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WS 107A-1 FLIGHT TEST WORKING GROUP

1. FLIGHT TEST REPORT,
2. MERCURY/ATLAS MA-1
(ATLAS 50D),
29 JULY 1960.

ENGINEERING CORRESPONDENCE
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FOREWORD

This report has been prepared to present preliminary information relative to the flight of Mercury/Atlas MA-1 50D. The information presented is based on visual observation and data evaluation to the extent permitted by time limitations. It should be considered as preliminary only and the final reports on this flight referenced for further information. The technical content has been prepared and jointly agreed upon by members of the WS 107A-1 Flight Test Working Group.

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SUMMARY

Mercury/Atlas MA-1 was launched from AMR, Complex 14 at 0813 EST on 29 July 1960. Atlas Missile 50D served as the booster for the Mercury R and D Capsule. The flight was unsuccessful and the missile was destroyed after sixty seconds of flight.

After fifty-eight and one half seconds of flight the vehicle was subjected to a severe impulse disturbance. The disturbance was reflected by all missile and capsule accelerometers and rate gyros. Within one-tenth of a second, telemetry measurements which had their source in the upper portion of the B1 equipment pod were lost, and the telemetry radiated power and the range safety and guidance systems input signals dropped abruptly. Within four-tenths of a second, propulsion system performance began to decay, and the thrust level was almost zero at the loss of all telemetry data at about sixty seconds.

Capsule telemetry data were received until impact and these data indicated proper capsule systems operation throughout the flight.

ASIS operation was satisfactory and properly reflected missile systems operation. Engine cutoff and abort signals were generated after the vehicle disturbance and prior to missile destruction.

Almost all the capsule was recovered, although it was broken up, apparently as a result of impact. Only a few parts of the missile have been recovered. Impact was less than five miles from the launch pad.

Neither telemetry data nor the portions of the vehicle which have been recovered have led to any conclusions as to the cause or exact nature of the events which led to termination of the flight. There were no range safety functions transmitted by the range and telemetry data indicate that none were received. Operation of all systems appeared normal prior to the disturbance and the vehicle trajectory was very close to the predicted.

All times in this report are referenced to range zero, which was 0813:03 EST. Two inch motion occurred at 0813 03 .92 EST.

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FLIGHT TEST OBJECTIVES

The primary objective for this flight was to determine the integrity of the Mercury Capsule. Other first order objectives for NASA included evaluation of the capsule structure and afterbody shingles, afterbody heating, flight dynamic characteristics, capsule re-entry system and recovery procedures.

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					
NASA Capsule Objectives					
1. Determine the integrity of the Mercury Capsule structure and afterbody shingles for a re-entry associated with a critical abort.	1		X		
2. Determine Mercury Capsule afterbody heating rates during re-entry.	1		X		
3. Determine the flight dynamic characteristics of the Mercury Capsule during re-entry.	1		X		
4. Establish the adequacy of the capsule re-entry system and recovery procedures.	1		X		
5. Familiarize Mercury/Atlas operating personnel with launch and recovery operations.	2			X	
Atlas Objectives					
1. Determine the ability of the Atlas booster to release the Mercury Capsule at the conditions of position, attitude, and velocity defined by the guidance equations.	1		X		

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
2. Evaluate the open loop performance of the abort sensing and implementation system.	1			X	
3. Obtain Data on the repeatibility of all Atlas missile and ground systems.	2			X	
4. Demonstrate the suitability of equipment and procedures used for checkout and launching the Mercury/Atlas vehicle.	3	X			
5. Determine the performance of the Convair Propellant Utilization System.	3			X	
6. Evaluate the Mercury/Atlas vehicle with regard to engine start and potential causes for combustion instability.	2	X			

SYSTEM PERFORMANCE

SYSTEMS OPERATION PRIOR TO FLIGHT FAILURE

All radar plots and trajectory information indicate the vehicle trajectory was proper in all respects prior to the vehicle disturbance at 58.5 seconds with altitude being approximately 33,000 feet at this time. Landline and telemetered data indicate that operation of all vehicle systems were also satisfactory until approximately 58.5 seconds. A summary of individual systems operation prior to the vehicle disturbance is presented below.

Mercury capsule operation was satisfactory. All data indicated normal operation. Shingle strain measurements indicated normal engine noise at lift-off and the expected aerodynamic noise up to Mach one. The predominant frequency of the shingle strain was at the shingle first resonant frequency of 350 to 400 cycles per second. Above Mach one the strain measurements indicated large pressure and strain fluctuations at 200 cycles per second. These fluctuations did not appear to damage the shingles. Thermocouples attached to the capsule structure and shingles showed no significant heating and that there was no structural damage or shingle loss.

Missile airframe structural integrity was satisfactorily maintained. The thrust section light detector indicated no illumination during the period from lift-off to 58.5 seconds. There were no temperature probes in the thrust section of this missile.

Abort Sensing and Implementation System (ASIS) performance was satisfactory. 50D was the first Mercury/Atlas vehicle to utilize this system, which was in an open loop configuration. All pressure switches operated properly in monitoring their respective parameters and the system was in an abort - ready condition between -4.15 seconds and 58.57 seconds.

Propulsion System performance was satisfactory. The engine start sequence, start transients, and operating levels of all recorded parameters were normal. The RCC outputs indicated normal thrust chamber vibration levels through engine start and the holddown period. Vibration levels compared favorably with acceptance data and those observed on previous wet starts of the MA-2 engine.

Performance of the Pneumatic System was satisfactory. All missile tanks and bottle pressures were within specifications prior to engine start and were satisfactorily maintained. Operation of the Hadley "D" Series pneumatic regulators was satisfactory as indicated by missile tank pressures. Minimum differential pressure across the bulkhead was 7.52 psid at 2.56 seconds.

Booster tank and engine control helium bottle pressure decay was normal during the ground run . The ISS pneumatic regulator operation and the Booster Control pneumatic regulator operation appeared satisfactory during the ground run period as indicated by landline data only.

Performance of the Flight Control System was satisfactory. Radar plots indicated satisfactory accomplishment of the 3 degree roll and the standard "D" Series pitch program. Engine deflections at engine start and during lift-off appeared normal. Missile motions during flight appeared normal.

The Hydraulic System supplied adequate pressure to gimbal the thrust chambers, and to perform sustainer control functions. Transition from ground system pressures to flight levels was satisfactory. Booster and sustainer steady state flight pressures were 3100 psia and 3150 psia respectively. Neither a vernier solo hydraulic power supply nor vernier solo accumulator was utilized because vernier solo operation was not planned for this flight.

Performance of the Guidance System was satisfactory. The missile was tracked off the pad in monopulse mode and tracking was maintained until 58.66 seconds. There were no steering or discrete commands generated due to early termination of the flight. Telemetered data indicated satisfactory operation of the airborne beacons.

The San Salvador Impact Predictor System (System 4) did not acquire the airborne beacons due to early termination of the flight. Telemetry instrumentation on the airborne beacons was deleted on this missile. The Impact Predictor Monitor Set in the blockhouse indicated proper airborne system operation prior to launch.

Electrical System performance was satisfactory. All voltage and frequency parameters were within specifications until after 58.5 seconds.

The Azusa ground station maintained tracking from launch to approximately 59 seconds. Realtime impact prediction plots and trajectory data were obtained. Telemetry instrumentation on the airborne transponder was deleted on this missile.

Performance of the Range Safety Command System was satisfactory. Telemetered r-f input/agc data indicated that received signal strength was sufficient to maintain proper airborne system operation. There were no cutoff or destruct signals transmitted by AMR during flight and there were no inadvertent airborne system outputs.

Closed-loop performance of the Convair Propellant Utilization (PU) System was satisfactory. PU valve response to the Error Demodulator Output (EDO) signal was correct after servo control acquisition. PU valve position land-line data indicated that the valve momentarily went below the mechanical stop to 22.0 degrees after servo control acquisition. Telemetry data did not reflect this condition. This same peculiarity was noted on the Flight Readiness Firing.

