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MERCURY BOOSTER WORKING GROUP

FLIGHT TEST REPORT

MERCURY/ATLAS MA-5

(ATLAS MISSILE 93D)

GD

GENERAL DYNAMICS | ASTRONAUTICS

29 November 1961

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AMR RANGE TEST NUMBER 1810

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FOREWORD

This report has been prepared to present preliminary information relative to the flight of Mercury/Atlas MA-5 93D. 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 Mercury Booster Working Group.

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SUMMARY

Mercury/Atlas MA-5 was launched from AMR, Complex 14 at 1008 EST on 29 November 1961. Atlas Missile 93D served as the launch vehicle for the Mercury Capsule. The primary objective of this flight was to place a full scale production model Mercury Capsule, containing a chimpanzee, into a prescribed orbit around the earth. The capsule completed two of the three planned orbits prior to being returned to earth, and successfully landed and was recovered in the planned recovery area near Bermuda.

The mission was terminated at the end of the second orbit due to a malfunction in the capsule roll control system. Except for not completing the three orbit mission, all test objectives were substantially accomplished.

Operation of all missile systems was satisfactory.

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FLIGHT TEST OBJECTIVES

The primary purposes of this mission were to obtain information concerning the effects of prolonged weightlessness upon the performance of a primate, to demonstrate satisfactory performance of the capsule and its primary systems throughout a Mercury orbital mission, to determine the ability of the Atlas Booster to release the Mercury Capsule at the prescribed orbital insertion conditions, and to demonstrate the satisfactory performance of the Mercury network in supporting an orbital mission.

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

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
1 - First Order					
2 - Second Order					
3 - Third Order					
Capsule Flight Objectives					
1. Obtain information concerning the effects of prolonged weightlessness upon the performance of a medium size primate before subjecting man to a similar environment.	1	X			
2. Demonstrate satisfactory performance of the capsule and its primary systems throughout a Mercury orbital mission. These systems are: Environmental Control, Stabilization and Control Sequence, Rocket, Electrical Power, Communications, and Instrumentation.	1				Capsule data is still being analyzed.
3. Determine by detailed measurements the heating rates and the thermal effects throughout the Mercury Capsule for all phases of an orbital mission.	1	X			
4. Demonstrate satisfactory performance of the Mercury network in supporting an orbital mission. The network facilities to be demonstrated are: launch, orbital, and landing point computing and display systems; the ground command system, the acquisition aid and radar tracking system; the telemetry receiving and display system; and the communications system (air-ground, intersite, and intrasite).	1	X			

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
5. Demonstrate the ability of the flight controllers to satisfactorily monitor and control an orbital mission.	1	X			
6. Demonstrate the adequacy of the recovery plans for an orbital mission.	1	X			
7. Determine the flight dynamic characteristics of the Mercury Capsule during re-entry from orbit.	2	X			
8. Evaluate Mercury network countdown and operational procedures.	2	X			
Atlas Systems Flight Objectives					
1. Determine the ability of the Atlas Booster to release the Mercury Capsule at the prescribed orbital insertion conditions.	1	X			
2. Evaluate the performance of the Abort Sensing and Implementation System.	2	X			
3. Determine the magnitude of the sustainer/vernier residual thrust after cutoff.	2	X			
4. Obtain data on the repeatability of the performance of all Atlas Missile and ground stations.	2	X			
5. Evaluate the Atlas Booster with regard to engine start and potential causes for combustion instability.	3	X			

FLIGHT TRAJECTORY

The Mercury/Atlas Vehicle propelled the instrumented capsule on a launch trajectory to satisfy orbital insertion conditions. The capsule then performed two elliptical orbits around the earth reaching an apogee of 128.2 nautical miles and a perigee of 86.2 nautical miles. The flight was terminated satisfactorily after re-entry was initiated by firing of the capsule retro-rockets.

A comparison of nominal flight performance parameters from Detailed Test Objectives Case S20, 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 which occurred at 1007:57 EST. Missile 2 Inch Motion occurred at 1007:57.04 EST.

Item	Unit	Nominal	Measured
Liftoff Weight	lbs	258,768	260,452
Pitch Plane Azimuth	deg	72.5	72.5
BCO Weight	lbs	64,137	-
BCO Velocity	ft/sec	9,155	9,133
BCO Altitude	ft	205,566	204,119
BCO Range	nm	45.8	45.2
BCO Time	sec	131.4	130.1
SCO/VCO Weight	lbs	10,415	-
SCO/VCO Velocity	ft/sec	24,378	24,365
SCO/VCO Altitude	ft	357,093	360,307
SCO/VCO Range	nm	445.3	440.8
SCO/VCO Time	sec	304.0	300.6

Note: Nominal times are corrected for the difference between Range Zero and 2 Inch Motion. Measured velocity, altitude, range are taken from Azusa data. Altitude is height above launch horizontal. Velocity is speed relative to earth's surface. Range is horizontal range from the launch pad.

SYSTEM PERFORMANCE

MA-5 CAPSULE PERFORMANCE

The MA-5 Capsule with its primate occupant was planned for a three orbit mission. The flight was terminated at the end of the second orbit because the capsule roll control system malfunctioned. Abnormal operation of the roll control system was first noted when the capsule was over the Mercury network stations in Australia and the abnormal operation was confirmed at the three succeeding stations at Canton Island, Hawaii, and California. Because of the malfunction a high rate of control system fuel usage was anticipated which would result in the fuel supply available for controlling the capsule in the third orbit being marginal. Re-entry was initiated with the firing of the retro-rockets by ground command from California. The capsule landed in the planned end of second orbit recovery area. The USS Stormes, a destroyer, recovered the capsule at latitude 29°02'N and longitude 65°57'W approximately one and one-half hours after landing. Except for not completing the three orbit mission, the test objectives were substantially accomplished.

Other than the roll control system malfunction previously noted, and somewhat higher than expected (but acceptable) cabin, suit inlet, and inverter temperature, the capsule systems functioned normally. The capsule was found to be in very good condition after the flight.

The chimpanzee performed excellently throughout the flight. His physiological reactions were as expected. The physiological parameters remained within the normal limits although he exhibited premature ventricular contractions (extra heart beats) after approximately 26 minutes of weightlessness. These were exhibited throughout the rest of the flight but did not interfere with his performance.

Further detailed performance data evaluation of the capsule systems and occupant is being performed.

AIRFRAME

Missile structural integrity was satisfactorily maintained throughout powered flight, during capsule separation, and until at least the completion of the second orbital pass, as indicated by propellant tanks pressure data.

Booster section jettison was normally accomplished as indicated by Measurement M 133 X, Booster Staging, at 133.2 seconds. The Atlas retro-rockets, normally installed in the forward end of the upper pod, were deleted. Instead, three posigrade rockets installed on the capsule provided separation velocity between the capsule and the booster. Measurement M 79 A, Missile Axial Acceleration Fine, indicated capsule separation upon posigrade rockets firing at 302.2 seconds.

Peak axial accelerations obtained from Measurement U 101 A, Missile Axial Acceleration, were 6.82 G's at booster engines cutoff and 7.70 G's at sustainer/vernier engines cutoff. Normal 5 cps longitudinal oscillations at lift-off of 0.75 G's maximum amplitude were damped by 26 seconds.

Mercury/Atlas Missiles have a telemetered measurement of engine compartment ambient temperature (P 14 T) located at Station 1210, Quadrant 2, used primarily for fire detection. This measurement indicated that the temperature did not rise above the reference junction temperature of 40°F. This measurement had been covered by insulation on Missiles 88D and 93D and no temperature rise was expected.

Measurement A 110 P, Adapter External Dynamic Pressure, was included in system instrumentation for continuing structural dynamic studies. The microphone utilized for this measurement was located on the outside of the capsule/booster adapter area in Quadrant 3. Response to dynamic pressure buildups was noted during the 3 second holddown period prior to launch, during the period the missile was approaching Mach 1, and after the maximum dynamic pressure region at approximately 65 seconds. The levels and general form of the data was comparable to that obtained from Missile 88D.

PROPULSION SYSTEM

Propulsion System performance was satisfactory throughout the flight. Engine thrust rise and decay appeared normal. The holddown time to verify engine performance prior to release was 2.97 seconds. Engine start was accomplished with an inert fluid lead (wet start). The RCC System was monitored on landline recorders. Acceleration levels at liftoff were 6G's, 5G's, and 7 G's, on B1, B2, and Sustainer Engines Respectively.

Sustainer and vernier engine cutoff occurred at the same time as no vernier solo operation was planned for this flight.

