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SYSTEM

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QUARTERLY PROGRESS REPORT

Prepared by TECHNICAL PUBLICATIONS

BELL Aircraft CORPORATION

BUFFALO, NEW YORK

REPORT NO.56-981-021-48

31 MARCH 1957

This document comprises a title page, frontispiece, pages i through iv, and pages 1 through 70.

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BELL Aircraft CORPORATION

SUMMARY

The Bell Aircraft Corporation presents here a brief resume on the status and progress of major elements and efforts of the System 112A Program for the quarter ending 31 March 1957.

RELIABILITY . . . the S-band and L-band beacon subsystems exceeded required reliability goals during a 1000-hour life test . . . . For the 80 tests conducted thus far on life-test missile No. 78, the cumulative observed reliability, excepting propulsion system, was 76% . . . . Phase II of the Rascal reliability educational program, completed in January 1957, was witnessed by more than 2600 Bell Aircraft employees . . . presentation of phase III, stressing reliability on a departmental level, will soon begin . . . . New factory-testing requirements for missiles call for 15 composite systems tests; 40% of tests must be free from reliability-type failures . . . GAM-63A No. 87, the first missile so tested, completed 10 composites successfully with a cumulative observed reliability of 76% . . . . Of 583 repetitive problems encountered during weapon system testing, 508 have had corrective action completed.

FLIGHT TEST PROGRAM . . . at Holloman Air Development Center, four missiles (Nos. 4581, 4684, 4783, and 4891) were expended during this quarter. . . . GAM-63A No. 4581 was released from a DB-47 director aircraft on 7 January 1957 . . . at launch, hydraulic discharge pressure began to decrease and reached a level insufficient to operate the servopilot . . . the control surfaces deflected hard over and No. 4581 impacted 5.0 nautical miles northeast of the launch point at 87.3 seconds . . . . Missile No. 4684, launched 16 January 1957, climbed to an altitude of over 64,000 feet and accelerated to a Mach number of about 3.0 . . . all systems performed satisfactory and the missile impacted 2.9 nautical miles northwest of the target at 274.9 seconds . . . . On 2 February 1957, GAM-63A No. 4783 was launched automatically at a pressure altitude of 38,470 feet and at Mach 0.78 . . . at 74.9 seconds, hydraulic flow rate began to increase and the turbine pump shut down at 78.9 seconds . . . No. 4783 climbed to 54,710 feet, then fell from this altitude to impact at 191.3 seconds without benefit of power or guidance. . . . Missile No. 4891, launched on 13 March 1957, attained all flight objectives . . . operation of propulsion and guidance systems was satisfactory during the 90.2-nautical-mile flight . . . maximum Mach number of 2.74 was attained at 156.1 seconds . . . impact occured 478 feet southwest of the target.

PROPULSION SYSTEM . . . successful application of the Linde flame-plating process on drilled-aluminum thrust chambers has led to an investigation of the possiblity of plating the convergent and throat sections of tubular thrust chambers . . . the tungsten-coated drilled-aluminum thrust chamber, with chrome-nickle binder, exceeded engine qualification requirements . . . . An explosion occurred during acceptance-testing of a gas generator package when the shutdown electrical signal failed to close the propellant valve and open the fuel-circuit gas purge after combustion had been interrupted . . . after investigating the practicability of initiating purge with loss of gas generator pressure, or eliminating the purge completely, a decision was made to retain the purge and resequence it by loss of gas generator chamber pressure . . . . Development of explusion bladders for IRFNA has been discontinued . . . . The feasibility of substituting air for nitrogen as the pressurizing medium proved that the use of air is unsafe . . . explosions in the gas generator damaged two pressure transducers.

GUIDANCE SYSTEM . . . results from launching GAM-63A No. 4891 provided further evidence that changes made in the electrical synchronizer have effectively improved AGC performance of the radar set . . . . The first set of hardware for the low-power antijam radar set has been ground-tested successfully; flight testing at HADC will follow . . . . Work on the high-power antijam radar set has been discontinued . . . . Test equipment and power supplies are being constructed for investigating the applicability of the QK-533 carcinotron power-transmitting tube as a replacement for the A1016 relay in the radio set . . . . In the nonemanating guidance system, an improved sensitive relay for the dive angle computer proved satisfactory during evaluation tests and has been incorporated in production assemblies . . . preliminary

evaluation has indicated that an improved chopper is satisfactory for use in the range and velocity computers.

FLIGHT CONTROL SYSTEM . . . in the environmental re-evaluation of the Rascal flight control system and the inertial range-computing system, 1612 tests have been completed on electronic and hydraulic components. . . . Mechanical coupling tests on missile No. 46 are complete and a test report is being prepared . . . . The feasibility of transitorizing the Rascal flight control system is being studied . . . . The search for more—reliable filters, accumulators, and seals for the hydraulic system is continuing.