Operation of the missile Telemetry System was satisfactory. Only 60 measurements were telemetered and analysis indicates there were no unsatisfactory measurements prior to 58.5 seconds.

Launcher operation was satisfactory. All holddown and release system blow-down parameters were within specifications.

The Landline Instrumentation System provided satisfactory data coverage prior to the time of umbilical ejection, however, four measurements were only partially satisfactory.

SYSTEMS OPERATION FOLLOWING FLIGHT FAILURE

A review of all available data and inspection of recovered hardware has not led to any conclusion as to the cause of the flight failure. The first deviation from normal was observed on FPS-16 radar data and GE Guidance radar data, which indicated changes in characteristics. This was followed by simultaneous disturbances on the capsule and missile accelerometers and rate gyros between three-tenths and one-tenth of a second later. There was also a drop in capsule received telemetry signal strength at this time, followed by a drop in missile received telemetry signal strength. Within one-tenth of a second following the disturbance noted on the gyros and accelerometers, several missile telemetry measurements ceased to function and the missile systems using the missile inverter output ceased functioning. Within four-tenths of a second propulsion system performance began to decay. Until approximately one second after the disturbance, the capsule and the booster were apparently structurally one unit. After this time they were apparently separated. Almost one and one-half seconds after the disturbance, all missile telemetry signals were lost. Capsule telemetry was received until impact with the water.

Starting at 58.2 seconds the characteristics of the Cape FPS-16 range data and the GE Mod III Guidance Conical AGC, receiver AFC and raw video data changed.

At 58.524 seconds a forward acceleration impulse of greater than 25 g's was experienced by the capsule. At 58.532 seconds an aft acceleration of 10 g's was experienced which lasted for less than 10 milliseconds. The longitudinal acceleration then went to zero for about 80 milliseconds and then went to about 7 g's of forward acceleration for about 60 milliseconds. The acceleration then returned to the booster thrust level. At about 59.0 seconds the acceleration began to decrease in an irregular manner ultimately reaching a maximum of about 7.5 g retardation (drag). The capsule normal and transverse accelerometers indicated some side loads of short duration at about 58.7 seconds. Starting at 59.5 seconds these accelerometers evidenced an oscillation of the type which indicates that the capsule was a free body.

At 58.525 seconds the capsule received telemetry signal strength showed a drop and at 58.566 seconds a more drastic drop occurred. Signals were received until impact of the capsule at about 203 seconds. The missile telemetry received signal strength showed a drop at 58.555 seconds, 30 milliseconds after the initial drop in capsule signal strength.

The capsule cabin pressure regulating valve appeared to function properly throughout the flight and did not appear to be affected by the flight failure. The heat shield cavity pressure appeared normal except for increases in pressure of less than one psi between 58.8 and 59.0 seconds and between 60.1 and 60.5 seconds.

Approximately 95 percent of the capsule was recovered. The general condition of the wreckage indicates that the capsule was intact at impact. Only a small portion of the adapter section has been recovered.

The only portions of the missile which have been recovered are the LO2 tank boil-off valve and the two booster thrust chambers with portions of the high pressure ducting. The boil-off valve was located in the same area as the capsule, whereas, the thrust chambers were located several hundred yards from the capsule. The thrust chambers were relatively undamaged except for skirt deformation, apparently resulting from impact. The boil-off valve was broken between the tank ducting attachment flange and the valve proper and one side was caved in. These results appeared to be due to impact with the water. The ducting between the tank and the valve was broken near the valve flange. About one-half of the break area appeared to be a fatigue failure. The remaining break appeared due to overstressing. The lateral brace was intact although bent and the plate which attaches the brace to the adapter was still fastened to the brace. This brace is fastened to a spacer between the two flanges of the valve body and the spacer has provisions for attachment to the flanges by using two screws through the inboard flange and one screw through the outboard flange. Inspection of the valve indicates that there had been no screw fastening the spacer to the outboard flange. The spacer was held intact by the screws in the inboard end. The vertical braces between the valve and the LO2 tank had been broken near the valve. At what time this break occurred could not be determined.

At 58.524 seconds the missile accelerometer indicated an aft acceleration impulse was experienced by the airframe, and a portion of the missile instrumentation system associated with the forward portion of the missile was lost within one-tenth second.

At 58.525 seconds the acceleration measurement began to oscillate from band to band (minus 0.25 g's to plus 10 g's) and at 58.665 seconds settled down somewhat at approximately 5 g's of forward acceleration. The acceleration then returned to the booster thrust level by 58.790 seconds and remained near this level until 58.988 seconds when another disturbance was apparent.

Acceleration appeared to remain in the forward 2 g range for approximately 100 milliseconds and then decreased erratically in the next 100 milliseconds to a negative acceleration of greater than 1.7 g's, where it remained until 59.350 seconds. At this time the measurement came back into band, however, it was varying between 5 and 30 percent of bandwidth except for a period between 59.625 and 59.645 seconds when data oscillated from band to band. After this the data continued to vibrate between 5 and 30 percent of bandwidth until 59.886 seconds. At this time the measurement started to go out of band on the high side and had completely disappeared 10 milliseconds before the final loss of data at 59.913 seconds.

The Thrust Section Light Detector in Quad IV (A622I) indicated no illumination until between 58.515 seconds and 58.615 seconds when it started to rise. A peak of 80 percent IBW was reached at approximately 58.822 seconds. After this time it decreased and reached zero percent IBW at 59.333 seconds, where it remained until approximately 59.433 seconds. It then went beyond the 100 percent level. The measurement remained above 100 percent until 59.843 seconds when it indicated 80 percent IBW. This was the last data segment received.

The Abort Sensing and Implementation System (ASIS), in the open-loop configuration, indicated that the missile systems (Propulsion, Hydraulic, Missile Tank Pressurization, Flight Control, and Electrical) operated satisfactorily until 58.470 seconds. Between 58.470 and 58.570 seconds E34X, AC Low Voltage, started to indicate an abort condition. This indicated that the 400 cps AC Phase A voltage supplied to the ASIS pressure switch transformer had decreased below the abort level of 80 $\pm$ 10 VAC and consequently reduced the current in the control winding of the 1-Not Gate amplifier. (E34X measures the output voltage of the 1-Not Gate amplifier and gives an abort indication when a high voltage output occurs which is caused by a reduction in the control winding current only). As a result of this occurrence, M28X, Abort System Signal, which was on the same telemetry channel, started to drop on the same commutation cycle, indicating an abort condition between 58.485 to 58.585 seconds. As a result of the Abort System signal, S179X, ECO System Output, indicated that an engine cutoff signal was generated between 58.570 and 58.670 seconds.

On the commutation cycle, between 58.510 and 58.670 seconds E 34 X, AC Low Voltage, had dropped to zero level indicating a complete loss of AC voltage to the two self saturating gate windings of the 1-Not Gate amplifier. This was substantiated by E 51 V, 400 Cycle AC Phase A, which dropped to below zero percent IBW, between 58.583 and 58.683 seconds.

All rate gyro data, both autopilot and the redundant gyros, indicated that the rates were within the abort limits prior to the abort time. After the abort time the ASIS system was in a configuration that would not reveal the state or condition of the remaining monitored systems. This is due to the circuitry of the ASIS.

The first indication of a change in Propulsion System operation was a decrease in booster engine chamber pressures beginning between 58.800 and 58.900 seconds and a 120 psi drop in Sustainer Gas Generator (SGG) discharge pressure between 58.775 and 58.875 seconds. The SGG discharge pressure subsequently recovered between 58.875 and 58.975 seconds to 450 psia and remained essentially constant at this level until between 59.180 and 59.280 seconds when it again started to decay. Booster gas generator combustion chamber pressure indicated a decay beginning between 58.942 and 59.042 seconds. Sustainer chamber pressure started to decrease between 59.100 and 59.200 seconds. The vernier chamber pressures were not affected until 59.150 seconds.