PROPULSION SYSTEM TIME SLICE DATA

Measurement No.	Description	Units	Nominal Values	L/L at Liftoff	TLM After Liftoff	TLM Prior to BCO	TLM Prior to SCO/VCO
Booster Engines							
P 1026 P	B Lo2 Reg Reference	psia	545*	551	-	-	-
P 100 P	B GG Combustor	psia	441	-	450	456	-
P 1017 T	B2 Turbine Inlet	dgf	1200	1145	-	-	-
P 84 B	B1 Pump Speed	rpm	6105*		6102	6102	-
P 83 B	B2 Pump Speed	rpm	6039*		6078	6078	-
P 60 P	B1 Thrust Chm	psia	541*	-	558	564	-
P 59 P	B2 Thrust Chm	psia	553*	-	546	546	-
P 1673 T	B1 Fuel Ign Vlv Amb	dgf	-	91	-	-	-
P 1674 T	B2 Fuel Ign Vlv Amb	dgf	-	64	-	-	
Sustainer Engine							
P 1326 T	S Turbine Inlet	dgf	1100	1099	-	-	-
P 339 P	SGG Discharge	psia	589	-	640	648	648
P 349 B	Sus Pump Speed	rpm	9944*	-	10110	10130	10110
P 528 D	PU Valve	deg	-	25.1	23.5	44.5	23.5

PROPULSION SYSTEM TIME SLICE DATA

Measure-ment No.	Description	Units	Nominal Values	L/L at Liftoff	TLM After Liftoff	TLM Prior to BCO	TLM Prior to SCO/VCO
Booster Engines							
P 1026 P	B Lo2 Reg Reference	psia	545*	551	-	-	-
P 100 P	B GG Combustor	psia	441	-	450	456	-
P 1017 T	B2 Turbine Inlet	dgf	1200	1145	-	-	-
P 84 B	B1 Pump Speed	rpm	6105*	-	6102	6102	-
P 83 B	B2 Pump Speed	rpm	6039*		6078	6078	-
P 60 P	B1 Thrust Chm	psia	541*	-	558	564	-
P 59 P	B2 Thrust Chm	psia	553*	-	546	546	-
P 1673 T	B1 Fuel Ign Vlv Amb	dgf	-	91	-	-	-
P 1674 T	B2 Fuel Ign Vlv Amb	dgf	-	64	-	-	-
Sustainer Engine							
P 1326 T	S Turbine Inlet	dgf	1100	1099	-	-	-
P 339 P	SGG Discharge	psia	589	-	640	648	648
P 349 B	Sus Pump Speed	rpm	9944*		10110	10130	10110
P 528 D	PU Valve	deg	-	25.1	23.5	44.5	23.5

Measurement No.	Description	Units	Nominal Values	L/L at Liftoff	TLM After Liftoff	TLM Prior to BCO	TLM Prior to SCO/VCO
P 6 P	S Thrust Chamber	psia	684*	-	710	700	680
P 1344 P	LO2 Reg Reference	psia	843	842	-	-	-
Vernier Engines							
P 28 P	V1 Thrust Chamber	psia	355	-	360	344	348
P 29 P	V2 Thrust Chamber	psia	355	-	356	340	348
Miscellaneous							
P 1021 T	LO2 At Breakaway Vlv	dgf	-	-296.7	-		-
P 1675 T	Eng Ctl Pneu Man	dgf	-	57	-		

* Value from engine acceptance test log.

PROPELLANT UTILIZATION

Operation of the General Dynamics/Astronautics Propellant Utilization (PU) System was satisfactory. The PU valve responded correctly to the Error Demodulator Output (EDO) signal. The Head Suppression Valve position was not monitored.

The EDO signal showed normal trend and developed the maximum LO2 rich signal at head sensing port uncovering. During the final phase of sustainer engine operation the EDO showed an oscillating characteristic similar to that observed on previous "D" Series flights. For approximately 30 seconds prior to reaching the maximum LO2 rich condition the EDO signal oscillated about the mean at a frequency of 0.5 cps with an average amplitude of plus 3 volts to minus 3 volts from the mean. PU valve response to the EDO signal oscillation was noted for about 20 seconds prior to the time the valve reached the closed limit. These oscillations were apparently caused by propellant slosh as indicated by concurrent variations in the LO2 tank head sensing pressure.

Residual calculations based on the time of fuel and LO2 head sensing port uncovering indicated 375 pounds of LO2 and 440 pounds of fuel remaining at SCO. These residuals represent a fuel excess of 270 pounds at SCO using a 2.28 mixutre ratio. There were sufficient propellants aboard for 1.9 seconds additional burning time after SCO with the PU and HS valves remaining in the same positions as at SCO.

The following constants were applicable for this flight:

Matched Set No. 351

Pu Valve Position

+ 15 Per cent	23.5 Degrees
Nominal	29.0 Degrees
- 15 Per cent	45.5 Degrees

EDO Volts/per cent 0.87

PNEUMATIC SYSTEM

System performance was satisfactory. Missileborne propellant tank pressures were satisfactorily maintained throughout flight. Supply pressure was adequate to perform all controls functions. Missile 93D was equipped with Hadley "D" Series pneumatic regulators and a Peacock "C" Series LO2 boiloff valve. Operation was satisfactory.

LO2 tank pressure was properly maintained within booster phase specification of 23.7 to 26.0 psig, except for a slight pressure trough between 1 and 4 seconds with a minimum of 23.3 psig. The same occurrence was noted on the flight data of Mercury/Atlas Missile 88D, and is apparently due to the inability of the pneumatic regulator to supply adequate helium to the LO2 tank when the ullage volume is rapidly increasing as a result of LO2 consumption and tank deformation (bulging) at liftoff. The flow through the regulator is restricted to 1 pound per second on all Mercury/Atlas flights to decrease the rate of LO2 tank overpressurization in the event of regulator failure.

LO2 boiloff continued to maintain tank pressure after jettison of the booster section, with 23 psig indicated at capsule separation.

Fuel tank pressure was properly maintained within booster phase specification of 55.5 to 59.9 psig until jettison of the pneumatic regulator with the booster section. Normal pressure decay to 47 psig at SCO/VCO was indicated.

Booster tank helium bottles pressure decay was normal.

The LO2/fuel tanks intermediate bulkhead differential pressure appeared normal and exhibited similar characteristics to those noted on Mercury/Atlas Missile 88D. Two separate measurements were made during flight. In addition to the standard Measurement (F 116 P), a second measurement incorporating a Pneumatic Filter (F 119 P) was made. The minimum differential pressures during the oscillatory period immediately after liftoff were 7.1 psid (F 116 P) and 10.4 psid (F 119 P), well above the ASIS capsule abort condition of 2.5 psid. Maximum oscillation noted was 7.2 psi (F 116 P), 1.2 psi (F 119 P), at 2 seconds. The pneumatic filter attenuation was clearly evident.

Sustainer control helium bottle pressure was adequate for all engine control functions throughout flight

PNEUMATIC SYSTEM TIME SLICE DATA

Measurement No.	Description	Units	Landline	Prior to Liftoff	After Liftoff	Prior to BCO	Prior to SCO/VCO
F 1 P	LO2 Tank Helium	psia	39.4	40.3	39.8	25.8	23.3
F 3 P	Fuel Tank Helium	psia	74.0	75.5	73.7	58.9	47.0
F 116 P	Inter Bulkhead D/P	psid	-	16.6	7.7-13.7*	11.8	23.2
F 119 P	Inter Bulkhead D/P, Filtered	psid	-	16.9	10.9-11.8	12.2	23.7
F 246 P	B Tk He Botties Hi	psia	3005	3005	2726	760	-
F 291 P	S Ctl He Bottle	psia	3185	3185	2935	2620	2450
F 1125 P	B Ctls Pneu Reg Out	psia	756	-	-	-	-
F 1288 P	S Pneu Reg Out	psia	636	-	-	-	-
F 1194 P	Facility GN2 Supply	psia	1872	-	-	-	-

* Data oscillating.

HYDRAULIC SYSTEMS

Systems performance was satisfactory. Hydraulic pressure was properly maintained throughout the booster and sustainer phases of flight to satisfy all engine control demands.

Hydraulic oil evacuation was indicated at -33.83 seconds from both booster and sustainer/vernier systems.

Booster system switchover from the Ground Booster Hydraulic Pumping Unit (HPU) to flight level was normal. B1 Hydraulic Accumulator Pressure telemetry data reflected 140 psi pressure variations in response to engine gimbaling demands from the Flight Control System.

Sustainer System switchover from the Ground Sustainer Hydraulic Pumping Unit to flight level was normal. Sustainer hydraulic accumulator telemetry data reflected normal flight pressures of about 3080 psia. After SCO/VCO, the accumulator maintained pressure for a period of 3.2 seconds before bottoming out at 24.0 psia.

The sustainer engine control manifold hydraulic pressure was maintained for 14 seconds after SCO/VCO by the associated accumulator which bottomed out at a pressure of 770 psia. Since cutoff of the sustainer and vernier engines was to be effected simultaneously on this flight, there was no vernier solo accumulator system installed.

Specific values from telemetry data are presented on the following page.

HYDRAULIC SYSTEMS TIME SLICE DATA

Measurement No.	Description	Units	-10 Prior to Liftoff	/5 After Liftoff	/128 Prior to BCO	/298 Prior to SCO/VCO
H 33 P	B1 Hyd Accumulator	psia	2210	3132	3132	-
H 52 P	S Hyd Accumulator	psia	2140	3080	3045	3010
H 310 P	S Eng Ctls Hyd Pressure	psia	2160	3120	3080	3080

MISSILE ELECTRICAL SYSTEM

System performance was satisfactory. Flight data indicated that electrical power was normally supplied to all user systems and that measured parameters remained within specification throughout flight. Major Electrical System components used on Missile 93D included the Bendix rotary inverter and the Eagle Picher main missile battery.

The inverter frequency, AC voltage Phase A, and the DC voltage exhibited small unusual step changes during booster phase. The inverter frequency stepped from 400.9 to 401.2 cps at 7 seconds. The AC voltage Phase A and the inverter frequency stepped from 115.0 to 115.2 vac and from 401.9 to 403.2 cps at 77 seconds, respectively. The missile systems input DC voltage stepped from 28.4 to 28.5 vdc at 98 seconds. There were no changes in any other systems at these times which would account for the above shifts.