GROUND SUPPORT EQUIPMENT . . . engineering efforts are centered on liaison, evaluation and testing to ensure scheduled delivery of operational ground support equipment to the Air Force . . . liaison units are setup to assist vendors fabricating operational ground support items . . . project personnel are providing technical assistance in the E&ST Program at Eglin AFB and in the Support Equipment Evaluation Program at HADC . . . . Design of the warhead pan pallet is complete . . . . Repackaged design of the GAM group simulator for use as director aircraft checkout equipment was completed and accepted by the USAF for future procurement articles . . . . Evaluation of the GAM and DB-47 checkout trailers with associated handbooks is about 50% complete.

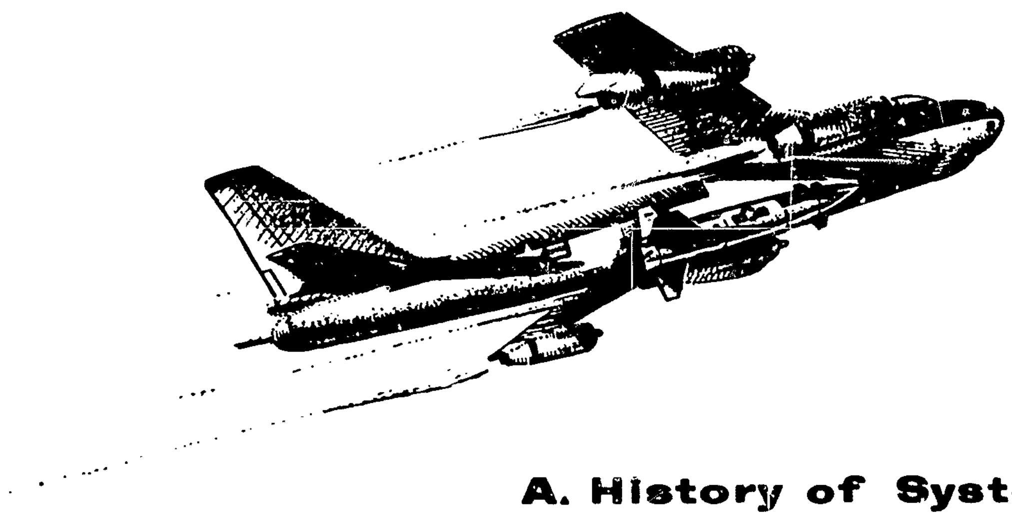
TRAINING EQUIPMENT . . . design work on the 25 units comprising the missile and director aircraft portions of the Mobile Training Unit is complete and all units are released for manufacturing . . . engineering liaison will assist Manufacturing in the fabrication of these units . . . . A new optical system was fabricated and installed in the radar simulator of the Rascal Guidance Operator Trainer . . . this unit provides improved light transmission efficiency. . . . The guidance operator's station was modified to duplicate exactly the production version of the DB-47; the instructor's console is being revised to incorporate the latest weapon system changes . . . . During a six-week refresher training program, Air Force AOB's utilized the RGOT . . . . A report was published on the Phoenix RBS phase of the Target Acquisition Program . . . . The development program on Radar Simulator Map-Making Techniques was expanded to include require... as requested by visiting USAF personnel.

DIRECTOR AIRCRAFT EQUIPMENT . . . production AN/APW-17 guidance systems, Nos. 117 through 123, were shipped to Boeing for installation in DB-47's . . . . System No. 107 was installed in the DB-47 airplane (USAF No. 52-2345); this aircraft was sent to HADC and service kit installation completed . . . after systems testing, the airplane will be sent to Eglin AFB in support of the E&ST program . . . . System 108 is mounted in DB-47 airplane (USAF No. 52-2346) and service kits were installed at Eglin AFB . . . . Systems 109 through 114 and system 124 are at AF Plant 40 . . . 23 units from each of systems 109 through 114 are on loan to Bell Aircraft Wheatfield . . . after kit and instrumentation installation, the units will be used in the R&D program at HADC . . . . System 110 is at Boeing for use as an installation model . . . system 115 is at Eglin AFB as a spare for DB-47 No. 346 . . . system 116 was sent to HADC as a spare for DB-47 No. 345 . . System 125 is scheduled for the DEI at Bell/Wheatfield on 16 through 18 April . . . system 117, in DB-47 airplane (USAF No. 51-2168), is the first production AN/APW-17 system incorporating the new warhead change.

SUMMARY OF GAM-63A'S — DELIVERY AND DISPOSITION . . . data concerning the delivery and utilization of GAM-63A missiles are presented in Appendix III of this document.

CONTENTS

ILLUSTRATIONS



SECTION I

INTRODUCTION

A. History of System 112A Project

The System 112A (Rascal) Project, formerly referred to as Project MX-776, was initiated by the Air Materiel Command, USAF, as a study program for the development of a subsonic air-to-surface missile (ASM) carrying a special warhead. This program was amended to include a supersonic ASM; eventually, the subsonic missile phase was discontinued.

