaxial cable. While checking resistance readings through this cable it was found the problem first encountered still existed and there was water dripping from the pods into the working area. The test was then terminated.

Test P1-402-00-66, the second launch attempt, occurred on 25 July 1960. The count was started at -150 minutes at 0630 EST as planned and progressed normally until -25 minutes, (0835 EST) when Azusa was reported not functioning properly. A hold was called and the Azusa canister was replaced. The count was resumed at 0955 EST (-45 minutes) and continued without further difficulty until -40 seconds (1039 EST), when it was discovered that there was no Acoustica ready light on the prestart ladder. Since the Acoustica PC System was not aboard for this flight, the Acoustica ready light was jumpered, but the sequencer had reached -19 seconds and automatic hold-fire. This pulled in the master hold-fire relay and the range ready light went out. Since the pad safety officer could not turn the range ready light on because the master holdfire relay was energized, the hold fire override switch was utilized to obtain a range ready light. The count was recycled to -7 minutes and resumed at 1032 EST.

When the count reached -19 seconds all the pre-start lights were proper but since the hold-fire was overridden, the sequencer kept running, and had reached -15 seconds by the time the start button was pushed. This made the ARMA computer reset late since it is a function of start button push. When no reset had occurred by -2 seconds, ARMA guidance called cutoff at approximately 1050 EST. The count was recycled to -70 minutes and holding for resetting the guidance computer and to put new film in the cameras.

At approximately 18 minutes after cutoff the engine fuel tank pressurized lights on the engine control and engine test panels indicated that the fuel tank had pressurized.

These indications lasted for about one minute but could not be verified by EA recorders since the paper was being changed at that time. However, a pressurization and vent was indicated by F 1288 P, ISS pneumatic regulator outlet press. Telemetry had been turned off during that time and therefore no vernier tank pressure data were available. A manual engine tank pressurization cycle was performed and all indications were proper. The test was subsequently terminated at 1145 EST due to a spurious vernier tanks re-pressurization which occurred at 1108 EST.

The third launch attempt occurred on 8 August 1960 and was terminated at 0705 EST with the countdown at -7 minutes because of loss of modulation on nose cone telemetry link 4.

The countdown was started at -150 minutes at 0430 EST as planned, and proceeded perfectly until the status check at -3:50. At this time nose cone personnel reported a "NO-GO" condition due to loss of telemetry link 4 modulation. The countdown was held momentarily at -3:30 and then was recycled to -7 minutes (0657 EST) and the hold continued. Termination of the test occurred during this hold.

A brief compilation of significant difficulties in system preparation and testing accomplished follows:

Range Safety Command System

There were no major difficulties encountered with this system during flight test preparation.

The following procedures were completed in the hangar:

Procedure	Description	Date Completed
27-72517-1	Range Safety Command System Test	6-25-60
FTP-D-002	Range Safety Command Backup Ejection Test	7-13-60

The following procedure was performed at the complex.

Procedure	Description	Date Completed
FTP-D-005B	Range Safety Command Blockhouse Compatibility Test.	7-11-60

Instrumentation Beacon System

There were no major difficulties encountered during flight test preparation. During hangar checkout Rate Beacon 4E1045 was removed to accomplish a modification ECR 3-24, and Rate Beacon 4E1050 was installed on the missile. On 17 June 1960 the rate and pulse beacons were removed for a lab test. Results were satisfactory and the beacons were re-installed on the missile.

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-G-016A	GE Mod III Instrumenation Beacon System Readiness Test	7-21-60, 8-4-60 8-10-60

Procedure	Description	Date Completed
FTP-G-019A	Mod III Instrumentation Missileborne Wave-guide and Canister Pressure Check	7-20-60, 7-26-60 8-2-60, 8-4-60

Flight Control System

During hangar checkout an excessive drift rate was discovered in the sustainer and vernier engines when the programmer was at approximately 145 seconds. Plugs in the system were disconnected and excessive water removed. The problem did not recur during subsequent hangar testing.