Maximum and minimum values of battery voltage, and inverter frequency and voltage recorded during flight were as follows

Measurement No.	Description	Units	Specification	Flight Min.	Flight Max.
E 28 V	Missile Systems Input	vdc	26.0 to 30.2	28.0	29.3
E 50 Q	Inverter Frequency	cps	394 to 404	400.0	403.2
E 51 V	400 Cycle AC Phase A	vac	113.3 to 116.7	114.8	116.2

RANGE SAFETY COMMAND SYSTEM

Operation of the Range Safety Command System was satisfactory. Telemetered data indicated that the airborne received signal strength was adequate to ensure proper operation of the system until well beyond capsule separation. The Auxiliary Sustainer Cutoff (ASCO) signal was properly decoded by the airborne system at 300.525 ±0.05 seconds. It could not be determined; however, whether cutoff was initiated by the Guidance discrete or the ASCO signal. The Destruct Enable occurred approximately three seconds after SCO at 303.481 ±0.05 seconds. The nominal delay time is three seconds. There was no requirement for a Manual Fuel Cutoff (MFCO) signal and none was generated.

AZUSA SYSTEM

Operation of the Azusa System was satisfactory. The airborne received signal strength was not telemetered. However, ground station data showed a rapid drop in received signal strength after liftoff until 10 seconds. Signal strength then increased to an adequate level. This loss of signal was caused by cross polarization and a poor look angle as the airborne antenna moved to the opposite side of the missile from the ground station during the programmed roll.

The system was in Automatic Track from 16.4 to 19.05 seconds. Successful Automatic Tracking was achieved at 22.9 seconds. The range parameter was in the fine mode at liftoff but acquired ambiguous data. The range data was resolved by 48.15 seconds. Both angle cosine parameters were switched to the fine mode at 12.15. An ambiguity was resolved from the 'm' parameter from 45.65 to 47.65 seconds and an ambiguity was resolved from the 'ℓ' parameter from 49.95 to 51.9 seconds. Ground Station transmitter power was increased at approximately 100 seconds but did not reach full power. Loss of signal occurred at 370 seconds. The Automatic Data Select Function of the 7090 Computer chose Azusa data for IP from 53.4 to 141.4 seconds and from 141.6 to 346.1 seconds. Data was reducible from 36.7 to 347 seconds.

FLIGHT CONTROL SYSTEM

Performance of the Flight Control System was satisfactory. Data indicated that the programmed roll and pitch maneuvers during booster phase were satisfactorily accomplished. Engine displacements at engine start were within the allowable tolerance and liftoff transients were small. There were no missile bending mode buildups as occurred on Missile 88D. Propellant slosh amplitudes during booster phase were moderate and comparable to Missile 88D flight. The staging transients appeared normal as did the staging sequence. The sustainer phase pitch program was initiated properly and was executed satisfactorily. Data indicated that all programmer switching functions were accomplished satisfactorily. Response to the Guidance discrete and steering commands was satisfactory. There was an apparent propellant slosh buildup of small amplitude in the pitch plane toward the end of sustainer phase. This was successfully damped out prior to sustainer cutoff.

The pitch and yaw stabilization filters were revised for Missile 93D and subsequent Mercury booster to alleviate the indicated marginal stability for the third bending mode during the period following liftoff. A buildup of this mode was encountered during the first 21 seconds of the Missile 88D flight. The filter switching was revised to provide additional attenuation for the 20 second interval following liftoff.

Instrumentation of the programmer clock 10 pps output and switch no. 15, enable ASIS Engine Cutoff, yielded satisfactory data. Missile 93D was the first Mercury booster and the second Series "D" Missile to fly the gyro self-check system consisting of the Spin Motor Rotation Detector (SMRD) System and the self-test rate gyros utilizing DC torquers for ground testing. The SMRD logic module output was not telemetered during the flight.

GUIDANCE SYSTEM

Performance of the Guidance System was satisfactory. The discrete and steering commands necessary to fulfill the orbital trajectory requirements were properly transmitted by the ground equipment and decoded by the missileborne equipment.

The missile was acquired in the first cube as planned at 63.9 seconds and automatic monopulse lock was maintained until 351.5 seconds. Rate lock was attained in all functions at 57.3 seconds and continuous lock was maintained until 340.7 seconds.

Test results and individual subsystem performance were as follows.

Guidance Trajectory Data

The significant trajectory events referenced to the Mod III Guidance System and extracted from Sanborn data are itemized in Table I.

The computer coordinate frame of reference for Mercury Guidance is termed "Quasi-inertial". The computer equations convert the radar inputs to the earth centered, rectangular position coordinates Xi (ξ), Eta (η), Zeta (ζ) and the rate coordinates Xi-Dot ($\dot{\xi}$), Eta-Dot ($\dot{\eta}$), and Zeta-Dot ($\dot{\zeta}$). The term quasi-inertial is used to mean that the coordinate frame is redefined each computing cycle so that the Xi-Eta plane is equatorial and Xi-Zeta plane contains the phase center of the central rate antenna at the instant the data are valid. The north polar axis corresponds to Zeta.

Table I
Trajectory Data

Event	Nominal[1] (Discrete Time)	Occurrence Referenced to end of Thrust Decay
BCO		
Time, seconds	131.5	130.6
Range, feet	358,899	360,587
Range Rate, ft/sec	8,995	9,092
SCO/VCO		
Time, seconds	304.1	300.7

Event	Nominal[1] (Discrete Time)	Occurrence Referenced to end of Thrust Decay
Range, Feet	2,746.261	2,725,381
Azimuth, Degrees	72.39	72.12
Elevation, Degrees	6.43	7.70
Range Rate, Ft/Sec	23,582	23,552
Auxiliary Sustainer Cutoff		
	SCO $+4$ ms	300.49 ± 0.05[2]

(1) Based on Trajectory No. MA 5 T-10 and corrected to Range Time.

(2) Time signal received by Missile Range Safety Command System recorded on telemetry.

The data at the time the missile responded to sustainer cutoff discrete command are compared in Table II to the nominal trajectory data found in the DTO. The flight figures were obtained by graphically averaging the data.

Table II

Flight Parameters at Sustainer Cutoff
Compared to Expected Values

Parameter	Actual Value	Expected Value From DTO
Xi (ξ), ft	18,327,500	18,335,700
Eta (η), ft	2,580,000	2,584,000
Zeta (ζ), ft	10,810,000	10,799,000
Xi-Dot ($\dot{\xi}$), ft/sec	-6,340	-6,240

Parameter	Actual Value	Expected Value From DTO
Eta-Dot ($\dot{\eta}$), ft/sec	24,380	24,330
Zeta-Dot ($\dot{\zeta}$), ft/sec	4,840	4,800

Evaluation of Test Results

The tolerances specified for Guidance performance have been compared to the corresponding errors that existed after cutoff. Results of these comparisons are presented below in Table III

Table III

Parameter	Results	DTO Expected Value	Error	Tolerance*
Altitude (h), nm	86.634	87.000	-0.366	±0.3292
Inertial Velocity (V), ft/sec	25,662.3	25,695	-32.7	±35
Crossrange Inertial Velocity (Vy), ft/sec	-29.2	0	-29.2	±30
Flight Path Angle, Γ, deg	+0.021	0	+0.021	±0.21

* These tolerances were defined as acceptable values at NASA, MSC Headquarters, Mercury Conference, 2 November 1961.

From this table it may be seen that all required Guidance parameters were within tolerance except altitude. Changes were made in the equations which affect smoothing to improve the terminal inertial velocity and flight path angles. It would appear from the data that the accuracy of altitude and crossrange velocity have been degraded while improving inertial velocity and gamma over the results of 88D.

Following sustainer engine cutoff, the guidance computer made computations to determine whether orbital conditions had been reached. Successful attainment of orbital conditions was indicated on both the computer "Go" relay display and information transmitted to NASA. This signal indicated orbital conditions for 21.5 seconds after SECO. From that time to loss of data the indication was intermittent. However, the relay indicated successful orbit for 84 per cent of the time from SECO to loss of data - about 53 seconds.

Track Subsystem

Performance of the Track Subsystem was satisfactory. The subsystem acquired the missile in the first cube as planned at 63.9 seconds. Tracking from this time was normal and continuous until loss of signal. Automatic monopulse lock ended at 351.5 seconds; reacquisition did not reoccur.

Received signal strength throughout monopulse tracking was lower than expected and discrepancies in the video return were noted. These phenomenon have been investigated and are believed to be caused by anomalous performance of the pulse beacon after acquisition (See Pulse Beacon:) Operation of the system was not adversely affected.

Pulse Beacon

Late in the countdown the GE Airborne Engineer reported low Pulse Beacon magnetron current indications. Since all observations made at the ground Track System indicated normal video and no frequency deviation, the beacon was considered to be flight worthy.

The Track CEC recording reveals that immediately before liftoff the video was normal and that there was no frequency deviation. However, throughout the period from acquisition until loss of signal a constant 4 mc frequency deviation occurred and throughout most of this time the video split into three distinct levels. Beacon magnetron current during flight as indicated from telemetry was at a lower level than before liftoff.