In 1948, the project was divided into two concurrent programs: the X-9 Shrike and the GAM-63 Rascal. Bell Aircraft Corporation, as the prime Weapon System Contractor, immediately initiated the design, development, and fabrication of Shrike, a supersonic test missile (small-scale version of the GAM-63) with a 50-mile range and capable of carrying a 1000-pound special warhead. Work on the radar-relay system for the missile included the use of two JB-17's as a simulated missile/director aircraft team. These early investigations and subsequent work with modified JF-80 and JF-89 airplanes have resulted in an improved guidance system for installation in the GAM-63A.

In 1950, Bell Aircraft was authorized to proceed with the detail design and fabrication of XGAM-63 missiles, and the first powered Shrike missile was launched successfully from a DB-50 R&D director airplane.

A major milestone was passed in September 1952 when the first XGAM-63 was flown under its own power. By the end of 1952, the Shrike program, which included 28 powered missiles, was successfully completed. At the close of 1953, two glide and four powered XGAM-63's had been flight-tested, the last containing full guidance equipment.

During 1954, the capabilities of the Rascal Weapon System were amply demonstrated during the flight testing of 18 missiles. These capabilities were demonstrated in search radar and microwave link operation, power plant performance and control, remote control of the missile during terminal guidance, and missile performance at high altitudes. A free-drop configuration and technique was devised and successfully proven during the launching of 10 missiles; the technique is now standard procedure. Vital structural and aerodynamic data were obtained from the flight test program. Pinpoint accuracy was demonstrated by missile No. 1626* which, under full guidance control, scored the first target bull's-eye of the Rascal flight test program.

In the first quarter of 1955, six Rascal missiles were launched from DB-50 airplanes. Two missiles, Nos. 2231 and 2430, scored direct target hits at missile ranges of approximately 38 nautical miles. This concluded the flight testing of Model D missiles and the use of B-50's as director aircraft.

On 5 May 1955, the first operational prototype missile of the Model F series, GAM-63A No. 2949, was launched from a DB-36 R&D director airplane. This missile included inertial guidance and a simulated warhead. Missile No. 3054, flight-tested on 14 July 1955, was the first launched from a DB-47 operational director.

Late in 1955, the System 112A development program was reorientated to emphasize reliability in the Rascal weapon. A firm comprehensive test

*The first two digits of the missile number indicate firing order; the last two digits indicate USAF airframe delivery number. Thus, missile 1626 is the 16th to be launched, but the 26th airframe delivered to the USAF.

During the first quarter of 1957, GAM-63A's Nos. 4581, 4684, 4783, and 4891 were launched in the flight test program at Holloman Air Development Center, New Mexico. Detailed flight test results are presented in Section II, B. program was established to provide an over-all increase in operational reliability with each successive missile. Repetitive acceptance and life tests, hot ground firings, and captive flight tests are providing a weapon of continually increasing reliability.

B. Weapon System Description

WEAPON SYSTEM

Designed as an all-weather airborne instrument of combat, the Rascal GAM-63A Weapon System provides strategic bombardment aircraft with an increased capability for attacking and destroying heavily defended targets with little possibility of being detected or intercepted. Major elements of the weapon system are: (1) the GAM-63A missile; (2) the DB-47 director aircraft; (3) ground support equipment; and (4) training aids.

RASCAL MISSILE

The GAM-63A is a rocket-propelled, air-to-surface, guided aircraft missile with a gross weight of about 18,300 pounds, half of which is propellants. Principal dimensions are: over-all length, 32 feet; maximum outside body diameter, 4 feet; and maximum horizontal span, 17 feet. The missile airframe combines a cylindrical semimonocoque fuselage with a canard cruciform wing configuration. Structurally, the airframe consists of five major sections: the radome nose, forward body, warhead section, center body (tank) section, and aft body shell. These divisions are based upon functional requirements, as well as system and component accessibility and ease of shipment.

For its specific employment in the GAM-63A Weapon System, the Rascal missile comprises four closely integrated component systems: (1) a liquid-propellant rocket power plant; (2) a servopilot and antenna stabilization system; (3) a range-computing inertial guidance system, incorporating a radar relay and command override feature; and, (4) a special warhead and fuzing system. The rocket power plant, utilizing inhibited fuming nitric acid and jet fuel as propellants, delivers 12,000 pounds thrust to accelerate the missile to supersonic velocity during its climb to level flight altitude. During the gyro-stabilized midcourse portion of flight, the missile follows a programmed course as dictated by its inertial guidance system. A range computer measures the horizontal distance traveled from the point of launch and causes the missile to enter a preset dive to target. During the terminal dive, a search radar in the radome of the GAM-63A scans the target area and relays missile position and target data to a guidance station in the director aircraft. This information is used to establish course-correcting command signals that are relayed to the missile as required to hit the target.