During flight control system checkout at the complex, excessive drift rate was again observed. It was corrected by the installation of a capacitor in the +28 vdc power supply line to the programmer and by replacing Servo Canister, Serial No. 11, with Servo Canister, Serial No. 9.

During the first launch attempt, test P1-401-00-65, programmer canister, Serial No. 12, was replaced with programmer canister, Serial No. 5, because of failure to switch to step number three of the pitch program output during the first guidance/autopilot test.

During test P1-402-00-66, the second launch attempt, an inadvertent signal to pressurize vernier tanks was received a considerable time after cutoff was given. The circuits were changed so the vernier tanks were pressurized by the booster engine cutoff relay at the engine relay box. Subsequent testing produced no undesirable effects from this change.

Servo Canister, Serial No. 9, was replaced by Servo Canister, Serial No. 5, because of a faulty relay within the Servo Canister.

The following procedure was completed in the hangar.

Procedure	Description	Date Completed
FTP-S-002 A	Vernier Engine Alignment	7-2-60

The following procedures were completed at the complex

Procedure	Description	Date Completed
FTP-S-034A	Sustainer Engine Alignment Check	7-11-60

Procedure	Description	Date Completed
FTP-S-006B	Booster Engine Alignment Check	7-13-60
FTP-S-021B	Flight Control System Threshold Transfer	[illegible]-13-60
FTP-S-022B	Autopilot Static Gain Test	7-13-60
FTP-S-019C	Autopilot Frequency Response Test.	7-14-60
FTP-S-049A	Autopilot Polarity Test	7-14-60
ATP-S-1010	Autopilot System Test	7-15-60
FTP-S-050B	Autopilot Squib Test	7-1[illegible]-60
FTP-S-059	Roll Program Readout Calibration	7-1[illegible]-60
FTP-S-060A	Abbreviated Frequency Response Test	
FTP-M-062B	Autopilot Inertial Guidance Integrated	8-5-60
FTP-S-051C	Autopilot System Readiness Test	8-10-60
FTP-S-052	Autopilot Precountdown Operation	8-12-60

Pneumatic System

No major difficulties were encountered during preparation of this system for flight test.

The following procedures were completed in the hangar

Procedure	Description	Date Completed
FTP-F-019B	Airborne Pneumatic System Leak Check	6-24-60
FTP-F-022B	Differential Pressure Switch Checkout	6-29-60

The following procedures were completed at the complex

Procedure	Description	Date Completed
FTP-F-020	High Pressure Leak Check and Airborne Regulator Lock-up Checkout.	7-12-60

Procedure	Description	Date Completed
FTP-F-007	Transfer of Missile Pressurization from Trailer to Tower.	7-13-60
FTP-F-015A	LO2 Tank Relief and Shut-off Valve Checkout	7-14-60
FTP-F-005B	Checkout and Validation Ground Airborne Pneumatic System.	8-7-60

Re-entry Vehicle

Re-entry Vehicle 421 arrived at AMR on 22 June 1960. Four major problems arose prior to flight as the result of major component failures. Three of the failures occurred at the complex and one in the hangar. During the first launch attempt the multiplexer would not start switching until the power supply voltage was increased to 30 volts. When the vehicle was recycled, the replacement multiplexer also failed. On T-1 Day of the first launch attempt the beacon failed and had to be replaced. During terminal count of the third launch attempt the tape recorder jammed.

In addition the vehicle had to be dissassembled after each launch abort due to time limits on J-47-1 experiment. One extra dissassembly was necessary to permit the removal of J-47-1 experiment.

The following tests performed on Re-entry Vehicle 421.