Booster No. 1 and sustainer pump speeds, as measured on continuous channels, began to decrease at 59,050 and 59. 225 seconds respectively. As seen from the foregoing, both the booster and sustainer chamber pressures decreased before the respective pump speeds were affected.

Performance of the Pneumatic System was satisfactory prior to 58.578 seconds. At this time the following values were recorded.

F 1 P	LO2 Tank Helium Pressure	29.6 psia
F 3 P	Fuel Tank Helium Pressure	62.1 psia
F 116 P	Differentiai Pressure Across The Bulkhead	11.0 psid

F246P	Booster LO2 Tank Helium Bottles	1411 psia
F291P	Sustainer Engine Control Bottle	2772psia

The Differential Pressure Across The Bulkhead measurement (F116P) opened electrically between the commutation cycle at 58.478 and the one at 58.678 seconds; the Fuel Tank Helium Pressure measurement (F3P) opened electrically between the commutation cycle at 58.492 and the one at 58.592 seconds; the LO2 Tank Helium Pressure measurement (F1P) opened electrically between the commutation cycle at 58.503 seconds and the one at 58.603 seconds. Booster tank helium bottle pressures were satisfactorily maintained until at least 59.237 seconds and sustainer engine control helium bottle pressure was satisfactorily maintained until at least 59.316 seconds. Data after these times were invalid due to the loss of the telemetry power supply.

Booster and sustainer Hydraulic System pressures remained at satisfactory levels of 3130 psia and 3080 psia until at least 59.263 and 59.253 seconds respectively. Since the telemetry transducer power supply began fluctuating at 59.300 seconds subsequent data were invalid. However, it appears that the wiring to the transducer monitoring the B1 hydraulic accumulator pressure opened up at 59.415 seconds. The wiring to measurement H140P, Sustainer/Vernier Hydraulic Pressure, apparently was intact until final loss of telemetry data at 59.913 seconds.

Flight Control System data were normal until 58.525 seconds. Between 58.526 and 58.530 seconds the rate gyros, which were located on the LO2 tank at about station 675, indicated a disturbance which continued until the rate gyro data appeared to become invalid at approximately 58.60 seconds. The disturbance had initial maximum peak-to-peak rates of 2.86 deg/sec in pitch, 1.33 deg/sec in yaw and 3.75 deg/sec in roll. The frequency of resulting oscillations appeared to be at 60 to 70 cps.

The backup rate gyros, which were located in the autopilot gyro package in B1 pod, indicated a similar disturbance, starting at 58.533 seconds. The engine positions show no indications of response to this disturbance. This appears normal, considering the high frequency involved, however, the B1 and sustainer engine began drifting off null during this period. Abrupt negative shifts were evident in B1 and sustainer yaw engine positions (which were monitored on continuous telemetry channels) at 59.45 seconds which coincides with additional missile shock as registered by the airframe axial accelerometer. The B1 and sustainer pitch positions (which were monitored on commutated telemetry channels) started moving positive at 58.570 and

continued moving toward the stop although the movement became erratic and intermittant after 59.028 seconds. It appeared that both engines reached their respective stops at approximately 59.178 seconds. The loss of the telemetry power supply followed at about 59,30 seconds and the validity of subsequent data is questionable.

The vehicle was tracked by GMCF No. 1 for 58.66 seconds. Telemetry data from the airborne guidance system indicated that inadequate a-c electrical power was supplied to the system after this time.

Rate Beacon AGC No. 1 (G279V) decreased from -38 DBM at 58.539 seconds to the telemetry bias level at 58.640 seconds where it remained until loss of data. Rate Beacon RF Output Power (G82E) decreased from 455 milliwatts at 58.585 seconds to zero at 58.688 seconds where it remained until loss of data.

Decoder Contacts No. 1 and No. 2 (G290X) remained at the telemetry bias level until loss of data.

Decoder Pitch Output (G287V) gradually decreased from zero percent commands at 58.524 seconds to the telemetry zero reference level at 58.933 seconds. Decoder Yaw Output (G288V) gradually decreased from zero percent commands at 58.528 seconds to the telemetry zero reference level at 58.936 seconds. Pulse Beacon Magnetron Average Current (G4C) gradually decreased from 0.92 milliamperes at 58.521 seconds to zero at 59.031 seconds. The gradual decrease exhibited by each of these three parameters is attributed to the time constant of the measurement integrating circuitry. After the zero level was reached by each of the parameters it remained there until loss of data.

Pulse Beacon AGC (G3V) was -41 DBM at 58.518 seconds. Data level variations which occurred between 58.620 seconds and 59.538 seconds are attributed to power supply discharge characteristics. From 59.538 seconds until loss of data the level remained at the telemetry bias level.

The effect of the disturbances on the airborne portion of the impact predictor system could not be determined since no telemetry measurements were made of the system. The flight was terminated prior to acquisition by the Station 5 ground system.

Phase A AC voltage was at a satisfactory level of 114.7 volts at 58.581 seconds, however, at 58.681 seconds the AC voltage output was below the instrumentation limit of 105 volts which indicates possible inverter or associated wiring failure between these times. The AC voltage output remained outside the instrumentation limit until loss of telemetered data.

The ASIS AC Low Voltage measurement (E34X) indicates loss of AC voltage to the abort system between 58.470 seconds and 58.570 seconds. This coincides very closely with loss of inverter phase A AC voltage to the telemetry system.

At 58.65 seconds the 400 cycle frequency started immediately decreasing and went beyond the telemetry band limit of 370 cps within 0.027 seconds.

The DC voltage was at a satisfactory level of 26.5 volts at 58.533 seconds, however, at 58.635 seconds telemetered data indicated an output of 21.4 volts, indicating a heavy load may have occurred on the battery between these times. Following this, at 58.734 seconds, the DC voltage was back at a normal value of 26.5 volts. After that time the DC voltage fluctuated between 21.8 volts and 30.0 volts. Just prior to the loss of data the DC voltage indicated an unloaded condition with an output value of 30.4 volts.

Azusa received signal was lost at the AMR ground station at approximately 58.6 seconds. Received signal strength immediately prior to signal loss was -82 DBW and ground station data indicated that the transponder performance was excellent. Effects of the disturbance on transponder operation cannot be determined since telemetry instrumentation on the transponder was deleted on this flight.

Telemetered r-f input/agc data from the No. 1 Range Safety Command Receiver indicated that received signal strength was approximately 6,000 microvolts prior to 58.525 seconds. By 58.627 seconds received signal strength had decreased to approximately 190 microvolts. This signal strength decrease could have been caused by loss of signal from one of the Range Safety Command/Telemetry antennae. From 58.627 seconds until loss of data the signal strength fluctuated from a maximum of 250 microvolts to a minimum of 4 microvolts. The r-f input/agc signal of the No. 2 Range Safety Command Receiver was not instrumented. There were no command system outputs prior to loss of data. The manual fuel cutoff signal was transmitted by AMR at 262 seconds as planned.

Performance of the Convair Propellant Utilization System was satisfactory until at least 58.470 seconds. After this time system data were inconclusive.

Measurement P528D, Sustainer Main Fuel Valve Position, indicated that the valve started toward the full open position between 58.691 and 58.791 seconds. Sustainer engine performance did not appear to reflect any such change in valve position.

U81P, Fuel Tank Head Pressure, went to zero percent IBW, which corresponds to equal pressure on both sides of the transducer, between 58.536 and 58.636 seconds and remained there until loss of all telemetered data. The characteristic of the data was not indicative of loss of wiring from the transducer to the telemetry system.

U91V, Error Demodulator Output, started to become erratic between 58.703 and 58.803 seconds and remained erratic with varying signal levels until loss of telemetered data.

U80P, LO2 Tank Head Pressure, indicated a decrease in head pressure between 58.940 and 59.040 seconds. The head pressure apparently continued to decrease until final loss of telemetered data. This pressure decay was accompanied by erratic pressure surges with interspersed spiked commutation segments.