Operation of the ground equipment has been normal since the flight and all tests and checks have revealed no ground system discrepancy that could have caused the phenomena observed. During tests with a laboratory beacon, pulse output similar to the output that occurred in flight was reproduced by shorting of the charging diode in the beacon modulator pulse forming network. It is considered probable that such an event was the cause of the discrepancies that occurred in flight.

The flight phenomena noted above did not adversely affect Mod III operation.

Rate Subsystem

The Rate Subsystem performance was satisfactory. The subsystem was locked in all functions at 57.3 seconds. Continuous lock was maintained until 340.7 seconds, 40.3 seconds after SCO/VCO. Received signal strength during the flight was satisfactory and as expected for this trajectory.

Measurements have been made of the cyclic variations in lateral digital data that began during the latter part of powered flight. Comparison with measurements made during the flight of 88D(MA-4) reveals that the variations were substantially reduced during the flight of 93D on both the 6000 and 2000 systems.

For example, peak to peak variation of lateral data at 7° elevation on this test was approximately 5 least counts in P-Dot and 6 in Q-Dot, compared with 12 least counts on the 88D flight. At 4° elevation, 9 and 12 least counts occurred on this test in P-Dot and Q-Dot, compared with 32 on 88D flight.

To yield data relating to lateral noise several special procedures were planned to be performed after SCO/VCO. Of these, only one, the switch to manual gain control (MGC), occurred before Rate unlock. All receivers were switched to MGC at 334 seconds, 33 seconds after SCO/VCO. No significant change in lateral data appears to have occurred after the switch. A planned procedure was the lay-down of the multipath fences at SCO +45 seconds. However, this action occurred after Rate unlock and therefore no evaluation of the effect of fences can be made.

Mod III Computer

Computer performance was satisfactory throughout the countdown and ensuing flight.

During normal post flight data processing, the computer input data is used to run a Guidance simulation. This was done with the data obtained during the MA-5 flight. The plotters and tapes (intermediate and output) matched identically with data obtained during the flight. This is evidence of no transient errors during the flight.

However, an incident occurred which did not affect the Guidance results, but did affect the data transmitted to NASA, and made time correlation of events confused. Approximately 12.5 seconds early, the computer received a signal which affected it the same as the two-inch liftoff signal. Following this event, the computer calculated a value for time from 2 Inch Liftoff, T_E, biased by this early event. This T_E affected the data being transmitted to NASA and showed the Mod III data to be significantly different from the range impact system data. Investigation has shown that the spurious pulse occurred at the time at which the radar recorders were started. The trouble has been isolated to the flight data recording subsystem and has been corrected.

Real Time Computer Plots

Plotter 1

The significance of this plot is the real time display of steering commands; ω_P for pitch and ω_Y yaw commands. Yaw right commands, though small in magnitude were given throughout the guidance phase.

Plotter 2

Gamma Γ , is the sine of the flight path angle, which is the angle between the missile velocity vector and the local horizontal. This is plotted versus cross-range component of velocity, V_Y . It may be seen that up to 15 seconds before staging the missile followed right on the nominal trajectory. It then began to diverge to the left. The small right turn, shown on plotter 1 was not enough to prevent the V_Y error from ending at 29.2 ft/sec at SECO.

Plotter 3

This plot shows the missile altitude (above a spherical earth), h versus inertial velocity, V. There is a faired nominal curve for comparisons. The plotted points follow along the nominal curve very closely. After SCO the data is plotted on the fine scale. The average of the velocity data is close to that desired. However, the time variation of velocity showed that after SCO the velocity increased slightly.

These data indicate that the noise content of the lateral rate data was considerably lower than that on the flight of 88D.

Amplitude of the plotted data scatter is estimated to be reduced by 25 per cent.

Guidance Command

The discrete and steering commands to fulfill the orbital trajectory requirements were properly transmitted and received at the missile.

Missile closed loop steering was enabled and initiated at 155.1 seconds with the generation of positive pitch of 67 per cent of full scale and positive yaw of 10 per cent of full scale. Pitch commands then decreased to zero in 15 seconds and yaw decreased to zero in five seconds. Thereafter commands were smooth and very small until 292.3 seconds, when brief positive commands of 25 per cent pitch and 5 per cent yaw occurred. From this time until SCO both pitch and yaw were very small. At 15 seconds before SCO small positive yaw commands were generated, becoming gradually larger and reaching a maximum of 12 per cent at SCO. This variation is indicative of a gradual deviation of missile control of about 3 degrees per minute such as could have been caused by thrust misalignment, Autopilot gyro drift, or airborne decoder drift.

The Range Safety Auxiliary Sustainer Cutoff was generated by Mod III approximately three milliseconds after SCO/VCO to provide a redundant command for SCO.

Table IV is the history of the discrete commands.

Table IV

Time and Duration of Discretes

Discrete	Range Time	Duration	EST
BCO	130.090	3.997	1010:07.090
SCO/VCO	300.407	0.680	1012:57.407
ASCO (Command)	300.410	4.68	1012:57.410

ABORT SENSING AND IMPLEMENTATION SYSTEM

Performance of the Abort Sensing and Implementation System (ASIS) was satisfactory. No critical missile performance was encountered and therefore, no abort command was generated during powered flight.

The ready condition was achieved at -3.79 ±0.01 seconds based upon satisfactory performances of monitored systems. Abort capability was enabled at 0.085 ±0.05 seconds.

Proper ASIS System performance was further evidenced by dropout of the B1 Fuel Injection Pressure Switch at booster cutoff, dropout of the sustainer fuel injection pressure switch at Sustainer/Vernier cutoff, and generation of the abort signal following sustainer fuel pressure decay. Dropout of the booster injection manifold pressure switches after booster cutoff does not generate an abort command as these functions are switched out of the circuit upon receipt of a booster cutoff signal. Dropout of the sustainer injection manifold pressure switch at sustainer cutoff does generate an abort command; however, the SCO command is connected to the capsule booster abort disarm relay which disarms the ASIS to prevent capsule action on the abort command.

PROPELLANT TANKING

Fuel Tanking

Fuel was tanked on 27 November 1961 to a level 34 gallons above the overfill probe and then drained until the level was just below the overfill probe and secured. On X-Day, approximately 20 gallons were topped to return the fuel to flight level between the 100 per cent and overfill probes. This additional fuel was required due to a bulk density shift of $+$ 0.09 lbs/ft^3. At ignition there were 76,050 pounds of fuel aboard at a density of 50.26 lbs/ft^3.

Fuel Density Data

Degrees API	43.0
Temperature	75.0 $^{\circ}$F
Calculated Density at Tanking	50.17 lbs/ft^3
Calculated Density at Ignition	50.26 lbs/ft^3

LO2 Tanking

LO2 Tanking was conducted referencing the level low and level high probes. Tanking was secured at a level 950 pounds above the weight monitored at the activation of the level high probe. At final status check the level was between the level low and level high probes. The LO2 tank pressure just prior to securing was 3.68 psig, resulting in a density of 70.35 lbs/ft^3. It could not be determined if the level low probe had uncovered prior to liftoff as the sequence pen monitoring this function was not inking at this time. On Missile 100D the level low probe uncovered 0.79 seconds after sustainer flight lock-in, and on Missile 88D there was no indication of uncovering. At sustainer flight lock-in the following conditions prevailed.

LO2 Weight	174,200 pounds
LO2 Tank Pressure	25.79 psig
LO2 Density	70.29 lbs/ft^3
EDO	$+$0.44 volts

Significant Weights	Nominal DTO	Nominal LWP	Test Results
MA-5 at Ignition	-	266,597	266,787
MA-5 at Liftoff*	258,768	260,203	260,452
MA-5 at Booster Cutoff	64,138	63,926	64,077
Booster Jettisoned	7,095	7,116	7,096
MA-5 at SECO/VECO	10,415	10,294	10,273
Total LO2 at Ignition	-	174,850	174,200
Total Fuel at Ignition	-	74,770	76,050
Expendable LO2 at Liftoff	167,634	168,714	168,655
Expendable Fuel at Liftoff	73,258	73,258	73,556

* Liftoff weights include 270 pounds of LN2 and 50 pounds of ice that are expended shortly after liftoff.

DTO - Nominal values obtained from the Detailed Test Objectives for 93D.

LWP - Load and Weight Parameters used in the 93D Range Safety Trajectory.

Weather Data	Fuel Tanking	Ignition
Pressure	30.105 Inches of Hg	30.005 Inches of Hg
Temperature	74.70 °F	63.20 °F
Relative Humidity	52.0 Per cent	75.0 Per cent
Wind Velocity and Direction	6.0 Knots - W	10.0 Knots - NW
Total Cloud Cover	10 Per cent	100 Per cent Thin
Time	1200 EST	1007 EST
Date	11-27-61	11-29-61

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 with the exception of maximum differential cylinder pressure at 2550 psig and B2 cylinder residual pressure.

Residual pressure data were based upon zero pressures taken 5 seconds after the blowdown. This was necessary since holddown cylinder pressure data at 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.	0.413
Time difference between start of B1 and B2 cylinder pressure decay	sec	0.010 max.	0.002
Time intercept of tangent at 2550 psig	sec	.110 min.	B1= 0.135 B2= 0.159
Residual pressure 0.5 seconds after 2550 psig	psig	350 max.	B1= 340 B2= 514
Maximum differential cylinder pressure after 2550 psig	psid	400 max.	618 B2 @ B1= 2550

TELEMETRY SYSTEM

The Telemetry System provided data until well after capsule separation. Required signal strength from the light-weight telemetry package was satisfactory. Data was also obtained from the Telemetry System on the first and second orbital passes over AMR. No attempts were made to acquire the signal after the second orbital pass.