DIRECTOR AIRCRAFT

The director aircraft that form an integral element of the Rascal Weapon System are modified B-47 strategic bombardment airplanes, redesignated DB-47. Their primary mission is to carry the GAM-63A missile to a point within 90 nautical miles of a target and to provide for its proper launching and guidance after launch. In addition to an MA-8 bombing-navigational system, the director aircraft are equipped with: (1) an automatic system to check out the GAM-63A quickly and completely before launch and, working in conjunction with the MA-8 system, to release the missile automatically; (2) a relay link system to establish and maintain continuous microwave contact with the missile; and (3) a control station that enables a guidance operator to monitor the flight path of the missile and, if necessary, to initiate course corrections during the midcourse and terminal dive phases of flight.

GROUND SUPPORT EQUIPMENT

Items of ground support equipment for the GAM-63A Weapon System are separated into three major categories: servicing, handling, and checkout. This equipment encompasses all items that are not an integral part of the missile or director aircraft, but are necessary to service, repair, test, and otherwise prepare the weapon for its mission. Servicing equipment includes the fuel and oxidizer trailers and the nitrogen boost trailer. Handling and transport items comprise carriages and dollies, assembly stands and slings, and packaging equipment. Checkout and test equipment is provided for the maintenance of electronic, electrical, and hydraulic systems in both the missile and director aircraft.

TRAINING EQUIPMENT

Rascal training equipment provides the means for indoctrinating and training maintenance and operations personnel of the Air Force in various phases of weapon system application. Equipment required by the Air Force comprises a mobile trainer unit for teaching theory of operation and techniques of maintenance in the field, and a guidance operator trainer for Aerial Observer Bombardiers. Additional equipment includes: mobile classroom demonstrators containing functional component systems of the missile and director aircraft; flight teams of F-80/B-50 aircraft modified to simulate the GAM-63A/DB-47 combination in actual air-to-surface training; and appropriate test units, bench test sets, and instruction manuals.

C. Weapon System Mission

The Rascal Weapon System* is designed to carry out air-to-surface bombing of strategic targets without exposing the bombardment airplane and aircrew to local target defenses. This mission is accomplished by combining a high-performance DB-47 bomber airplane with a relatively short-range, supersonic, GAM-63A missile. In its operational employment, the weapon system is based upon the ability of the missile to penetrate local defenses and to deliver a 2800-pound special warhead to a strategic target with little probability of being detected or intercepted. Thus, DB-47 strategic bombers as director aircraft armed with GAM-63A missiles need not approach the target closer than 90 nautical miles, the range of the missile.

An Air Force letter dated November 1953 established a maximum range requirement of 90 nautical miles for the Rascal missile. Based upon a missile range of 75 nautical miles, the GAM-63A will provide an airburst with a horizontal circular probable error (CEP**) of less than 1500 feet and, excluding errors in weather prediction and target intelligence, a vertical standard deviation*** of less than 405 feet.

In a typical maximum-range mission, the DB-47 director aircraft, carrying the GAM-63A missile, is navigated to a predetermined launch area by means of its MA-8 bombing-navigational system which constantly computes distance and course to the target. Immediately prior to launch, an automatic checkout system (ACS) checks items of the missile in sequence, while data regarding director aircraft velocity, heading, and changes in range-to-target are fed into the missile to serve as "initial condition" data for its nonemanating guidance system. At a preset distance from the target, the ACS, in conjunction with the MA-8 system, automatically releases the GAM-63A on the proper heading for the target. Minimum launch altitude is 40,000 feet MSL; minimum launch velocity is Mach 0.78. After the missile clears the launch gear of the DB-47, the rocket engine ignites. The GAM-63A accelerates to supersonic velocities in its climb to level flight altitude as programmed by a pressure-sensing circuit. From release to warhead detonation, the missile is controlled by a gravity-referenced inertial guidance system. The missile's range computer continuously computes ground range to target by double integration of a signal from a pitch-stabilized accelerometer. At a pre-established distance from the point of launch, the range-computing system places the GAM-63A in a 35° dive toward the target.

At the initiation of terminal dive, a search radar mounted in the nose of the missile is automatically