FTI	Test Performed	Date Completed
N/A	Special Incoming Confidence	6-22-60
24376	C-Band Beacon System	6-24-60
N/A	Special J-48	6-27-60
24373	Telemetry Systems	6-29-60
24372	Hangar Systems Confidence Test	6-30-60
N/A	Shield Harness	6-30-60
N/A	Special J-47-2	7-5-60

FTI	Test Performed	Date Completed
24375	Sensor Stimulation	7-6-60
N/A	Special J-32A	7-7-60
N/A	Special J-32B	7-7-60
N/A	Special J-21	7-8-60
N/A	Special J-43	7-8-60
N/A	Special J-30-1	7-8-60
N/A	Special J-30-2	7-8-60
24378	Pressure Seal Test	7-12-60
N/A	Special J-26	7-12-60
N/A	Special J-29	7-13-60
N/A	Special J-22	7-13-60
24380	Final Acceptance Test	7-14-60
N/A	Special Recovery Monitor Events	7-14-60
24384	Mating for FAC Test	7-14-60
N/A	Pad Checkout Test	7-14-60
24385	FAC Test	7-15-60
24384	Demating following FAC Test	7-15-60
N/A	Special J-22	7-20-60
N/A	Special J-47-1	7-20-60
24383	Explosive Confidence Test	7-20-60
24382	Weight and C.G.	7-20-60

FTI	Test Performed	Date Completed
24384	Mating for Launch (am)	7-21-60
24386	T-1 Day (Bad Beacon)	7-21-60
24384	Demating for Beacon Change	7-21-60
23872B	Beacon Sub-System Test	7-21-60
24384	Mating for Launch	7-21-60
24386	T-1 Day (pm)	7-21-60
24387	Launch Countdown (Scrubbed)	7-22-60
24384	Demating (R/V Returned to Hangar)	7-22-60
24383	Explosive Confidence Test	7-23-60
24384	Mating for Launch	7-24-60
24386	T-1 Day Test	7-24-60
24387	Launch Countdown (Scrubbed)	7-25-60
24384	Demating (R/V Returned to Hangar)	7-25-60
24372A	Incoming Confidence Test (partial)	7-26-60
24378	Pressure Seal Test	7-26-60
N/A	Special J-26	7-26-60
N/A	Special J-42	7-27-60
N/A	Special (Multiplexer)	7-28-60
N/A	Special (Confidence Test)	8-2-60
N/A	Special J-29	8-3-60
24378	Pressure Seal Test	8-3-60

FTI	Test Performed	Date Completed
24380	Final Acceptance Test	8-3-60
24383	Explosive Confidence Test	8-4-60
24384	Mating for Launch	8-5-60
24384	Demating for Removal of J-47-1	8-5-60
24383	Explosive Confidence Test	8-6-60
24384	T-1 Day Test	8-7-60
24387	Launch Countdown (Recorder Failure, scrubbed Flight)	8-8-60
24384	Demating to return R/V to Hangar for repair	8-8-60
24373	Telemetry Systems Test	8-8-60
24376	C-Band Beacon Systems Test	8-9-60
N/A	Special J-29	8-9-60
24378	Pressure Seal Test	8-9-60
24380	Final Acceptance Test	8-9-60
24383	Explosive Confidence Test	8-9-60
24384	Mating for Launch	8-10-60
24386	T-1 Day Test	8-10-60
24387	Launch Countdown	8-12-60

Propulsion System

The initial launch countdown was terminated due to water in the plugs at the coaxial cable between plug 600P5 and the sustainer RCC accelerometer. This problem existed before start of the count and a hold was called at -70 minutes to check out a newly installed cable. Resistance readings indicated the problem still existed and it was noted water was dripping into this area from the pads. This condition was corrected and no further difficulties from this area were encountered during subsequent countdowns.

The second launch attempt was terminated due to a spurious vernier tanks repressurization after an observer cutoff. At approximately 18 minutes after cutoff a spurious vernier tanks repressurization occurred. However only the fuel tank lights on the engine control and engine test panels actuated.

These indications lasted for about one minute but could not be verified by EA recordings since the paper was being changed at that time, however, a pressurization and vent was indicated by F 1288 P, ISS Pneumatic Regulator Outlet Pressure. A manual engine tank pressurization was performed and all indications were proper. The shuttle valves in the ISS package were checked, and the pressurization solenoid was leak checked. All results were proper and indicated that both tanks must have pressurized after the launch attempt.

Two mock countdowns were performed to see if the spurious pressurize vernier tanks (PVT) signal would occur. No extraneous signals were noted. During trouble shooting the ISS package and the engine relay box were replaced to eliminate these components as a source of the problem.