Data indicated the usual 0.5 second dropout of the RF at Staging.

All measurements functioned properly.

Missile 93D contained one light-weight Mercury telemetry package operational at 232.4 mc. Basic telemetry channel assignment is given in Astronautics Report AZC-27-066 93. Included in that report are channel assignment, commutation information, frequency response, and made and model of transducer.

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LANDLINE INSTRUMENTATION

The Landline Instrumentation System provided satisfactory information.

Accelerometer information from RCC functions were recorded on FM tape. Data was satisfactory. Data from the corresponding five binary counters was recorded on AM tape. One measurement, P1454 W, B1 Primary Binary Counter, appeared to function properly. The other four measurements did not appear to function properly and no count was observed prior to or after liftoff.

Measurement E 1006 V, Inverter Phase A Voltage, provided no countdown data due to being inadvertently misadjusted.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The mission was successful and the Mercury Capsule was properly injected into orbit. Performance of all booster subsystems appeared satisfactory.

2. The lateral rate noise was approximately one-third that encountered during the flight of 88D.

3. Guidance cutoff conditions were close to the limits for cross-range error and inertial velocity and were slightly below the tolerance for altitude.

4. Anomalous returns of the track subsystem in flight were probably caused by a Pulse Beacon problem. This did not adversely affect Guidance System performance

Recommendations

1. Continue the investigation of the lateral rate cyclic noise phenomenon.

2. To investigate the cause of the near tolerance condition which existed at Guidance Cutoff.

COUNTDOWN TIME VERSUS EVENTS

This test was scheduled for a total countdown time of 390 minutes. The Mercury Capsule countdown started as planned at -390 minutes at 2330 EST on 28 November 1961. The Atlas Booster countdown started as planned at -360 minutes at 0000 EST on 29 November 1961. There were 5 holds totaling 212 minutes and one countdown recycle of 35 minutes which resulted in a total countdown time of 637 minutes. These holds and recycle were as follows:

1. At -165 minutes (0315 EST) a planned 60 minute hold was executed. The countdown was resumed at -165 minutes at 0415 EST.

2. At -65 minutes (0555 EST) a planned 30 minute hold was executed. The hold was extended for 15 minutes at 0618 EST in order to complete certain Mercury Capsule Countdown Operations. The hold was extended for an additional 15 minutes at 0632 EST for the same reason. The countdown was resumed at -65 minutes at 0655 EST after a total hold duration of 60 minutes.

3. At -30 minutes (0730 EST) a hold was called when the Mercury Capsule Telemetry High Link was found to be inoperative. The countdown was recycled to -65 minutes at 0742 EST and the hold was continued in order to investigate the problem. The Mercury Capsule was opened and investigation revealed an improperly positioned switch. The Mercury Capsule and Atlas Booster were returned to the -65 minute countdown configuration and the countdown was resumed at -65 minutes at 0855 EST after a total hold duration of 85 minutes.

4. At -15 minutes (0945 EST) for 4 minutes, due to an equipment problem at the Mercury Control Center. The Mercury Control Center was not receiving Guidance Ground Station Data. The problem was corrected and the countdown was resumed at -15 minutes at 0949 EST.

5. At -7 minutes (0957 EST) for 3 minutes, due to Low Pulse Beacon Magnetron Current indications at the Blockhouse Guidance Monitor Set and on telemetry data. Since all indications at the Mod III Guidance Facility were normal, it was concluded that this condition was an instrumentation anomaly. It was decided to launch with this condition existing and the countdown was resumed at -7 minutes at 1000 EST.

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

EST	Countdown Time	Countdown Procedure	Event
2330	T-390	T-390	Mercury Countdown Started.
0000	T-360	T-360	Booster Countdown Started.
		T-360	Range Safety Command Tests Started.
-	-		Range Safety Command Tests Completed Satisfactorily.
-	-	T-345	Electrical Connection of Red Destruct Box Started.
0023	T-337		Electrical Connection of Red Destruct Box Completed.
		T-335	Electrical Connection of Capsule Escape Rocket Started.
0130	T-270	T-308	Capsule Power Switch Up Started.
0135	T-265	T-294	Capsule Power Switch Up Completed.
0144	T-256	T-286	Capsule Command Checks Started.
0200	T-240		Capsule Cable Cutter Installation In Progress.
0207	T-233		Capsule Cable Cutter Installation Completed.
0215	T-225	T-225	Azusa Check Started.
0220	T-220		Azusa Reported "Go" by AMR.
0230	T-210	T-210	Azusa Check Completed Satisfactorily.
0315	T-165H	T-165H	Executing Planned 60 Minute Hold.

EST	Countdown Time	Countdown Procedure	Event
0343			Boot Installation Completed.
0404			Status Checks - All Reports "Go".
0415	T-165		Countdown Resumed.
0430	T-150	T-150	Guidance Beacon Testing Started.
		T-150	Flight Control System Tests Started.
0435	T-145	T-145	Main Missile Battery Activated.
0445	T-135	T-135	Loop Test Preparation Started.
0455	T-125	T-125	Loop Test Started.
0457	T-123	T-125	Landline Electrical Calibrations Started.
0503	T-117		Loop Test Completed Satisfactorily.
0504	T-116		Integrator Servo Gimbaling Test Will Be Rerun Due to Discrepancy in Data.
0524	T-95	T-65	Landline Electrical Calibrations Completed.
0525	T-95		Integrator Servo Gimbaling Test Rerun Was Satisfactory - Original Discrepancy Was Caused by Defective Sanborn Amplifier Which Will Be Replaced.
0546	T-74	T-75	Guidance Beacons On For Checkout.
0555	T-65H	T-65H	Executing Planned 30 Minute Hold.
0558		T-95	Raising East Service Tower Platforms.
0601			East Service Tower Platforms Have Been Secured.
0613			Guidance Beacon Checks Completed Satisfactorily.

EST	Countdown Time	Countdown Procedure	Event
0618			Extend Hold Additional 15 Minutes For Mercury Capsule Operations.
0632			Extend Hold Additional 15 Minutes For Mercury Capsule Operations.
0641			Loop Test No. 2 Started.
0647			Loop Test No. 2 Completed Satisfactorily.
0650			Status Check - All Reports "Go".
0655	T-65		Countdown Resumed.
0700	T-60	T-60	GN_2 Topping Gear Secured.
		T-60	Helium Storage Started.
0701	T-59	T-60	Raising West Service Tower Platforms.
0710	T-50	T-50	Flight Control System Final Check Started.
		T-50	Service Tower Removal and Securing Started.
0711	T-49	T-40	LO_2 Tanking Preparation Started.
0722	T-38		Gyro Stiction Test Started.
0725	T-35	T-35	Capsule Telemetry and Beacons "On".
0727	T-33		Will Hold At -30 Minutes Due to Loss of Capsule Telemetry High Link.
0729	T-31		Mercury Control Center, Hangar S, and GMCF No. 1 Are Receiving a Liftoff Signal.
0730	T-30H		Holding For Capsule Telemetry High Link Problem - Hold Duration Indefinite.

EST	Countdown Time	Countdown Procedure	Event
0733			Service Tower Being Returned to Test Stand.
0741			Will Recycle Countdown to -65 Minutes And Continue Hold - Estimate 75 Minute Hold Duration.
0742	T-65H		Countdown Recycled to -65 Minutes and Hold Continued.
0800			Service Tower Has Been Returned to Test Stand and Platforms Lowered.
0820			Capsule Telemetry High Link Problem Was Caused By Incorrect Positioning Of Switch In Capsule.
0834			Will Rerun Loop Test In 6 Minutes.
0843			Loop Test No. 3 Started.
0849			Loop Test No. 3 Completed Satisfactorily. Status Checks - All Reports "Go".
0855	T-65		Countdown Resumed.
0857	T-63	T-60	Raising West Service Tower Platforms.
0900	T-60		West Service Tower Platforms Are Locked In Position.
		T-60	GN2 Topping Gear Secured.
		T-60	Helium Storage Started.
		T-50	Flight Control System Final Check Started.
0905	T-55	T-50	Service Tower Being Removed to Maintenance Area.

EST	Countdown Time	Countdown Procedure	Event
0906	T-54	T-40	LO2 Tanking Preparation Started.
0911	T-49		Gyro Stiction Test Started.
0917	T-43	T-35	LO2 Tanking Started.
0925	T-35		Mercury Control Center Has A Problem With Signal Buffer Equipment-This Condition May Require Subsequent Hold.
0935	T-25	T-25	Azusa Check Started.
0938	T-22	T-22	Range Safety Command Final Test Started.
0940	T-20		Flight Control System Final Check Completed.
0943	T-17	T-17	Telemetry Final Check Started.
			Will Hold at -15 Minutes For Mercury Control Center Problem - No Estimate On Hold Duration.
0945	T-15H		Holding For Mercury Control Center Problem.
0949			Mod III Guidance Pulse Beacon Magnetron Current Problem Reported.
0949	T-15		Countdown Resumed.
0950	T-14		Azusa Reported "No-Go" By AMR.
0953	T-11		Azusa Was "Go" On Internal Power.
0954	T-10	T-10	Capsule Telemetry "On".
		T-10	Range Safety Command Final Test Completed Satisfactorily.