At 58.555 seconds the missile telemetry received signal strength showed a significant drop. Various telemetry measurements opened electrically beginning at the time of and following the vehicle disturbance. These are discussed elsewhere in this section. Between 59.270 and 59.370 seconds the telemetry power supply began to fluctuate. Much of the data after this time was invalid due to these fluctuations. Telemetry signals were received until 59.913 seconds.

PROPELLANT TANKING

The missile was propellant tanked utilizing the Propellant Loading Control Unit (PLCU) tanking procedure for special mission missiles.

Fuel was tanked to a level just below the PLCU 95 percent probe on X-1 Day. Fuel was topped during the precount to a level just below the 100.2 percent PLCU probe. LO2 was tanked during the countdown to a level about 3000 pounds above the PLCU 95 percent probe and Sequence III pressurization was started. The 95 percent probe light was extinguished before Sequence III pressure was stable. This is an abnormal condition and possibly reflects improper probe operation. The step was repeated and this time the pressure was stable before the probe extinguished. This PLCU 95 percent weight at Sequence III was used as a reference weight. It was planned to secure tanking at a level 8700 pounds above this reference point and to ignite at 8300 pounds above this point as measured by the load cells. The topping pump was unable to obtain the desired level therefore LO2 tanking was secured at 8600 pounds above the reference point and ignition occurred with the level 8000 pounds above the point. The correlation among weight measuring systems was satisfactory, however, during the LO2 topping operation, the load cells showed intermittent oscillations of up to ± 300 pounds.

	Units	Desired(1)	Load Cells	PLCU	Primary Systems(2)
Fuel Weight	lbs.	75,876	75,876	75,876	75,876
LO2 Weight	lbs.	173,554	173,817	174,156	173,254
Missile Wet Weight(3)	lbs.	15,006	15,006	15,006	15,006
Ignition Weight	lbs.	264,436	264,685	265,038	264,136
Ground Run Consumption(4)	lbs.	8,646	8,646	8,646	8,646
Lift-Off Weight	lbs.	255,790	256,039	256,392	255,490

(1) Desired values are based on actual weights, actual densities and planned volumes.
(2) PLCU for fuel; Load cells and the 95 percent PLCU probe for LO2.
(3) Based on the AMR weighing.
(4) Based on actual run time and nominal flow rates.

Weather Data	Fuel Tanking	Fuel Topping	Ignition
Barometric Pressure	29.850 In. Hg	29.790 In. Hg	29.765 In. Hg
Ambient Temperature	79.8°F	76.5°F	75.2°F
Relative Humidity	83 Percent	88 Percent	93 Percent
Wind-Velocity and Direction	11 Knots, South	15 Knots, South	20 Knots, So.
Cloud Cover	8/10	10/10	10/10

LANDLINE INSTRUMENTATION

The landline instrumentation system provided satisfactory information prior to missile liftoff, however, the measurements listed below were only partially satisfactory for the reasons stated.

Measurement No.	Description	Source	Comment
P 1091 P	B1 LO2 Inj Man	Osc.	Open Transducer
P 1901 P	Booster Fuel Jacket Purge	Osc.	Erratic
P 1894 D	B2 RCC Accel (Back-up)	Osc.	Failed at -3 Seconds
P 1069 X	B2 Fuel Vlv. Closed	Osc.	Erratic. Did not Activate at Proper Times.

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.	0.404
Time Difference Between Start of B1 and B2 Cylinder Pressure Decay	sec.	0.010 Max.	0.007
Time Intercept of Tangent At 2550 psig	sec.	0.110 Min.	B1 = 0.125 B2 = 0.129
Residual Pressure 0.5 seconds After 2550 psig	psig	350 Max.	B1 = 24 B2 = 252
Maxium Differential Cylinder Pressure After 2550 psig	psid	400 Max.	262 @ B2 = 2550 psig

FILM REVIEW

A review of quick process engineering sequential films indicated all missile and launcher systems functional properly from ignition to the limit of camera coverage.

Detailed film review was hindered somewhat by adverse weather conditions at the time of launch, which affected film quality. Tracking films were changed from color film to Tri-X black and white film during the countdown in anticipation of bad weather conditions at launch. Tracking film analysis was very limited since the missile was lost in the clouds shortly after start of the pitch program. Films reviewed were as follows.

Item No.	Camera Pad	Size mm Color Or B & W	Frames Per Sec	Fixed Or Tracking	Field of View
1.2.8	Ramp	16C	400	Fixed	Entire Launcher and Missile To Above Vernier. Views Quads I and II.
1.2-11	Top of Umb. Twr.	16C	200	Fixed	Mercury Capsule and Umbilical Plug.
1.2-12	14-9	16C	96	Fixed	Mercury Capsule.
1.2-13	Gantry	16C	96	Fixed	Mercury Capsule.
1.2-14	12-2	B & W Neg.	96	Track	Entire Missile Looking into Quads II and III.
1.2-15	12-2	B & W Neg.	96	Track	Entire Missile Looking into Quads II and III.
1.2-16	16-2	B & W Neg.	96	Track	Entire Missile Looking into Quad I.
1.2-17	16-2	B & W Neg.	96	Track	Entire Missile Looking into Quad I.
1.2-20	U75R6	B & W Neg.	48	Track	Entire Missile Looking Quad II.
1.2-41	East "A" Frame	16C	400	Fixed	View of High Pressure Propellant Lines at Bottom of Clamshell Doors.
1.2-42	West "A" Frame	16C	400	Fixed	View of High Pressure Propellant Lines at Bottom of Clamshell Doors.
1.2-43	North Launcher		100	Fixed	Views Upper Portion of Turbine Exhaust Duct.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The flight was unsuccessful.

2. The booster was destroyed after 60 seconds of flight as a result of a structural failure at the forward end. No specific reason (s) have been determined.

3. The Mercury capsule survived and good telemetry was received until impact.

4. The ASIS operated satisfactorily and properly generated an abort signal at the first sign of missile failure.

Recommendations

1. Investigate the LO2 boiloff valve ducting capsule adapter structure and consider additional instrumentation in this area.

2. Re-examine weather restrictions for Atlas launches.

COUNTDOWN TIME VERSUS EVENTS

This test was planned for a 215 minute countdown, starting at 0355 EST. Three holds and one recycle occurred which added an additional 43 minutes making a total countdown time of 258 minutes.

The holds and recycle were as follows:

1. At -35 minutes (0655 EST), for 30 minutes, to clear the area for LO2 tanking and to evaluate the limited complex camera coverage. Camera coverage limitations were due to inclement weather.

2. At -7 minutes (0753), for 12 minutes, to complete LO2 sub-cooled topping. Difficulty was encountered in maintaining LO2 flight level through the 2 inch topping line and was apparently due to icing of the inline filter.

3. At -19 seconds (0812 EST), for approximately one minute, to determine the cause of no TCC water ready light. The water ready switch was inadvertently not thrown. The count was recycled to -25 seconds and continued as planned with no other difficulties being encountered.

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

EST	Countdown Time	Countdown Procedure	Event
0355	T-215	T-215	Countdown Started. Range Safety Command Checks Started.
0408	T-202		Range Safety Command Checks Completed Satisfactorily.
	T-202	T-205	Start Electrical Connection of Red Destruct Box.
0416	T-194		Mercury Pyrotechnic Connections Started.
0418	T-192		Installation of Range Safety Destruct Boxes Completed.

EST	Countdown Time	Countdown Procedure	Event
0440	T-170	T-170	Flight Control System Tests Started.
0450	T-160	T-165	Guidance And IP Beacon Testing Started.
	T-160	T-160	Loop Test Preparation Started For Flight Control System.
0500	T-150	T-150	Loop Test Started.
0507	T-143		Loop Test Completed Satisfactorily.
0510	T-140		Reported That Loop Test was "GO".
0559	T-91		Mercury Electrical Connections of Posigrade Rockets Completed.
0600	T-90		Landline Electrical Calibrations Completed.
0610	T-80		Service Tower Removal and Securing Started.
0645	T-45	T-45	LO2 Tanking Preparation Started.
0647	T-43	T-70	Helium Storage Started.
	T-35H		Holding To Clear The Area For LO2 Tanking And To Evaluate The Limited Camera Coverage At The Complex.
0700	T-35H		Missile Helium Bottles Pressurized To Flight Level.
0705	T-35H		Hold Extended 5 Minutes.
0710	T-35H		Hold Extended 5 Minutes.
0715	T-35H		Hold Extended 10 Minutes.