At this time wiring revisions to the system were made such that the missile system would still give an indication of spurious signals but these signals would not effect vernier tanks pressurization. A TVA was worked to route the hot side of the ISS PVT solenoid through the 42" umbilical so that this solenoid could not be energized by the PVT relay output after liftoff. The wiring was also changed so that a PVT signal would come directly from the closed side of the booster cutoff relay. Several telemetered measurements were also added to monitor for spurious PVT signals. Satisfactory checks of the new circuitry were made prior to launch.

During investigation of the spurious PVT signal it was discovered that the LO2 vent and relief valve opened prior to closure of the pressurizing shuttle valve, when the tanks were vented. This permitted the ISS regulated supply to be vented overboard through the LO2 vent and relief valve for a short period of time which resulted in fluctuation of ISS regulated pressure. It was decided to go "as is" with this condition, however, as noted above the ISS package was replaced before flight.

The following procedures were completed during hangar checkout.

Procedure	Description	Date Completed
FTP-P-027	Main Propellant and Hot Gas System Leak Check.	6-29-60
FTP-P-025B	Propulsion Pneumatic Control Leak and Functional Check	7-1-60
FTP-P-026B	Vernier Engine and Start System Leak Checks	7-11-60
FTP-P-030B	Head Suppression Servo Controller Leak and Functional Check.	7-13-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-P-029A	Pneumatic Purge System Leak and Functional Check	7-7-60
FTP-P-012	Propulsion System Nose Cone Separation Pneumatic Leak Checks	7-12-60
FTP-P-006F	Propulsion System Leak and Functional Check	7-13-60 7-19-60
FTP-P-023	Propulsion System Components Inspection Check	7-19-60
FTP-P-014	Retorquing Procedure on Booster and Sustainer Gimbaling Blocks	7-20-60 8-3-60
FTP-P-020A	Post-Firing Securing Operations	7-22-60 7-25-60 8-[illegible]-60
FTP-P-009F	Propulsion X-1 Day and Precountdown Operations	7-22-60 7-25-60 8-8-60 8-12-60

All-Inertial Guidance System

After installation of the Missile Guidance Set (MGS) components in the missile, [illegible] system checks were completed satisfactorily. A Guidance Autopilot Telemetry Integrated Test was attempted but [illegible]. [illegible] partial telemetry data were received as 8 channels of RF link 2 were inoperative because a TVA had not been [illegible] to incorporate these channels in [illegible].

Following erection of the missile at the [illegible] Computer, S/N [illegible], was replaced by Computer, S/N 7130012, because of an incorrect [illegible] at the start of a computer problem. This difficulty was traced to a [illegible] start after a cold-soak.

A defective roll resolver card was found during the FACT on 15 [illegible] and the Analog Signal Converter (ASC), S/N 71 [illegible], was replaced by ASC, S/N [illegible]. Also during this test, the [illegible] temperature was [illegible], which was apparently due to a defective [illegible].

On 21 July 1960, ASC, S/N 71[illegible], was replaced with ASC, S/N 71[illegible], because of no output from Z2 string [illegible] card. [illegible] later ASC, S/N 71[illegible], was replaced by ASC, S/N 71-0020, because of a defective [illegible] card.

The Krohn-Hite power supply was replaced on [illegible] August 1960, because of a high Digital Signal Converter count.

All of the MGS components of Missile [illegible] underwent one individual component [illegible] prior to installation into the missile.