EST	Countdown Time	Countdown Procedure	Event
0955	T-9		Azusa Reported "Go" On External Power By AMR. Mod III Guidance Requests Hold At -7 Minutes To Resolve Pulse Beacon Magnetron Current Problem - Estimate 10 Minute Hold Duration.
0957	T-7H		Holding For Mod III Guidance Problem.
0959			Mod III Guidance Problem Appears to Be A Missileborne Instrumentation Anomaly - Will Proceed With Countdown "As Is".
			Status Check - All Reports "Go".
1000	T-7		Countdown Resumed.
		T-7	RCC Switch to "Active".
		T-7	Forecast Final Range Clearance From AMR.
1002	T-5	T-5	All Communications Switch to Channel 1.
	T-3:50	T-3:50	Status Check - All Reports "Go".
	T-3:30	T-3:30	T-3 Minutes 30 Seconds and Counting.
		T-3:30	Telemetry to "Internal".
1004	T-3	T-3	Timer Off - Ready Switch to "Ready".
	T-2:10	T-2:10	Securing LO2 Tanking.
1005	T-2:00	T-2:00	Starting Flight Pressurization.
		T-2:00	Turning Water Systems "On".
	T-1:45	T-1:45	Arm Switch to "Arm".
		T-1:45	Engine Preparation Complete Light "On".

EST	Countdown Time	Countdown Procedure	Event
	T-1:40	T-1:40	Missile To Internal Power.
	T-1:15	T-1:15	Status Check - All Reports "Go".
1006	T-0:60	T-0:60	T-60 Seconds And Counting.
		T-0:60	Missile Helium To "Internal".
		T-0:60	Autopilot To "Arm".
		T-0:60	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 "On".
	T-0:19	T-0:35	Eject Mercury Capsule Umbilical.
		T-0:35	Mercury Umbilical Clear.
		T-0:26	Mercury "Go".
		T-0:25	Oil Evacuate.
		T-0:25	Evacuation Lights "On".
		T-0:18	All Recorders to "Fast".
		T-0:18	T-18 Seconds And Counting.
		T-0:18	Engine Start.
1007:57			Range Zero.

CAPSULE/BOOSTER CONFIGURATION

Mercury/Atlas Booster 93D was an SM-65D missile modified for the Mercury Project in accordance with the GD/Astronautics Report AZC-27-026, "Model Specification for Atlas/Mercury (HS-36) Booster USAF Model SM-65D (Modified) Astronautics Model 27", Reference 10.

Airframe

Astronautics "D" Series airframe with the following significant modifications.

a. "C" type peacock LO2 boiloff valve.

b. Installed a forward rate gyro package.

c. Skull cap insulation added to the top of the LO2 tank dome, boiloff valve and ducting.

d. LO2 tank skin thicknesses were increased. (See Table 5-1 in Detailed Test Objectives.

Azusa System

Type "B" coherent carrier transponder with flush mounted, co-axial fed antenna in conjunction with the Mark II tracking facility.

Abort Sensing and Implementation System (ASIS)

System operated closed loop. Comprised of instrumentation monitoring specific Atlas Booster system parameters to sense impending malfunctions and activate Mercury Capsule escape system.

Critical parameters monitored were:

1. AC Voltage
2. Attitude Rates
3. LO2 Tank Pressure
4. LO2/Fuel Tank differential press.
5. Booster and Sustainer engine fuel injector pressure.
6. Sustainer hydraulic pressure
7. Loss of capsule/booster electrical interface.

Abort System Control Unit

1. Quad diode matrices were added in parallel with the coil of all ASCU relays in order to suppress transients resulting from the in-flight operation of such relays.

2. For purposes of autopilot programmer instrumentation telemeter signal M 394 X was added to record the 28-volt signal from the programmer to the ASCU at 30 seconds.

ASIS Arm Relays

Both ASIS arming relays were modified for transient suppression by the addition of quad diodes across the relay coil.

Missile Harness Changes

1. The Abort System arming function at 2 inch motion was separated from the autopilot programmer arming function also occurring at 2-inch motion. A new umbilical wire was assigned for use by the Abort System. No connection, either ground or missileborne, now exists with the autopilot programmer start function.

2. The T-O function to the capsule is no longer routed through the autopilot programmer arm/safe switch in order to minimize interface between the ASIS and the programmer.

Because of the foregoing modifications, new dash numbers were assigned to the affected components.

Electrical System

Standard electrical system utilizing a Bendix rotary inverter and a remotely activated, primary type, Eagle-Picher main missile battery.

Guidance System

Mod III A radio guidance system. The missileborne rate and pulse beacons had individual antennas which were installed on B2 pod. These two antennas were traveling wave type antennas and were flushmounted to individual ground planes. The mounting of the ground planes was at an angle of 12 1/2 degrees relative to the missile longitudinal axis, with the apex of the angle forward.

As a backup to the SCO/VCO discrete, an Auxiliary Sustainer Cutoff (ASCO) signal was generated in the Mod III Guidance Computer within five milliseconds after SCO/VCO for a period of 4.0 seconds. This ASCO, through separate relay closure, caused the range safety transmitter at Station 5 to transmit the appropriate tone combination to cause cutoff of the sustainer and vernier engines.

Hydraulic Systems

Modified Astronautics hydraulic systems; booster and sustainer systems only (vernier solo package deleted.)

Impact Predictor

Azusa transponder and tracking system.

Pneumatic System

Standard Astronautics system with Hadley "D" tank pressurization regulators.

Propellant Tanking System

Astronautics Propellant Loading Control Unit with re-designed LO2 level probes.

Propellant Utilization System

Astronautics liquid manometer system with 10 kc feedback.

Propulsion System

Rocketdyne MA-5 rocket engine system using wet start procedure. Holddown time delay of 3.00 seconds between "Main Engines Complete" and "Pre-release Cutoff Disarm." An engine relay box was utilized which incorporated ECP MA-5-43. This modification incorporated a redundant sustainer cut-off circuit.

RC filter networks added to booster and sustainer/vernier cutoff relay circuits to reduce possibility of inadvertent engine cutoff resulting from spurious transients.

Utilized two independent parallel rough combustion cutoff (RCC) systems for each booster engine and one RCC system for the sustainer engine. Backup RCC accelerometers were connected through 42 inch motion for instrumentation purposes.

Vernier solo refill orifices for refilling start tanks were plugged.

Range Safety Command System

Modified system with two ARW-62 receivers and incorporating two improved three second destruct delay relays. Auxiliary Sustainer Cutoff (ASCO) signal transmitted as backup to SCO to be initiated by the Mod III Guidance Computer within 5 milliseconds after SCO/VCO discrete. NASA Flight Dynamics Officer also has capability of initiating ASCO. Transmission of Manual Fuel Cutoff (MFCO) is not required; however, the capability does exist. Utilized two manually activated Yardney batteries. The ASCO circuitry was rerouted to bypass the autopilot programmer.

Telemetry System

One FM/FM telemeter transmitted Atlas systems data at 232.4 megacycles. A lightweight Mercury telemetry package was utilized. Electrical power for the telemetry system was provided by a manually activated secondary type Eagle-Picher battery.

Capsule/Booster Adapter

A slightly tapered, cylindrical shaped, titanium structure of semi-monocoque construction 50.75 inches high. Height is sufficient to provide clearance for booster LO2 tank dome, boiloff valve, and capsule retro-rocket package. Upon receipt of an abort signal, booster and sustainer engines are cut off; Mayday relays are energized and capsule adapter clamp-ring explosive bolts are fired.

Separation of capsule from booster was acoomplished by posigrade rockets in retro-rocket package .

Mercury Capsule

The overall length of the Mercury Capsule and its escape tower was 294.39 inches. The capsule itself was 114.83 inches in length and 74.50 inches in diameter. The main capsule section contained the pressurized cabin, the recovery compartment, the heat shield, and all of the major capsule systems. The escape system consisted of a tubular support structure, the main escape rocket, the pylon jettison rocket, and aerodynamic spike, ballast, a heat shield for the horizon scanners, and an attaching clamp ring. The MA-5 capsule carried a medium-size primate aboard for this mission.

The following major MA-5 Capsule Systems were aboard for this flight.

1. Communcations
2. Stability and Control
3. Reaction Control
4. Environmental Control
5. Electrical Power
6. Explosive Devices
7. Cabin Equipment
8. Landing and Recovery
9. Rocket Systems
10. Protection from External Heating.

Flight Control System

Square canister autopilot system. Autopilot control rate gyros were located at Station 675; displacement gyros and redundant rate gyros were located at Station 975.

System modifications included:

1. A sustainer phase pitch program of 2.0 degrees/second pitch down between the interval of Staging +5.0 seconds and Staging +24.0 seconds.

2. Incorporation of a 4 + 3 cps lag for the stabilization filter from launch to 20 seconds.

3. Incorporation of a 4 + 8 cps lag for the stabilization filter from 20 secs to 85 secs and from booster cutoff to the end of powered flight.