EST	Countdown Time	Countdown Procedure	Event
0725	T-35		Countdown Resumed.
	T-35	T-35	LO2 Tanking Started.
	T-35		Autopilot System Final Check Started.
	T-35		Gyro Stiction Test Started.
0738	T-22		Range Safety Command Final Test Started.
	T-22	T-25	Azusa Check Started.
0746	T-14		Impact Predictor Reports "GO".
0747	T-13		Azusa Check Finished.
0751	T- 9		Range Safety Command Final Check Completed.
	T- 9		Autopilot System Final Check Completed.
0753	T- 7H		Holding For The Completion Of LO2 Sub-cooled Topping.
0754	T- 7H		Weather Report - Surface Winds 21 Knots; Gusts To 31 Knots.
0800	T- 7H		Hold Extended 5 Minutes.
0805	T- 7		Countdown Resumed.
0806	T- 6		RCC Inactive- Active Switch To "ACTIVE."

EST	Countdown Time	Countdown Procedure	Event
0808	T-3:50	T-3:50	Status Check - All Systems Reported "GO".
0809	T-3:00	T-3:00	Timer Off - Ready Switch To "READY".
	T-2:10	T-2:10	Securing LO2 Tanking.
0810	T-2:00	T-2:00	Starting Flight Pressurization.
	T-2:00	T-2:00	Turning Water Systems "ON".
	T-1:45	T-1:45	Arm Switch To "ARM". Engine Preparation Complete Light "ON".
	T-1:40	T-1:40	Missile To Internal Power.
	T-1:35	T-1:35	Mercury Report Switch To "READY".
	T-1:20	T-1:20	RF Systems Ready Switch "ON".
	T-1:15	T-1:15	Status Check - All Systems Reported "GO".
0811	T-0:60	T-0:60	Missile Helium To Internal. Autopilot To "ARM". Water Full Flow.
	T-0:55	T-0:55	PSO Range Ready Switch "ON".
	T-0:40	T-0:40	Status Check - All Systems Reported "GO". All Pre-Start Panel Lights Are Correct.

EST	Countdown Time	Countdown Procedure	Event
	T-0:19H		Ready Light Not On - Sequencer Stopped.
	T-0:19H		Discovered TCC Water Ready Switch Was Not Switched To Ready.
	T-0:19H		Recycled The Count To -25 Seconds.
	T-0:25		Countdown Resumed.
		T-0:25	Oil Evacute. Evacuation Lights "ON". Mercury Umbilical Eject. Mercury Boom Clear.
	T-0:18	T-0:18	All Recorders To "FAST". T-18 Seconds And Counting. Engine Start.
0813:03			Range Zero Time.

MISSILE CONFIGURATION

Mercury/Atlas Booster 50D was an SM-65D missile modified for the Mercury Project in accordance with Convair Astronautics Report AZC-27-026, "Model Specification for Atlas/Mercury (HS-36) Booster USAF Model SM-65D (Modified) Convair Model 27", reference 10.

A major system addition was the Abort Sensing and Implementation System which monitored selected critical functions in the Mercury/Atlas Booster. Failure of any of these critical systems will result in a switch closure which would normally initiate a capsule abort. For this mission, the system was operated in an "open-loop" configuration for evaluation purposes only and could not command a capsule abort. The capsule portion of the ASIS was not installed.

A brief description of the Mercury Capsule is also included for information purposes only.

Airframe

Skin gauges of the Mercury/Atlas Booster fuel tank were increased between 0.001 and 0.003 inch, stations 1198 to 1057.5 inclusive, over the initial Mercury/Atlas Vehicle 10D. Skin gauges of the oxidizer tank were the same as D Series R and D dry start vehicles. These changes maintained the dry start configuration although propulsion system was wet started.

Pneumatic System

"C" Series type boiloff valve was installed for light weight and reliability. The installation was made using the standard early "D" Series boiloff ducting. The valve was attached to the top of the LO2 tank by means of two parallel braces which were fastened to the valve near the ducting flange. The valve was attached to the Capsule adapter by means of a lateral brace which attached to a spacer between the two flanges of the valve body. This spacer had provisions for three screws for attachment to the valve. The valve protruded through the adapter and this section of the adapter was fitted around the valve.

Standard "late" D Series pressurization system with self-pressurization of the oxidizer tank following staging.

Hadley "D" tank pressurization regulator valves were installed.

Electrical System

Harness modification was required to include Abort Sensing and Implementation System. The missile main and telemetry batteries were remotely activated.

Guidance System

A GE Mod III airborne guidance system was aboard. The system consisted of three "D" Series canisters (a pulse beacon, a rate beacon, and a decoder), a junction box, and a special Convair antenna assembly. The canisters were relocated to the B2 pod.

The ground station configuration consisted of the Mod III Radio Tracker and the Burroughs A-1 Computer.

Azusa Transponder System

Comprised of the Type B Coherent Carrier transponder with a flush mounted antenna on the B2 pod. The canister was relocated to the B2 pod.

Impact Predictor System

The Mod II airborne system in conjunction with the Mod I ground system and the Mod I Burroughs computer served as a downrange Range Safety Impact Predictor System.

Range Safety Command

Standard dual system for "D" Series configuration (two ARW-59 receivers and a destruct package) which included the automatic sustainer engine cut-off capability, linked with the San Salvador IP/RSC ground systems.

Propulsion System

Basic MA-2 rocket engine assembly. The propulsion system was wet started.

The vernier solo refill orifices normally used in refilling the vernier start tanks were plugged. Also incorporated the MA2-55 Engine Oxidizer Tank rapid fill installation.

Abort Sensing And Implementation System (ASIS)

This system was comprised of instrumentation to sense missile malfunctions which would affect the safety of an astronaut. The system in use for this flight monitored significant pressures, missile voltages and rate gyro outputs.

Propellant Utilization System

The Convair Astronautics propellant utilization system which incorporated Nubelon-S coated mandrels was installed.

Hydraulic System

Standard "D" Series hydraulic system except for the vernier solo hydraulic power supply which was deleted.

Propellant Loading System

Propellant loading was monitored by the Propellant Loading Control Unit (PLCU) and load cells.

Anti-slosh Control

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

Flight Control System

The flight control system was a standard "D" Series configuration with the following exceptions:

The rate gyro package for flight control was located at station 675.

The pitch and yaw position gain was reduced during the period from launch / 85 seconds to booster engine cutoff.

An eight cps filter was added to the stabilization filter for use during the periods from launch to launch / 85 seconds and from booster engine cutoff through the remainder of the flight.

A three cps filter was added to the stabilization filter for use during the period from / 85 seconds to booster engine cutoff.

Telemetry System

Standard "D" Series utilizing one airframe transmitter.

Outputs from the ASIS package were monitored via airframe telemetry. The system was complete with the exception of capsule and capsule-missile interface circuits and was operated open-loop.

Mercury Capsule

The basic flight capsule is supplied by McDonnell Aircraft Corporation under contract to NASA. The overall length of the capsule including the parachute housing and the antenna housing is 114.34 inches. The maximum diameter is 74.5 inches at the heat shield. Capsule on board equipment will include one prototype telemetry unit, two tape recorders, to movie cameras, McDonnell Aircraft Corporation heat exchanger and fan, and the landing and recovery systems.

The parachute housing on the capsule is 20 inches long and 32 inches in diameter. It contains the Landing and Recovery Systems which consist of the following:

1. Main parachute
2. Reserve parachute (installed as ballast only)
3. Drogue parachute
4. Sequence control package
5. Two SOFAR bombs
6. Two SARAH beacons
7. Recovery light
8. Impact switch
9. Dye marker
10. Radar chaff
11. Power supplies

The antenna housing is 24 inches long and tapers from a 25 inch diameter to a 20-inch diameter. It houses the main bi-conical horn antenna system, the drogue parachute, and its mortar.