The following test procedures were performed in the course of MGS checkout at AMR:

Procedure	Description	Date Completed
Hangar K		
ATP G-0043	MGS System Check	[illegible]
Complex 11		
CTP-1-0[illegible]	MGS System Test	[illegible]
ETP G-010A	Autopilot Polarity Test	[illegible]

Procedure	Description	Date Completed
FTP-M-062	Autopilot/Guidance Integrated Test	7-1[illegible]-60
CTP-17H	FAC Test	7-1[illegible]-60
CTP-1[illegible]C	MGS System Test	7-13-60 7-14-60
CTP-17H	FAC Test	8-1-60
FTP-G-025	X-2 Day Pre-Readiness Check	7-20-60 8-3-60 8-6-60 8-10-60
FTP-G-026	X-1 Day Readiness Check	7-21-60 8-4-60 8-7-60 8-11-60
FTP-G-027	Precountdown Checks	8-8-60 8-12-60
Test Prep 40 and 41	Special Computer Problems	8-10-60
CTP-17H	Launch Countdown	8-12-60

Telemetry System

In the checkout of the telemetry system one major discrepancy was noted. During the FAC Test on 1 August 1960, U 91 V, Error Ratio Demod Output, became erratic. Checks on this measurement traced this erratic behavior to the accessory package. On 3 August 1960, the accessory package, S/N [illegible], was removed and S/N 003-0004 was installed. Subsequent checkout of this measurement indicated satisfactory operation.

On 11 July 1960, the telemetry packages were changed to check out the spare packages. The flight packages were then reinstalled for the remaining tests. The following procedures were completed in the hangar.

Procedure	Description	Date Completed
FTP-T-005	Bridging of Temperature Transducers	6-21-60
FTP-T-017	Vernier Engine Position Calibration	6-25-60
FTP-T-022	Telemetry System Functional Check	5-30-60
FTP-T-023	Telemetry High Pressure Transducer Checkout	6-29-60
FTP-T-024	Telemetry System Checkout	6-27-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-T-019	Telemetry Blockhouse Compatibility	7-11-60
FTP-T-020	Telemetry System Functional Check	7-11-60
FTP-T-008	Alignment and Calibration of Engine Position Transducers	7-13-60
FTP-T-026	Telemetry System Readiness Test	7-21-60 8-4-60 8-10-60
FTP-T-027	Telemetry System Precount Operation	7-22-60 7-25-60 8-8-60 8-12-60

Missile Electrical System

No significant problems were encountered during missile electrical system testing at AMR.

The following procedures were completed in the hangar.

Procedure	Description	Date Completed
FTP-E-033	Inspection of Electrical Disconnects	6-17-60
FTP-E-044	Battery Fit Test	6-17-60

Procedure	Description	Date Completed
FTP-E-036	Separation Circuitry Check	7-5-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-E-003	Operational Checkout of Closed Circuitry	7-8-60
FTP-E-026B	Pneumatic/Propulsion/Electrical Interlock Test	7-14-60
FTP-E-032B	Missile Electrical Blockhouse Compatibility Test	7-18-60
FTP-M-056B	Missile RF and Electrical Readiness Test	8-10-60
FTP-M-064A	Missile RF and Electrical Precount Operations	

Complex Electrical System

No significant problems were encountered during checkout of the complex electrical system.

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-E-034	Launcher Microswitch Adjustment	7-6-60
FTP-E-041	Sustainer Overspeed Trip Check	7-13-60
FTP-E-039	Launch Control Automatic Sequence Test	7-14-60
FTP-E-040	Release Sequence Test	7-14-60
FTP-E-037B	Umbilical Adjustment Ejection Procedure	8-8-60
FTP-E-053	Complex Electrical Readiness Test	8-10-60
FTP-E-054	Complex Electrical Precount Operation	8-12-60

Hydraulic Systems

The sustainer hydraulic system hydraulic oil did not meet specifications due to low viscosity when analyzed prior to flight. The oil was approved as acceptable, however, since viscosity can be expected to drop when oil has been in use.

No other major difficulties were encountered with this system during flight test preparation.

The following procedure was completed in the hangar.

Procedure	Description	Date Completed
FTP-H-005B	Horizontal Fill and Bleed	7-7-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-H-002D	Ground and Airborne System Fill and Bleed	7-13-60
FTP-H-007	Vernier Solo Hydraulic Accumulator Installation	7-15-60
FTP-H-004C	Airborne Hydraulic System X-1 Day and Pre-count Operations	8-12-60

Azusa System

During system preparation for flight, it was discovered that Azusa Canister, S/N 731-0044, had an internal short in the IF amplifier due to a pressurization leak. The canister was IR'd and was replaced with S/N 731-0024. This canister indicated difficulties with the transponder in recovering on the high frequencies. Later checks by the Azusa ground station proved this to be false, however, the canister was replaced with S/N 731-0062. No other difficulties were encountered during system preparation for flight.