4. Incorporation of a 4 + 3 cps lag for the stabilization filter from + 85 seconds to BECO.

The electronic programmer was modified per ECP 1370. Some of the more significant modifications affecting the Flight Control System were:

1. Programmer in-flight reset capability was disabled.

2. Filters were added to the 28V and 115V bus to remove spurious high amplitude electrical transients.

3. 2" Motion relays were divorced from the Autopilot System to prevent spurious electrical transients from occurring from the interconnection.

4. The stop lead was isolated to preclude harness leakage.

5. Capsule start circuitry did not go through the Autopilot safearm switch. This modification was to prevent high amplitude electrical transients from inadvertently initiating capsule functions.

HISTORY OF SM-65D MISSILE NO. 93D

Mercury/Atlas Booster 93D arrived at AMR by air transport on 9 October 1961. Transfer from the IOC trailer to the R and D trailer and to south bay of Hangar "J" was accomplished on the same day. The missile was weighed on 12 October 1961 and transferred to Complex 14 and erected on the same day. Pre-launch operations were performed in accordance with planning documented in Report AA 61-0145, Flight Test Directive, Mercury/Atlas Vehicle 93D.

Significant events concerning Mercury/Atlas Booster 93D from arrival at AMR to launch are delineated below.

Date	Event
12 August 1961	Arrived at AMR.
5 October 1961	Missile weighing
6 October 1961	Transferred to Complex 14 and erected.
31 October 1961	Satisfactory Flight Acceptance Composite Test.
1 November 1961	Successful Propellant Tanking.
6 November 1961	Satisfactory Joint FAC Test.
9 November 1961	Successful Propellant Tanking.
11 November 1961	Unsatisfactory Joint FACT
14 November 1961	Satisfactory Booster FACT
24 November 1961	Satisfactory Joint FACT
29 November 1961	Flight.

A brief description of significant difficulties encountered in system preparation and testing accomplished at AMR is as follows:

Landline Instrumentation

No significant problems were encountered.

Missile Electrical

IR 653820 - Main missile battery Plug P995 was received from San Diego with large pins spread. Plug was replaced.

IR 653828 - Destructor mount installation was not per B/P when installed in San Diego, Brackets were re-located per B/P.

IR 653875 - Power C/O Switch Serial No. 011-0064 removed because it was operated under sustainer high current conditions during performance of Joint FACT on 6 November 1961.

IR 653874 - Inverter Serial Number 102-0202 was removed because it was operated under low voltage conditions during performance of Joint FACT on 6 November 1961.

IR 653881 - Inverter Serial No. R50 receptacle J791 damaged because of mating of plug with voltage turned on.

IR 653882 - Power C/O Switch Serial No. 010-0058 removed because of excessive current being drawn through contacts when inverter was plugged in with voltage turned on.

IR 653876 - Inverter Plug P791 replaced because of damage as a result of mating with J791 with voltage turned on.

IR 653908 - Harness 27-61906-817-01 Main Missile Battery P885 Pin "E" to ground plate Wire No. P155A16X too short. The wire was rerouted.

IR 653897 - Main Missile Battery Plug P995 replaced because of cracked potting compound.

Range Safety Command

RSC Battery Mount 27-61199-1 was not installed on missile in San Diego. The mount placed on critical shortage and added with P/C 27-61028-503-08.

Azusa

IR 653848 - Azusa canister Serial No. 026-0045 indicated slow warmup time. Can was returned to service center and new can installed.

IR 653862 - Azusa Canister Serial No. 026-0046 indicated slow warmup time. Can was returned to service center and new can installed.

Telemetry

Four parts were replaced in the Light Weight Telemetry Canisters, 27-12290-803.

1. The transducer power supply had an output of 3.0 volts instead of 5.0 volts. Reference : IR 653835 and IR 672955.

2. The channel seven sub-carrier oscillator was noisy. Reference: IR 653854 and IR 672998.

3. The transmitter had several intermittent power drop outs. Reference: IR 656035.

4. The crystal rectifier had an open in the E51V circuit. Reference: IR 646038.

The telemetry canister mount was not adjusted properly according to note 5 on 27-11512. The braces were adjusted to give the proper distance between the mounts. Reference: IR 653834.

Flight Control

During Sustainer Engine Alignment per Procedure 27-93549-1C, Sustainer Pitch was 5/16 inch toward the B1 Engine with 3/16 inch specified. Tolerance was broadened to 5/16 inch per SanCap 10-834 and EO 240750 to Procedure 27-93549-1C.

While conducting Booster Engine Alignment per 27-93587-1D, B2 Pitch measured 0.27 inches toward the blockhouse with 0.25 inches from level specified. This was an acceptable tolerance reference SanCap 10-619 dated 24 October 1961. Procedure was changed per EO 240763 effective on Missile 93D only.

Vernier 2 Yaw Feedback Transducer Connector P603 Pin "B" reference harness 27-62711-925-02 wire pulled out of one end of splice located approximately six inches from connector. This was found during re-wrapping of harness. Splice was poorly crimped, and was replaced on IR 653853 and satisfactory operation obtained.

Guidance

Pulse Beacon 1A9005, Rate Beacon 4A1010 and Decoder 8A1032 (ground test only units) removed and 1A9044, 6A9005, 8A1045 (Mercury flight qualified units) installed on missile. 1A0944 had high magnetron current and no power output and was returned to depot for repair, and replaced by 1A9045

Pin tension test per TPS 14-1347 was conducted on decoder, pulse and rate beacon power Connectors 5A1P1, 3P1, and 4P1 . All three connectors failed and were replaced on IR 653867. When connectors were changed, an MC11E-10-6SN type was replaced in error with an MC11E-10-6SY type on pulse beacon connector 3P1.

While conducting the Mod III Compatibility Check per 27-93526-1A, the pulse beacon failed. Indication was loss of 100 volt power supply and high magnetron current. Malfunction was connected with wrong clocking on Connector 3P1. Connector was replaced with correct item, pulse beacon 1A9045 replaced by 1A9005 (Ground test only). Subsequently Pulse Beacon 1A9005 was replaced by 1A9044, a Mercury qualified unit.

Hydraulics

The airborne hydraulic fill and bleed procedure had to be rerun several times to regain bleed lost for reasons such as replacement of vernier hydraulic filters (IR 653805 and IR 653806), replacement of hydraulic line (IR 653898), and removal of pressure gages and pressure switches for calibration.

The engine turbo-pumps had to be re-preserved per 27-90475-Bk 1C due to schedule slippage after the pumps were rotated in bleed procedure.

Propellant Utilization

No significant problems were encountered.

Propulsion

Discovery of an unreliable HS 394 Booster Bootstrap LO2 flexline led to the subsequent replacement of five R-10952 Flexhoses found defective on arrival.

Abundance of leaks were detected including eleven (11) in closing control system, fifteen (15) in start system, Vernier No. 1 LO2 dome leaking (IR 653846), 27-72268 Fuel Probe leaking in Pod I (IR 653825), Part No. 100142 High Pressure LO2 Duct Orifices leaking (IR 653826), and Part No. 301992 LO2 Start Tank Vent and Relief Valve leaking (IR 653836).

Detected booster GG omega joint tie rod without clearance (IR 653865). Although requirement to make this check was no longer mandatory, this problem was found to still exist and caused several man-hours to readjust.

Detection of vernier engines being loose in mounting. This could have caused serious damage in flight (IR 653879 and IR 653880) had not the bolts been replaced and tightened.

Major interference between vernier engine electrical conduits (27-61393) and LO2 lines (350785). Replacement of conduits (IR 653891 and IR 653892) and attempt to readjust (TVA 32319) did not resolve interference. Replacement of LO2 lines to another type(350432) per GMA 10-849 finally resolved problem after extensive loss of man-hours and slipped completion of vernier fairing installation from 30 October 1961 to 27 November 1961.

NAS 1291-4 nuts were installed on booster high pressure ducting instead of NAS 679-A4 per blueprint (IR 653831). Nuts were replaced taking several man-hours, but not affecting schedule.

Detection of water in trich GSE. Unit was drained, purged, refilled, and re-sampled many times before results were acceptable.

Complex Mechanical

During Missile 93D checkout a problem developed concerning the launcher stabilizing system whereby a satisfactory hydraulic fill and bleed could not be maintained. The south stabilizing cylinder was found to be defective and was replaced. (Reference: IR 669935) The stabilizing system was inoperative for two days due to this problem.

Complex Electrical

Excessive potting compound was found in receptacles J1007, J1003, J1005, and J1004 during performance of 27-93494-Bk 1B, Umbilical Adjustment Procedure, causing misalignment of the locking stud insert. The potting was removed and locking stud adjusted to proper depth on 1007 and 1005. Receptacles 1004 and 1003 required further rework due to bad harness routing inside the doghouse. The doghouse was opened and the respective harnesses were rerouted to relieve the strain on the back plate of the receptacle thus allowing the locking stud to be adjusted to the proper depth.

The coax cable in the thrust section for B1A had to be rerouted per TVA A 32938.

An interference problem with the MAC umbilical eject lanyard occurred due to the installation of the White Room door. An additional slide bumper had to be added to the umbilical opening in the White Room door to prevent the lanyard from "hanging up" during tower removal.

Propellant Tanking

During propellant tanking, the ground fuel fill and drain valve actuator shaft seal developed a slight leak. The tanking operation continued, but the valve was replaced at conclusion of the test. (Reference: IR 650228) This is the second recent occurrence of this failure.