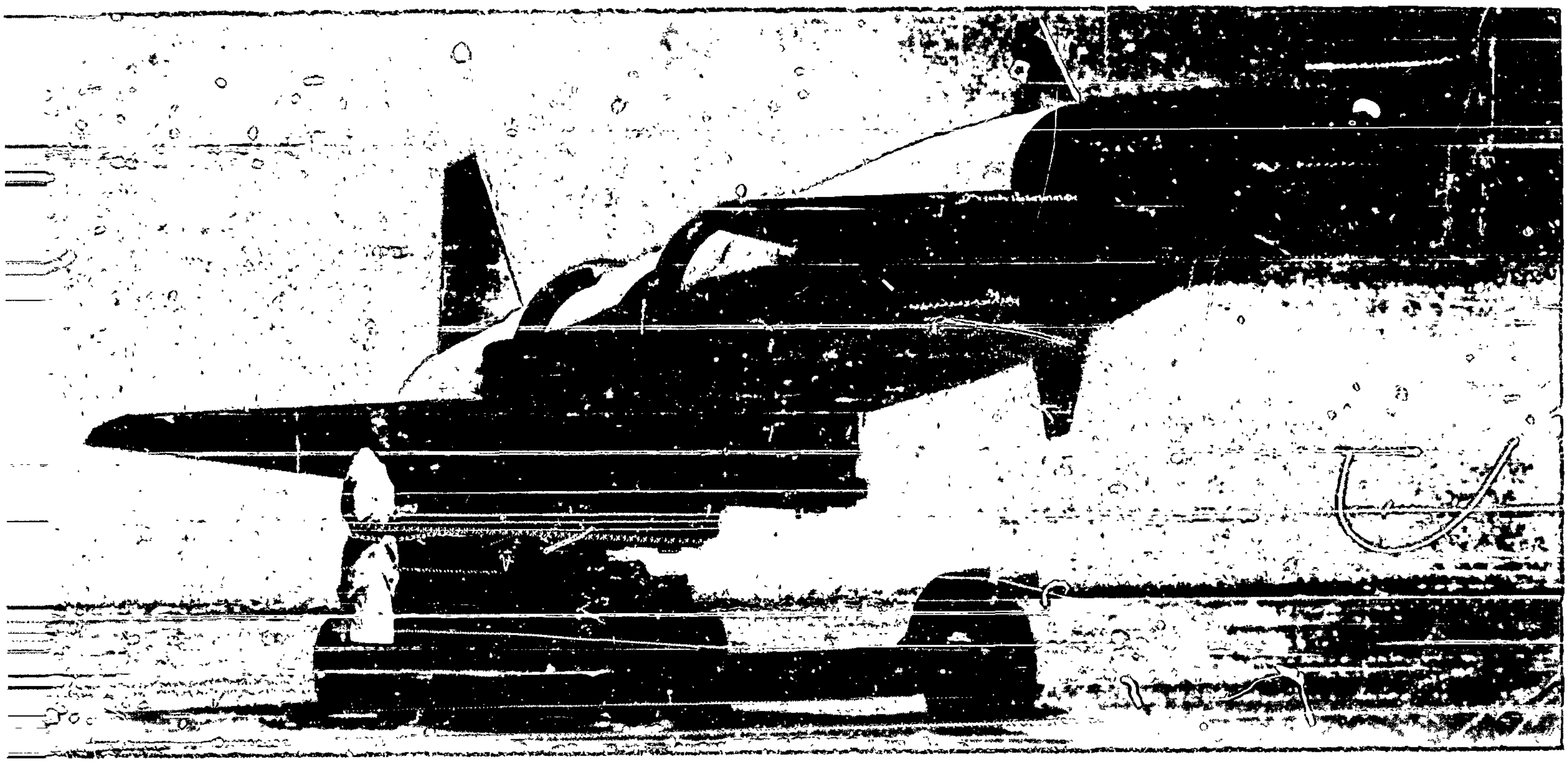
* "Military Characteristics for a Pilotless Parasite Bomber," SAB-51-B1, 14 December 1951, Directorate of Requirements, Hq. USAF; "Development Directive," No. 00-27-A1, 4 February 1952, ARDC; and Reorientation of Project MX-776, Contract W33-038ac-14169," AF letter WCSGA/HDH/nrw, 4 March 1952.

** CEP: The limiting value, as the number of flights becomes large, of the radius of a right circular cylinder whose axis is a vertical line through the target and within which 50% of the detonations occur.

*** VERTICAL STANDARD DEVIATION: The limiting value, as the number of flights becomes large, of the root-mean-squared distance between the actual and intended detonation altitude.

activated and scans the area ahead of the GAM-63A over a 150° sector. A radar image of the target and surrounding area is sent via a microwave relay link to the director aircraft. Here, the radar information, displayed on a plan position indicator, enables a guidance operator to monitor the progress of the flight and to ascertain errors in the missile's path to the target by the relative position of the target with the indicator cursors. If the GAM-63A is headed off course, guidance commands in elevation and azimuth are computed and transmitted via the relay link to the missile's autopilot. This is accomplished as the operator manipulates a tracking stick to align cursors on the radar display in coincidence with the target. Displacement of the tracking stick determines the magnitude of the flight path corrections which are automatically computed, coded, and relayed to the missile's autopilot system. With the radar definition of the target area constantly improving as the GAM-63A approaches its objective, the required degree of accuracy in target acquisition is assured.

It is important to note that the guidance operator may, at any time after launch, initiate a command to energize the search radar in the missile. The relayed video information can be utilized to check and correct the flight path of the GAM-63A in relation to known checkpoints. Also, the terminal dive can be initiated through the command link.