HISTORY OF SM-65D MERCURY/ATLAS BOOSTER NO. 50

Mercury/Atlas Booster 50D arrived at AMR by air transport (C-133) on 17 May 1960. Transfer of 50D from the IOC trailer to the R and D transport trailer was accomplished in Hangar H. Further transfer to the south bay of Hangar K to perform receiving inspection was effected the same day. Following the completion of receiving inspection on 18 May 1960, planning card tasks were started.

Since "D" Series pre-flight hangar checkout can only be accomplished in Hangar J, 50D was positioned in the south bay of Hangar J as soon as space became available on 23 May 1960. Mandatory hangar tasks, system checks and modifications were then initiated.

50D remained at AMR for a period of approximately eleven weeks before being launched. This time was utilized in performing system tests and modifications and in readying the Mercury/Atlas Booster and complex for flight test. Pre-flight testing was performed in accordance with planning documented in Report AA 60-0028, "Flight Test Directive, Atlas Missile 50D." Unplanned operations were performed on an "as required" basis.

Significant events concerning 50D from arrival at AMR to launch are listed chronologically below.

Date	Event
17 May 1960	Arrived at AMR by air and transferred to south bay of Hangar K.
18 May 1960	Completed receiving inspection.
23 May 1960	Transferred to south bay of Hangar J.
30 June 1960	Weighed, transferred to Complex 14 and erected.
6 July 1960	Mated Mercury Capsule to Booster.
7 July 1960	Successful Fuel Tanking Test. Demated Mercury Capsule from Booster.

Date	Event
8 July 1960	Successful LO2 Tanking Test.
11 July 1960	Mated Mercury Capsule to Booster.
13 July 1960	Performed Flight Acceptance Composite Test. Convair test objectives satisfied. The capsule did not complete the test.
18 July 1960	Successful Flight Acceptance Composite Test. All flight objectives were satisfied.
21 July 1960	Successful Flight Readiness Firing.
26 July 1960	Mated Mercury Capsule to Booster.
28 July 1960	X-1 Day Operations.
29 July 1960	Launch.

A brief compilation of significant difficulties encountered during system preparation and testing accomplished follows.

Range Safety Command System

A Flight Acceptance Composite Test scheduled for 12 July 1960 was postponed, partially due to trouble in the vernier engine cutoff panel light circuit of Range Safety Command Receiver No. 1. It was found that the trouble was caused by a loose pin (Pin 9) in umbilical receptacle J1003. The pin was tightened and the circuit was subsequently tested satisfactorily.

The following procedure was completed in the hangar.

Procedure	Description	Date Completed
27-92026D EO S	Range Safety Command System Checkout	6-23-60

The following procedure was completed at the complex.

Procedure	Description	Date Completed
FTP-D-006A DA 1084	Range Safety Command System Checkout	7-13-60

Propulsion System

No major difficulties were encountered during preparation of this system for flight test. Minor difficulties included several leaks discovered during the start system and lube system leak checks, and around the fuel tank apex flange. All leaks were corrected and no further problems were encountered. Due to erratic operation of the B2 fuel valve closed microswitch all booster RCC units were activated by the B1 fuel valve closed microswitch.

The following test procedures were completed in the hangar.

Procedure	Description	Date Completed
27-92564 EO A	Fuel Staging Valve Adjustment Check	5-23-60
FTP-P-0258	Propulsion Pneumatic Control Leak and Functional Check	6-14-60
FTP-P-027	Main Propellant and Hot Gas System Leak Checks	6-21-60
FTP-P-026B	Vernier Engine and Start System Leak Checks	6-24-60

Procedure	Description	Date Completed
FTP-P-030B	Head Suppression Valve Servo Controller Leak and Functional Check	6-27-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-P-029	Pneumatic Purge System Leak and Functional Check	7-2-60
FTP-P-011	Propulsion System Booster Separation Pneumatic Leak Checks	7-7-60
FTP-P-006E	Propulsion System Leak and Functional Tests	7-9-60
FTP-P-014	Retorquing of Booster and Sustainer Gimbaling Blocks	7-1-60 7-13-60 7-27-60
FTP-P-009F	Propulsion X-1 Day and Precountdown Operations	7-21-60 7-28-60

Pneumatic System

The Hadley "D" Series pneumatic fuel regulator, Part Number 27-08102-23, was replaced on 12 July 1960 with Part Number 27-08102-7 due to no record of previous testing on the regulator.

The following procedures were completed in the hangar.

Procedure	Description	Date Completed
FTP-F-019B	Airborne Pneumatic Leak Check	6-25-60
FTP-F-022B	Differential Pressure Switch Checkout	6-27-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-F-009A	Checkout of Bulkhead Differential Pressure Switch and Warning Horn	7-7-60
FTP-F-020A	High Pressure Leak Check and Airborne Regulator Lock-up Checkout	7-11-60
FTP-F-003C	Cold Test - LN2 Shroud and Transfer System Checkout	7-12-60
FTP-F-005D	Checkout and Validation of Ground Airborne Pneumatic System	7-12-60
FTP-F-015A	LO2 Tank Relief and Shutoff Valve Checkout	7-12-60

Flight Control System

During hangar checkout, Gyro Canister, Serial No. 121, was returned to San Diego on 30 June 1960, due to an abnormally high roll displacement gyro null and no fine heater indication. Gyro Canister, Serial No. 121, was returned as a flight article 8 July 1960.

No difficulties were encountered during flight control system checkout at the complex.

The following procedures were completed in the hangar.

Procedure	Description	Date Completed
FTP-S-035	Voltage and Circuit Test of Autopilot System	6-26-60
FTP-S-002A	Vernier Engine Alignment	6-29-60

Procedure	Description	Date Completed
FTP-S-036A	Autopilot Preliminary Test	6-30-60
FTP-S-045A	Pyrotechnic Substitution Fuse Test	7-7-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-S-034A	Sustainer Engine Alignment Check	7-6-60
FTP-S-021B	Flight Control System Threshold Transfer	7-12-60
FTP-S-056	Autopilot Static Gain Test	7-12-60
FTP-S-006B	Booster Engine Alignment Check	7-25-60
FTP-S-013A	Position and Polarity Test	7-27-60
FTP-S-019C	Autopilot Frequency Response Test	7-27-60
FTP-S-032	Autopilot Precountdown Operations	7-29-60

Missile Electrical System

During hangar checkout, holes were found in numerous missile system harness wires. IR's 542260 and 542251 were initiated and these wires were repaired.

No other difficulties were encountered during flight test preparation.

The following procedures were completed in the hangar.

Procedure	Description	Date Completed
FTP-E-044	Battery Fit Check	6-2-60
FTP-E-030	Separation Circuitry Check	6-15-60
FTP-E-021	Inspection of Airborne Quick Disconnect Plugs	6-29-60
27-92020-1	Missile Electrical System Checkout	6-29-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-E-042B	Booster Separation Circuit Ringout Check	7-8-60
FTP-B-011D	Propellant and Explosive Area Checkout and Trial Fitting of Pyrotechnic Devices	7-28-60
FTP-E-055	RF Electrical and Telemetry Redline Calibration	7-12-60
FTP-E-006A	Missile Electrical Block-house Compatibility Test	7-13-60
M-052C	Missile RF and Electrical Precountdown Operations	7-29-60
M-050	RF and Missile Electrical X-1 Day	7-21-60
E-021C	Release Sequence Test	7-25-60
M-050	RF and Missile Electrical X-1 Day	7-29-60

Hydraulic System

No 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	6-30-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-H-002D	Ground and Airborne Hydraulic System Fill and Bleed	7-13-60
FTP-H-004	Airborne Hydraulic System X-1 Day and Precount Operations	7-29-60

Azusa Transponder System

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

The following procedure was completed in the hangar.