The following procedure was completed in the hangar.

Procedure	Description	Date Completed
27-92504	Azusa System Checkout	7-2-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-Z-001	Azusa Blockhouse Compatibility Test	7-21-60 8-3-60
FTP-M-056	Missile RF and Electrical Readiness Test	8-10-60

Convair Propellant Utilization System

System difficulties were encountered during the FAC Test when variations occurred on the Error Demodulator Output (EDO) signal. It was found the RF system was inducing these variations at the sandwich plug and also that the accessory package was inducing 0.3 volts into the PU system. The accessory package was replaced and the interference ceased. No other major difficulties were encountered during flight test preparation.

The following procedures were completed in the hangar.

Procedure	Description	Date Completed
FTP-F-018A	Propellant Utilization System Leak Check	6-25-60
FTP-U-016	Propellant Utilization Sensing System Test	6-29-60
FTP-U-026	Convair PU Valve Angle Setting	7-13-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-U-021B	Alignment of Fuel/LO2 Ratio Valve	7-18-60
FTP-U-022	Five Point Pressure Check of PU Error Demodulator Output	7-21-60 7-21-60
FTP-U-024	Readiness Check of Convair PU System	7-21-60 8-5-60 8-10-60
FTP-U-023B	Functional Check of PU System	8-5-60 8-10-60

Holddown and Release System

One of the four cold release tests performed in accordance with FTP-L-006B, in preparing the system for flight test, was satisfactory. Three of the tests were unsatisfactory due to no release signal being recorded on the oscillograph.

The following procedures were performed at the complex.

Procedure	Description	Date Completed
FTP-L-017A	Launcher Release System Functional and Restraint Test	7-6-60
FTP-L-001C	General Launcher Alignment	7-8-60
FTP-L-008C	Servicing Launcher Arresters	7-12-60
FTP-L-007D	Functional Checkout Launcher Stabilizing and Launcher Auxiliary Frame System	7-15-60
FTP-L-014D	Launcher Lines Leak Check	7-1[illegible]-60
FTP-L-005B	Checkout of the Launcher Stabilizing System	7-20-60
FTP-L-006B	Shakedown for Launcher Cold Release	7-20-60

APPENDIX

FLUID CHEMICAL ANALYSIS

Due to the several launch attempts on Missile [illegible], the Fluid Chemistry samples were taken over a period of [illegible] days between [illegible] August and 10 August 1[illegible]0. The results were acceptable.

[illegible]	Units	Sample	Specifications
Purity	Percent	[illegible].5	[illegible].5 Min.
Hydrocarbons			
As Methane	ppm	10 ppm	[illegible]5.0 Total Max.
As Acetylene		None	0.5 Max.
Gaseous Helium			
Purity	Percent	(a) [illegible] (b) [illegible] (c) [illegible]	[illegible] Min.
Hydrocarbons		(a) None (b) None (c) None	
Lubricating Oil			
Viscosity	Centistokes @ 100°F	26	23.0 to 34.0
Flash Point	°F	364	280 Min.
Viscosity Index	[illegible]	103.6	80 Min.
Trichloroethylene			
Appearance		Pass	Clear and Free
Color		- -	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	199	199.4 Max.
Water		Pass	Cloudless @ [illegible]°F
Non-volatile	Percent	.0003	0.002 Max.

Hydraulic Fluid	Units	Sample	Specifications
Flash Point	°F	220	200 Min.
Color		Red	Report
Viscosity	Centistokes @130°F	8.4*	10.0 Min.
Water by Distillation	Percent	Cannot be measured by spec. method.	0.00[illegible] Max.