SECTION II

RESEARCH AND DEVELOPMENT PROGRAM

A. Ground Test Program

1. SYNOPSIS

As the Rascal Weapon System progresses from the R & D stage to the fabrication of prototype operational hardware, an increasing amount of final testing and evaluation of equipment is undertaken to assure the quality of the end items. The major effort is directed toward (1) systems testing of components and subsystems, (2) flight testing of GAM-63A's, and (3) evaluating director aircraft and ground support equipment. In such a testing program, system deficiencies are pinpointed and corrective development work is accomplished concurrently with the evaluation of the weapon system and its elements.

Presented here is the progress being made in systems testing of various elements of the Rascal weapon.

2. TESTING AT THE NIAGARA FRONTIER FACILITIES

a. Missile Test Stations

The Quality Control Department maintains 18 missile test stations (positions) that are used to ensure the proper quality and functioning of GAM-63A's. These stations permit the complete testing of missile emanating guidance, nonemanating guidance, fuzing, instrumentation, and beacon systems, as well as portions of the propulsion system. The test equipment at these stations is modified as required to ensure compatibility with the latest missile configuration and to incorporate improvements resulting from field operations.

Design effort is aimed at reducing the complexity of the test equipment required to perform a smoothly coordinated test countdown. This effort is expected to decrease the number of personnel presently required to perform such tests. Examples of this design work are the new radar and radio test sets which will replace two X-band signal generators, a pulse power amplifier, a video simulator, and a polycode driver.

One of the test positions, station P, is being redesigned to facilitate pressure-testing of the missile under simulated turbine and rocket fire sequence. Presented in Table I is a description of the test stations, together with their location and capabilities.

Two R & D test stations are being used to evaluate engineering changes and development problems that affect GAM-63A systems testing operations. In addition, a special test station, consisting partly of Station M, has been used successfully to check out the three test vehicles allotted to the gravity bomb program. Presented in Table II is a listing of the R & D test stations, together with their location and capabilities.

b. Missile Testing

(1) GAM No. 78

Missile No. 78 was transferred to AF Plant No. 38 on 28 September 1956 and positioned in test cell E-5. Fifteen composite systems tests (with propulsion) were performed at a temperature of -55°F.

TABLE I

QUALITY CONTROL TEST STATIONS

Station	Location	Missile Effectivity	Missile In Test	Test Capabilities
A-1	Wheatfield	93 & subq	No. 89	Subsystems and composite systems
A-2	Wheatfield	93 & subq	No. 90	Subsystems and composite systems
B-1	Wheatfield	93 & subq	No. 98	Emanating and nonemanating guidance systems
B-2	Wheatfield	93 & subq	No. 94	Emanating and nonemanating guidance systems
C-1	Wheatfield	93 & subq	No. 100	Nonemanating guidance, telemetering, and fuzing systems
C-2	Wheatfield	93 & subq	No. 99	Nonemanating guidance, telemetering, and fuzing systems
D-1	Wheatfield	93 & subq	Vacant	Nonemanating guidance system
D-2	Wheatfield	93 & subq	No. 101	Nonemanating guidance system
P	Wheatfield	—	Vacant	Pressure testing of GAM-63A
E-5	AF Plant 38	93 & subq	No. 78	Used with R&D trailer for subsystems, and composite systems, and static hot firings
E-8E	AF Plant 38	93 & subq	Vacant	Static hot firings and composite systems
E-8W	AF Plant 38	93 & subq	No. 93	Static hot firings and composite systems
E-9E	AF Plant 38	93 & subq	No. 88	Static hot firings and composite systems
E-9W	AF Plant 38	93 & subq	No. 96	Static hot firings and composite systems
F (1)	HADC	87 — 93	Vacant	Composite systems
G (2)	HADC	73 & subq	No. 80	Composite systems
X (1)	HADC	73 & subq	Vacant	Composite systems (portable)
Y	HADC	73 & subq	Vacant	Composite systems (portable)

NOTES: (1) Reserved for GAM-63A's 81 and 83.

(2) Adapted for dual (23-channel) telemetering system and gravity bomb testing.

Ten of these static hot firings were successful. Three tests were terminated after turbine fire owing to:

(1) Lack of gas generator chamber pressure

(2) Lack of lubrication oil pressure

(3) Erratic indications of internal phase "B" voltage

The two remaining tests were terminated before turbine fire owing to:

(1) A defective tube in the low-voltage power supply of the radar set

(2) No indication of single-phase voltage in the inverter

TABLE II

R&D TEST STATIONS

Station	Location	Missile Effectivity	Missile In Test	Test Capabilities
M	Wheatfield	93 & subq	No. 97	Subsystems and composite systems
R&D Mobile Checkout Unit	Wheatfield	93 & subq	No. 86	Subsystems and composite systems
Gravity Bomb Test	Wheatfield	—	Vacant	Power and control, telemetering, and hydraulic systems

Testing of GAM No. 78 was conducted as part of Missile Life Test Program. Following the test series, the missile was returned to the Wheatfield plant on 5 February 1957 for further environmental testing.