Procedure	Description	Date Completed
27-92504 EO "J"	Azusa Coherent Carrier Transponder System Check-out	6-3-60

The following procedure was completed at the complex.

Procedure	Description	Date Completed
TPS-14-376	Azusa System Confidence Test	7-13-60

Convair Propellant Utilization System

There were no major difficulties encountered during hangar and complex system preparation. Matched Set No. 297 was the flight article, however, Matched Set No. 280 was used during the Flight Readiness Firing. This exchange was made since Matched Set No. 280 was accidently dropped and its reliabiltiy would be questionable on a flight.

The following procedures were completed in the hangar.

Procedure	Description	Date Completed
FTP-U-026B	Propellant Utilization Valve Angle Check	6-23-60
FTP-F-018A	Propellant Utilization System Leak Check	6-29-60
FTP-U-016A	Propellant Utilization Sensing System Test	7-12-60
FTP-U-027	Convair Propellant Utilization System Initial Laboratory Checkout (Matched Set No. 297)	7-13-60
FTP-U-014C	PU Manometer 13 Point Calibration and Tanking Capacity (Matched Set No. 297 and No. 298)	7-27-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-U-013D	Calibration of PU Null Meter	7-2-60
FTP-U-016A	PU Sensing System Readiness Test	7-7-60

Procedure	Description	Date Completed
FTP-U-015B	27-43040 Alignment Procedure Fuel/LO2 Rate Valve (For Matched Set Numbers 297 and 280)	7-14-60
FTP-U-019A	Functional Check of PU System (Matched Set No. 280)	7-19-60
FTP-U-019A	Functional Check of PU System (Matched Set No. 297)	7-27-60

Holddown and Release System

One of the three cold release tests performed was unsatisfactory due to lack of calibration on the record and no generation of a release signal.

No other difficulties were encountered.

The following procedures were performed on the system.

Procedure	Description	Date Completed
FTP-L-017A	Launcher Release System Functional and Restraint Test	6-28-60
FTP-L-001C	General Launcher Alignment	6-29-60
FTP-L-005B	Checkout of the Launcher Stabilizing System	7-1-60
FTP-L-007D	Functional Checkout Launcher Stabilizing and Launcher Auxiliary Frame System	7-11-60
FTP-L-006C	Shakedown for Launcher Cold Release	7-11-60
FTP-L-014A	Launcher Lines Leak Check	7-12-60

Procedure	Description	Date Completed
FTP-L-013C	Adjustment of Rise-off Disconnect Panel	7-13-60
FTP-L-006B	Shakedown Procedure for Launcher Cold Release	7-13-60
FTP-L-016B	Release Mechanism Timing Check	7-14-60
FTP-L-002B	Launcher Pin Retraction Procedure	7-22-60
FTP-L-006B	Shakedown Procedure for Launcher Cold Release	7-25-60

Telemetry System

No major difficulties were encountered during preparation of this system for flight test. The flight telemetry package No. 9240, was removed for modification to accomodate added instrumentation on the backup gyros. This package was reinstalled for flight.

The following procedures were performed in the hangar.

Procedure	Description	Date Completed
FTP-T-005	Bridging of Temperature Transducer and Accessory Package	5-22-60
FTP-T-009	Telemetry System Hangar Checkout	6-2-60
FTP-T-017	Vernier Engine Position Calibration	6-15-60
FTP-T-022	Telemetry System Functional Check	6-23-60
FTP-T-023	Telemetry High Pressure Transducer Checkout	6-21-60

The following procedures were performed at the complex.

Procedure	Description	Date Completed
FTP-T-011	Telemetry System Functional Test (Flight Package)	7-1-60
FTP-T-011	Telemetry System Functional Test (Spare Package)	7-18-60
FTP-T-018	Telemetry Blockhouse Compatibility	7-1-60
FTP-T-008	Alignment and Calibration of Engine Positon Transducer	7-7-60
FTP-T-007	Missile Telemetry System X-1 Day and Precount	7-20-60
FTP-T-029	Telemetry System Precount	7-21-60
FTP-T-028	Telemetry System Test	7-21-60
FTP-T-028	Telemetry Readiness Test	7-28-60
FTP-T-029	Telemetry Precount	7-29-60

Impact Predictor System

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

The following procedure was completed in the hangar.

Procedure	Description	Date Completed
FTP-G-018	Mod II IP System Checkout	6-17-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-G-006A	GE Impact Predictor Blockhouse Compatibility Test	7-5-60
TPS-14-407	IP 30 Day Lab Check	7-25-60

Abort Sensing And Implementation System

There were no major difficulties encountered during system preparation at the hangar and complex.

The following procedure was performed in the hangar gyro laboratory:

Procedure	Description	Date Completed
FTP-S-063	Calibration of Over Rate Detectors	6-23-60 7-11-60 7-14-60 7-22-60

The following procedures and test preparation sheets were performed at the complex.

Procedure	Description	Date Completed
TPS-14-403	ASIS X-1 Day Checkout (FRF)	7-20-60

Procedure	Description	Date Completed
27-92577-1	ASIS System Checkout	7-27-60
FTP-S-069	ASIS Pre-Readiness Test (X-2 Checkout)	7-28-60
TPS-14-415	ASIS X-1 Day Checkout	7-28-60
FTP-S-070	ASIS Precount Operation	7-29-60

Guidance System

During hangar checkout, Decoder, Serial No. 8A1035, was removed from the missile on two occasions and sent to the GE Lab to check the pitch and yaw signal outputs. The decoder was found to operate satisfactorily on both occasions and was returned and re-installed on the missile. During the GE Lab profile test it was found that Rate Beacon, Serial No. 4A1023, would not pass the bandwidth specifications test. Rate Beacon, Serial No. 4A1036, was assigned as a replacement.

The guidance system satisfactorily supported a Flight Acceptance Composite Test on 13 July 1960. However, Pulse Beacon, Serial No. 1A9034, Rate Beacon, Serial No. 4A1036, and Decoder, Serial No. 8A1035 were removed from the missile and sent to the depot because of possible overheating. It was found that phase A electrical power had been applied to the guidance system for an unknown length of time, with and without pod air cooling, due to a wiring error on plug P704. Pulse Beacon, Serial No. 1A9033, Rate Beacon, Serial No. 4A1031, and Decoder Serial No. 8A1036 were installed on the missile.

The guidance system satisfactorily supported a Flight Acceptance Composite Test on 18 July 1960. However, additional tests performed after the FAC Test revealed that the guidance system responded to misaddress signals both with the umbilicals installed and removed. Also, the Guidance Monitor Set (GMS) indicated that the Rate Beacon AGC No. 2 was erratic and the Pulse Beacon AGC was too high. The guidance system was removed from the missile and sent to the GE Lab for a confidence check. The lab check failed to confirm the high Pulse Beacon AGC reading, however, Pulse Beacon, Serial No. 1A9033, was replaced by Pulse Beacon, Serial No 1A9038, to insure that the pulse beacon was not causing the high pulse beacon AGC reading on the GMS. The high pulse beacon AGC and misaddress problems were corrected by replacing

umbilical P1004. The erratic rate beacon AGC problem was found to be caused by the presence of potting substance between the plates of umbilical receptable J1004. The substance was removed and no further difficulties were encountered.

The following procedures were completed in the hangar.

Procedure	Description	Date Completed
FTP-G-017 DA 901	Mod IIIA Guidance System Checkout	6-23-60
TPS-J-96	GE Guidance System Removal for Lab Test	6-27-60

The following procedures were completed at the complex.

Procedure	Description	Date Completed
FTP-G-011A DA's 1110 & 1117	Autopilot/Mod III Guidance Integrated Checkout	7-11-60
FTP-M-026C	Guidance and Impact Predictor Readiness Check List	7-20-60 7-21-60 7-28-60
FTP-M-026C DA 1127	Guidance and Impact Predictor Readiness Check List	7-27-60
FTP-G-007B	GE Guidance Blockhouse Compatibility Test	7-5-60
FTP-G-002A TPS-14-405	Missileborne Waveguide Pressure Check	7-26-60

APPENDIX

FLUID CHEMICAL ANALYSIS

All Fluid Chemistry samples were taken for Mercury/ Atlas Booster launch on 29 July 1960. The results were acceptable.