Also during propellant tanking, no output could be obtained through the LO2 2 inch topping line. It was later found that moisture in the LO2 system had caused a check valve in the by-pass line from 6 inch to 2 inch systems to freeze open allowing LO2 to pass into the 2 inch line from the 6 inch line. This condition can be attributed to the warmup and entry of the LO2 storage tank, introducing moisture into the system. The check valve was cleaned, dryed and reinstalled into the system thus correcting the problem.

Airframe

Distorted holes in 7-73806 Adapter Ring experienced (IR 653813) while attempting to install interim Mercury adapter (TVA 32678). This cost many man-hours, but did not significantly slip tasks.

Interference was found when attempting to install new 27-72472-3 Heat Shields on vernier fairings. Trimming was attempted (IR 653877 and IR 653878) but to no avail. Redesigned -5 shields were finally installed.

Pneumatics

During performance of 27-93417-Bk 1G, the fuel emergency raise valve No. 43 was sticking open and a pin in the linkage of the fuel emergency lower Valve No. 60 was sheared. A replacement was not available for either valve, making it necessary to rework the valves before continuing the procedure. Valve No. 43 was found to be contaminated and the emergency system was IR'd. TPS 14-1290 was written to check for further contamination, but none was discovered and IR was cleared.

During the propellant tanking on 1 November 1961 fuel entered the fuel PU head sensing line contaminating the system. This was caused by the low output of the constant flow valve. The components of the head sensing system were IR'd and replaced and the lines were cleaned per TPS 14-1334. 27-93551-1A was rerun to check the replacement constant flow valve and 27-93469-2E was rerun to leak check the head sensing system after the cleaning. To prevent a recurrence of this problem it was decided that a constant flow valve inlet pressure of 600 psig must be maintained any time the PU head sensing line is connected to the missile tank.

Because of launch slippage, the 30 day limit on the regulator was exceeded necessitating a rerun of Procedure 27-90286-Bk 1D, A/B High Pressure Leak Check and Regulator System Test. During the rerun of the procedure, the launcher shuttle valves were in the closed position shutting off sensing pressure from the A/B regulators and relief valves, which caused the regulators to be full open and the relief valves inoperative upon stepping to internal pressurization. As a result, the A/B ducts were over-pressurized. It was necessary to IR and replace the A/B regulators, relief valves, and the changeover valve. The ducts were inspected for damage because of over-pressurization, and leak checked per 27-93509-Bk 1F. A portion of 27-90202-1C was performed to check the bellows for damage because of over-pressurization. 27-93417-Bk 1H, Checkout of Ground Pneumatic System, was performed to check the PCU for damage, but none was discovered.

ASIS

A very significant delay [illegible]ulted from decision to modify test set for real time recorder and PC[illegible] [illegible]odification and validation delays were very time consuming.

APPENDIX

FLUID CHEMICAL ANALYSIS

Liquid Oxygen

	Units	Sample	Specification
Purity	Per cent	99.55	99.2 Minimum
Hydrocarbons			
As Carbon	ppm by wt	25	75.0 Total Maximum
As Acetylene	ppm by wt	None	1.5 Total Maximum
Particle Count			
350 - 500	Microns	0	2 Maximum
500 +	Microns	0	0

This item is within specifications.

Gaseous Helium

	Units	Sample	Specification
Purity	Per cent	99.95	99.9+ Minimum
Hydrocarbons	ppm by wt	None	75.0 Total Maximum

This item is within specifications.

Gaseous Nitrogen

	Units	Sample	Specification
Purity	Per cent	99.8	99.5 Minimum
Hydrocarbons	ppm by wt	None	75.0 Total Maximum

This item is within specifications.

Lubricating Oil

	Units	Sample	Specification
Viscosity @ 100°	Centistokes	23.97	23.0 to 34.0
Flash Point	°F	357	280.0 Minimum
Viscosity Index		90.3	80.0 Minimum

This item is within specifications.

	Units	Sample	Specification
Trichloroethylene			
Color		Pass	Not dyed.
Odor		Pass	Characteristic
Specific Gravity	@68°/68°F	1.475	1.454 to 1.476
Water Content	@+14.0°F	Pass	Cloudless
Non-volatile	Per cent	0.0005	0.002 Maximum
Distillation			
Initial Boiling	°F	188.5	187.7 minimum
Dry Point	°F	188.7	190.4 Maximum

This item is within specifications.

	Units	Sample	Specification
Fuel, RP-1			
Initial Boiling	°F	344	Report
10 Per cent	°F	380	365 - 410
50 Per cent	°F	417	Report
90 Per cent	°F	456	Report
End Point	°F	486	525 Maximum
Residue	Per cent	1.2	1.5 Maximum
Loss	Per cent	0.1	1.5 Maximum
Gravity	°API	43	42.0 to 45.0
Particle Count			
350 - 500	Microns	8	20 per liter.
500 +	Microns	1*	0

* This item was not within the specification delineated in CCN No. 29; however, this was deemed acceptable.

	Units	Sample	Specifications
Hydraulic Fluid - Booster			
Flash Point	°F	210	200.0 Minimum
Color		Clear	Report
Viscosity @130°F	Centistokes	8.3	8.0 - 10.5
Dye		Red	Red
Particle Count			
10 - 25	Microns	4080	5500 Maximum
26 - 50	Microns	960	1200 Maximum
51 - 100	Microns	180	300 Maximum
100 - 500	Microns	6	20 Maximum
500 +	Microns	0	0 Maximum

This item is within specifications.

Hydraulic Fluid - Sustainer

	Units	Sample	Specifications
Flash Point	°F	210	200.0 Minimum
Color		Clear	Report
Viscosity @130°F	Centistokes	8.38	8.0 - 10.5
Dye		Red	Red
Particle Count			
10 - 25	Microns	3840	5500 Maximum
26 - 50	Microns	1200	1200 Maximum
51 - 100	Microns	240	300 Maximum
100 - 500	Microns	9	20 Maximum
500 +	Microns	0	0 Maximum

This item is within specifications.

REFERENCE DOCUMENTS

Flight Test Plan - Missile No. 88D	AE 60-0783
Detailed Test Objectives (AFBMD/Aerospace)	TOR-594(1101)-DTO-8
Flight Test Directive (FTWG)	AA 61-0145

Technical Requirements for Atlas Project Mercury Ascent Guidance Equations. STL Reference No. 7230.5-1435 dated 19 December 1961 classified Confidential.

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

Report	Approximate Issue Date (time after test)
General Dynamics/Astronautics, San Diego, Calif.	
Flight Test Evaluation Report	14 days
AFBMD/Aerospace, El Segundo, Calif.	
Flight Evaluation Summary	3 - 4 weeks
GE/Burroughs, AMR	
Guidance System Preliminary Evaluation Report	10 days
General Electric, Syracuse, N. Y.	
Guidance System Detailed Evaluation Report	6 - 8 weeks
NASA, Project Mercury Space Task Group, Langley Field, Va.	
Post Launch Report	10 days

SERIAL NUMBERS OF SYSTEM COMPONENTS

Azusa Transponder

Canister, Serial No. 026-0041

Range Safety Command System

Range Safety Command Receiver No. 1, Serial No. AF 61-160
Range Safety Command Receiver No. 2, Serial No. AF 60-90
Range Safety Command Receiver No. 1, Battery Serial No. 106-0540
Range Safety Command Receiver No. 2, Battery Serial No. 106-0533
Range Safety Command Power and Signal Control Unit, Serial No. 104-0050

Propulsion System

Sustainer, Serial No. 222144
Booster, Serial No. 112144
Vernier No. 1, Serial No. 332293
Vernier No. 2, Serial No. 332298

Electrical System

Main Missile Battery, Serial No. 106-1259
Inverter, Serial No. 107-0226
Power Changeover Switch, Serial No. 012-0068

Guidance System

Decoder, Serial No. 8A1044
Pulse Beacon, Serial No. 1A9044
Rate Beacon, Serial No. 6A9005

Telemetry System

Telemeter RF, Serial No. 107-0006
Telemeter RF, Battery, Serial No. 101-0024

Flight Control System

Gyro Canister, Serial No. 110-005(236)
Forward Rate Gyro Canister, Serial No. 109-0049(56)
Servo Canister, Serial No. 101-0088(100)
Programmer Canister, Serial No. 104-0001(215)

Propellant Utilization System

Matched Set, Serial No. 351

Abort Sensing Implementation System

Canister, Serial No. 109-0033(31)

SIGNIFICANT DATES DURING TESTING OF MERCURY/ATLAS VEHICLES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
10D	4-10-59	14	6-2-59 *7-22-59	9-3-59	9-9-59	2119	Successful flight although booster section failed to jettison. Project Mercury Capsule recovered.
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.
67D	7-8-60	14	11-4-60	11-19-60	2-21-61	419	Successful MA-2 mission. Impacted Mercury Capsule as planned. First closed loop flight for ASIS. Capsule recovered.
100D	3-14-61	14	3-27-61	None	4-25-61	835	Unsuccessful. Missile was destroyed by range safety action 40 seconds after lift-off. This action was necessitated by the absence of the roll and pitch-over maneuvers.
88D	7-16-61	14	7-19-61	None	9-13-61	1254	Flight was successful. Capsule was placed in orbit; after one scheduled orbit capsule was recovered east of Bermuda. All objectives were satisfied.

* Returned to hangar for booster power package replacement.