(2) GAM No. 86

The following subsystems tests have been performed satisfactorily on Missile No. 86 at Station M:

(1) Instrumentation

(2) Fuzing

(3) Inertial range-computing system

(4) Servo (except servo computer tests previously performed at Station B)

After scheduling GAM No. 86 for a life test program comprising 50 composite systems tests, all applicable service kits and missing parts were installed in the missile. The initial composite test was then run successfully. However, owing to the urgency of testing missile No. 85 at Station M, No. 86 was placed in storage and the following components were removed from GAM No. 86 to facilitate the testing of other missiles with more urgent schedules:

(1) Radio transmitter

(2) Command receiver

(3) Yaw amplifier

(4) Spin-drive amplifier

(5) Alternator

(6) Yaw gyro

(7) Regulator package (rocket engine)

These components were later replaced and GAM No. 86 was returned to Station M for retesting on 25 February 1957. Following this retest phase, the life test program will be resumed.

(3) GAM No. 87

Missile No. 87 was transferred to AF Plant No. 38 on 28 December 1956. Eleven composite systems tests (without propulsion) were conducted at ambient temperature. Seven of these tests were successful. Major causes of the four unsuccessful tests were:

(1) Defective crystal — low-current in radar set crystal No. 2

(2) Altitude control timer did not meet specifications

The test program on No. 87 was completed on 27 February 1957 and the missile was returned to the Wheatfield plant in preparation for shipment to HADC.

(4) GAM No. 88

All subsystems of Missile No. 88 were tested satisfactorily at Stations B, C, and D. Seven composite systems tests (without propulsion) were then performed at Station A-1; three of these tests were successful.

GAM No. 88 was transferred to AF Plant No. 38 on 31 January 1957 and positioned in test cell E-9E. Thus far, 70%, of the composite systems tests (with propulsion) required in the Rascal Reliability Program have been completed.

(5) GAM No. 89

Subsystems testing of GAM No. 89 has been completed satisfactorily. The missile is positioned at test Station A-1 and 80% of its composite systems testing has been completed for the Reliability Program.

Limited life components in GAM No. 89 are being replaced and alignment tests will be conducted to assure the required operation of all replacement components.

(6) GAM No. 90

Missile No. 90 is at Station A-2 for subsystem testing. About 60% of the composite systems testing has been completed for the Reliability Program.

(7) GAM No. 91

Missile No. 91 was transferred to AF Plant No. 38 on 14 November 1956 and positioned in test cell E-9E. Eleven composite systems tests were performed between this time and 11 January 1957 (see Figure 1). The goal of two successful (and consecutive) composite tests was achieved on the 2nd and 11th of January. Following the replacement of limited life components and surveillance tests, alignment tests were performed. The missile was then returned to the Wheatfield plant in preparation for shipment to HADC.

(8) GAM No. 93

This missile was shipped to AF Plant No. 38 on 15 February 1957 and positioned in test cell E-8W. GAM No. 93 is scheduled for a minimum of 15 composite systems tests in conformance with the Reliability Program. Testing will be completed during the next quarter.

(9) GAM No. 94

Missile No. 94 was moved to AF Plant No. 38 on 3 March 1957 and positioned in test cell E-8E. Composite systems testing is scheduled to be completed during the next quarter.

(10) GAM No. 96

On 8 March 1957, Missile No. 96 was transferred to AF Plant No. 38 and installed in test cell

Figure 1. Composite Systems Testing of GAM-63A, Air Force Plant No. 38

E-9W. Hydraulic and power plant pressure checks have been completed satisfactorily. Testing of the servo and guidance systems is under way. GAM No. 96 is scheduled for 15 composite systems tests.

(11) GAM No. 97

Subsystems testing of Missile No. 97 was completed with no major discrepancies or delays encountered. In addition to a four-channel telemetering system, GAM No. 97 is equipped with a six-channel system that consists of four continuous vibration channels and two vibration commutators. The missile is at Station M awaiting a series of composite systems tests which will be performed after the following items have been installed:

(1) Bladder assembly (fuel tank)

(2) Pitch amplifier

(3) Vibrotron

(4) Regulator package

(5) Radio set package

(6) Warhead door

(12) GAM's Nos. 98 and 99

Missiles 98 and 99 have passed the required subsystems tests at Stations C and D. These GAM's are now positioned at Station B where telemetering system tests are under way.

(13) GAM's Nos. 100 and 101

Hydraulic tests have been completed successfully on Missiles 100 and 101 at Station D. These GAM's are now positioned at Station C where servo system tests are being conducted.