Liquid Oxygen	Units	Sample	Specifications
Purity	Percent	99.6	99.5 Min.
Hydrocarbons			
As Methane	ppm	7	75.0 Total Max.
As Acetylene		None	0.5 Max.
Fuel - RP - 1			
Initial Boiling	°F	381	Report
10 Percent	°F	490	365-410
50 Percent	°F	417	Report
90 Percent	°F	449	Report,
End Point	°F	470	525 Max.
Residue	Percent	0.5	1.5 Max.
Loss	Percent	1.0	1.5 Max.
Flash Point	°F	140	110 Min.
Gravity	°API	44.1	42.0 Min.
Particle Count			
10 - 20	Microns	2520	No solid particles greater than 175 microns. (Fibers not defined.)
20 - 40	Microns	1080	
40 - 80	Microns	540	
80 /	Microns	6 fibers 7 particles	
Moisture Content	ppm	None	5.0 Max.
Gaseous Helium			
Purity	Percent	99.9/	99.9/ Min.
Hydrocarbons		None	

Hydraulic Fluid	Units	Sample	Specifications
Flash Point	°F	220	200 Min.
Color		Red	Report
Viscosity	Centistokes @ 130°F	8.3*	10.0 Min.
Water by Distillation	Percent	Cannot be measured by spec. method.	0.005 Max.
Dye		Red	
Particle Count			
10 - 20	Microns	1020	4800 Max.
21 - 40	Microns	600	2400 Max.
41 - 65	Microns	160	800 Max.
66 - 100	Microns	40	160 Max.
Over 100	Microns	0	0 Max.
Gaseous Nitrogen			
Purity	Percent	99.75	99.5 Min.
Hydrocarbons		None	
Trichloroethylene			
Appearance		Pass	Clear and Free.
Color		Pass	Not Red, Blue, Green, or Purple Dyed.
Odor		Pass	Characteristic
Specific Gravity	@68°/68°F	1.468	1.454 to 1.476
Distillation	°F	185.0	185.0 to 191.3
End Point	°F	195.9	199.4 Max.
Water Content		Pass	Cloudless @14°F
Non-Volatile	Percent	0.0009	0.002 Max.
Lubricating Oil			
Viscosity	Centistokes @ 100°F	25	23.0 to 34.0
Flash Point	°F	322	280 Min.
Viscosity Index	136.7	136.8	80 Min.

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

REFERENCE DOCUMENTS

Flight Test Plan - Missile No. 50D	AZC-27-073
Detailed Test Objectives (AFBMD/STL)	TR-59-0000-00818
Flight Test Directive (FTWG)	AA 60-0028

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
General Electric, Syracuse, N.Y.	
Guidance System Preliminary Evaluation Report	10 Days
Guidance System Detailed Evaluation Report	6 - 8 Weeks
NASA, Project Mercury Space Task Group, Langley Field, Va.	
Post Launch Report	5 Days
Flight Test Report	3 Weeks

SERIAL NUMBERS OF SYSTEM COMPONENTS

AZUSA TRANSPONDER, Serial No. 026-0029

RANGE SAFETY COMMAND SYSTEM

Range Safety Command Canister No. 1, Serial No. 910-0031
Range Safety Command Canister No. 2, Serial No. 910-0030
Range Safety Command Canister No. 1, Power Supply, Serial No. 55
Range Safety Command Canister No. 2, Power Supply, Serial No. 54
Range Safety Command Canister No. 1, Battery, Serial No. 2
Range Safety Command Canister No. 2, Battery, Serial No. 240

PROPULSION SYSTEM

Sustainer Engine, Serial No. NA 222091
Booster Engine, Serial No. NA 112091
Vernier No. 1, Serial No. NA 332090
Vernier No. 2, Serial No. NA 332182

ELECTRICAL SYSTEM

Missile Main Battery, Serial No. 001-0492
Inverter, Serial No. 905-0004
Power Changeover Switch, Serial No. 078

GUIDANCE SYSTEM

Decoder, Serial No. 8A1036
Pulse Beacon, Serial No. 1A9038
Rate Beacon, Serial No. 4A1031

IMPACT PREDICTOR SYSTEM

Rate Beacon, Serial No. 92-72
Pulse Beacon, Serial No. 93-96
Beacon Trigger Generator, Serial No. 96-17

TELEMETRY SYSTEM

Telemeter RF #1, Serial No. 9240
Telemeter RF #1, Battery, Serial No. 912-0063
Accessory Package, Serial No. 912-0002

FLIGHT CONTROL SYSTEM

Gyro Canister, Serial No. 121
Servo Canister, Serial No. 98
Programmer, Serial No. 816
Stabilization Filters, Serial No. 152

PROPELLANT UTILIZATION SYSTEM

Matched Set, Serial No. 297
Computer Comparator, Serial No. 004-0055

ABORT SENSING IMPLEMENTATION SYSTEM

Canister, Serial No. 005-0004

REDUNDANT RATE GYRO, Serial No. 11

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

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

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

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

*** FRF terminated prematurely, but considered satisfactory.

**** Prematurely terminated due to APS shutdown.

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

Missile	Arrival	Complex	Erection	FRR	Flight	AMR Range No.	Comments
3B	4-12-58	11	5-29-58	*6-23-58 **6-27-58 7-8-58	***7-12-58 7-19-58	1564	Missile broke up at 42 seconds of flight. Due to failure of the yaw rate gyro.
4B	5-31-58	13	6-13-58	7-15-58	8-2-58	1382	Successful flight. Impacted approximately 2345 nm downrange.
5B	5-30-58	11	7-22-58	8-20-58	8-28-58	1383	Successful flight. Impacted approximately 2853 nm downrange. First completely closed loop guidance system flight.
8B	7-31-58	14	8-4-58	9-5-58	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	11	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 1.96 seconds after BGG links break.

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

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

**** Vernier ignition only.

\# Manual cutoff at 6.69 seconds.

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

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

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

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

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3C	10-31-58	12	11-4-58 *11-25-58	12-17-58	12-23-58	2501	Successful flight. Impacted approximately 3803 nm downrange.
4C	11-9-58	12	1-6-59	1-19-59	1-27-59	10	Although impact was close to intended point, the guidance system did not function.
5C	1-31-59	12	2-4-59	None	2-20-59	251	Missile exploded at 174 seconds due to a malfunction at staging. Probable cause was improper operation of the fuel staging valve.
7C	2-12-59	12	2-23-59	None	3-18-59	761	Booster engine shut down prematurely at 131 seconds of flight. Missile was unstable for remainder of flight.
8C	5-7-59	12	5-11-59	**5-22-59 **7-9-59	#7-15-59 7-21-59	2103	Successful flight. Impacted in target area 4385 nm downrange. RVX-2 Re-entry Vehicle recovered.
11C	7-15-59	12	7-25-59	8-14-59	8-24-59	2121	Successful flight. Impacted almost 5 miles long in MILS net due to residual thrust after vernier cutoff. Re-entry Vehicle was recovered.
9C	4-4-59	12	4-15-59 ##8-17-59	***9-24-59		2934	

* 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.

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	3-3-59	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	4-1.-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 solo hydraulic package.
18D	5-27-59	11	9-2-59	None	10-6-59	2129	Successful flight. Impacted in MILS net less than 1/2 mile from target.
22D	8-26-59	13	9-21-59	None	10-9-59	3505	Successful flight. Impacted in MILS net less than 1 1/2 miles from target.
26D	9-18-59	11	10-8-59	None	10-29-59	2344	Due to malfunction of V2 engine at staging, impacted approximately 14 miles short of target point.
28D	9-18-59	13	10-14-59	None	11 -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	14 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.

SECRET

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 1/2 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.

* 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.