Particle Count			
10 - 20	Microns	1080	No solid particles greater than 1.5 microns. (Fibers not defined.)
21 - 40	Microns	476	
41 - 65	Microns	328	
66 - 100	Microns	44	
Over 100		2 particles 2 fibers	

Fuel - RP-1			
Initial Boiling	°F	383	Report
10 Percent	°F	392	365-410
50 Percent	°F	418	Report
90 Percent	°F	450	Report
End Point	°F	475	525 Max.
Residue	Percent	0.8	1.5 Max.
Loss	Percent	0.9	1.5 Max.
Flash Point	°F	140	110 Min.
Gravity	°API	44.1	42.0 Min.

Particle Count			
10 - 20	Microns	2860	No solid particles greater than 1.5 microns. (Fibers not defined.)
20 - 40	Microns	1040	
40 - 80	Microns	610	
80 +		3 particles 2 fibers	
Moisture		None	

* Below procurement specification, however, viscosity can be expected to drop when oil has been in use and this value is acceptable.

REFERENCE DOCUMENTS

Flight Test Plan - Missile No. 66D	AZ-2[illegible]-032
Detailed Test Objectives (AFBMD/STL)	STL/OR-60-0000-09007
Flight Test Directive ([illegible])	AA 60-0034

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 66D	6-10 Weeks

SERIAL NUMBERS OF SYSTEM COMPONENTS

Azusa Transponder, Serial No. 731-0062

Re-entry Vehicle, Serial No. 421

Range Safety Command System

Range Safety Command Battery No. 1, Serial No. 230
Range Safety Command Battery No. 2, Serial No. 006-0043
Range Safety Command Canister No. 1, Serial No. AF 58-127
Range Safety Command Canister No. 2, Serial No. AF 58-161
Range Safety Command Canister No. 1, Power Supply And Signal Unit, Serial No. 8

Propulsion System

Sustainer Engine, Serial No. NA 222093
Booster Engine Assembly, Serial No. NA 112093
Vernier No. 1, Serial No. NA 332188
Vernier No. 2, Serial No. NA 332187

Electrical System

Missile Main Battery, Serial No. 002-0047
Bendix Inverter, Serial No. R-89
Power Changeover Switch Assembly, Serial No. 008

AIG Guidance System

Platform, Serial No. 7110009
Control, Serial No. 7120018
Computer, Serial No. 7130012
Analog Signal Converter, Serial No. 7150020
Digital Signal Converter, Serial No. 7140025

Instrumentation Beacon System

Rate Beacon, Serial No. 4E1050
Pulse Beacon, Serial No. 6E1008

Telemetry System

Telemetry RF Package No. 1, Serial No. 1024

Telemetry RF Package No. 2, Serial No. [illegible]
Telemetry RF Package No. 3, Serial No. [illegible]
Telemetry Battery No. 1, Serial No. [illegible]
Telemetry Battery No. 2, Serial No. [illegible]
Telemetry Battery No. 2, Serial No. [illegible]
Telemetry Accessory Package, Serial No. 005-0001

<u>Flight Control System</u>

Gyro Package, Serial No. 002-002 (11)
Filter Servo Amplifier Package, Serial No. [illegible]
Programmer Package, Serial No. [illegible]

<u>Propellant Utilization System</u>

Propellant Utilization System, Serial No. [illegible]

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 24.9 seconds of flight. Missile destroyed at 50.1 seconds.
6A	4-4-57	14	8-2-57	9-20-57	9-25-57	1622	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	2140	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 1-6-58	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 120.7 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 2653 nm downrange. First completely closed loop guidance system flight.
8B	7-31-58	14	8-6-58	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	****12-9-58 ****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 1.76 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.

[redacted]

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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.

[redacted]

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

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	3-20-59	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.
16D	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 sol. 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-[illegible]-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
20D	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	4205	Successful flight. Impacted 1/4 mile from target in MILS net.
40D	11-20-59	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.	Comments
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 controls 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	####-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.

*	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.
#	Rerun due to Guidance System difficulties.
##	Engine cutoff prior to release due to erroneous callout in blockhouse.
###	Terminated by erroneous output from B2 primary RCC accelerometer.
####	Terminated 1.53 seconds after sustainer flight lockin by the sustainer RCC system.

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[redacted]