(14) Gravity Bomb Test Vehicles

In the gravity bombing capability program, three full-scale Rascal airframes are to be released from a DB-47 under typical launch conditions (see Section II, H, Weapon System Investigations). The three modified airframes selected for this program have been tested successfully at a specially constructed area of Station M. Owing to the configuration of these missiles, the only items to be tested were the telemetering and limited hydraulic systems. After completing these subsystems tests satisfactorily, composite tests were run successfully.

c. Missile Equipment

Systems testing of components and subsystems designed for GAM-63A missiles is performed to ensure satisfactory operation of these units under environmental conditions simulating those expected in actual field operations.

To accomplish environmental testing, both conventional and specialized test facilities are available. These include vibration, shock, acceleration, and radio interference equipment; temperature, humidity, and altitude chambers; and chambers for proof-testing under conditions of sand and dust, frost, and explosion.

Systems testing of missile components and subsystems at the Wheatfield plant has been completed in accordance with Bell Aircraft Report 56-989-129.

d. Director Aircraft Equipment

Preproduction systems testing of the terminal guidance system (TGS is part of the AN/APW-17 Radar Course-Directing Central) is progressing according to Bell Aircraft Specification 110-947-043. Testing is in the third of three phases; the first two phases of testing have been completed satisfactorily.

Phase III is complete except for the evaluation of one TGS unit which must undergo vibration-testing without isolators and must be subjected to sand and dust conditions. The unavailability of test equipment has temporarily caused a delay in this effort. The reports covering Phase III are 80% complete.

e. Miscellaneous

(1) Missile Equipment

A study has been made of the failure of the a-c voltage during the flight testing of GAM-63A No. 4783 (launched 11 February 1957). During this investigation, actual flight conditions were simulated in the laboratory and various faults were intentionally applied to the a-c voltage network to duplicate the telemetered data of the flight. A 160-ampere overload, with a 0.7 power factor, was applied to Phase B; a 14-ampere overload, with a 1.0 power factor, was applied to Phases A and C. Although the investigation disclosed no conclusive results, there was a good indication that an overload had been applied to Phase B during the actual flight test.

A new transformer-rectifier that features a silicon diode has been designed for high altitude operation. Tests on a laboratory model of this 28-volt, 70-ampere unit are under way to determine if design criteria can be met and to reveal inherent weaknesses in the design. Preliminary results of this work have disclosed that silicon diodes offer numerous advantages over other types of metallic rectifiers.

Several rocket engine cut-off timers (Haydon Models N6417 and N6418) have successfully passed bench tests and high- and low-temperature tests. Contact chatter occurred during vibration testing which was conducted according to Bell Aircraft Specification 66-947-011. A newly designed isolation mounting system is being evaluated.

The 5ENI-6 microswitch has been evaluated as a replacement unit for the AN3234-1 microswitches comprising the lanyard initiator switch. The 5ENI-6 unit has successfully completed all environmental and bench tests required for GAM-63A application.

Room-temperature cycling tests have been completed on the SV-5C servo valve and associated hardware. Operational tests will be conducted under environmental conditions of high and low temperature, altitude, and humidity.

In the endurance testing program on the hydraulic pump, utilizing XF4270 low-temperature hydraulic fluid, 350 hours have been accumulated to determine lubricity characteristics of the fluid.

The GAM-63A primacord destruct system has been tested under controlled conditions of low temperature, humidity, and vibration. Successful separations were obtained during all tests using either plastic-coated or plain primacord systems.

Special environmental testing has been completed on two 6-channel telemetering assemblies for GAM No. 97 (plus a spare).

Susceptibility tests have been conducted on the servo control system and the inertial range-computing system. Reports are being prepared on the susceptibility testing of the radio set and radar set.

A report on the re-evaluation testing of the radar set subsystem was completed during this quarter.

The re-evaluation program on servo components is about 80% complete. In this program, the servo components are scheduled for three complete cycles of environmental testing plus one extended cycle including life tests. The effectiveness of circuitry modifications, component changes, and wiring changes are being evaluated during these tests.

A 1000-hour life test on 20 blower motors (Type F2-3) and a life test on 40 relays (Sigma Type 5RJ-10,000) are under way. A report covering the life testing of the AN/DSW-1 radio set was completed during this quarter.

Special vibration tests have been run on the telemetering transmitter (Bell Dwg. No. 65-535-070) to find a suitable isolating system to reduce the noise level inherent in the transmitter. The isolating systems used during the tests were either Bell-design or commercial types. The tests revealed that the noise level can be reduced appreciably by using an isolating system capable of dissipating the heat generated by the transmitter.

Evaluation tests have been performed on two telemetering transmitters to determine the frequency versus temperature repeatability characteristics. A second phase of this test is under way with the transmitter installed in a closed case with heaters to improve the frequency repeatability.

Qualification testing has been started on transformers from various manufacturers with the objective of securing a list of approved sources for transformers.

(2) Director Aircraft Equipment

Two additional AN/APW-17 guidance systems have been returned to the Wheatfield plant from HADC for incorporation of the alternate warhead modification.

Bench and environmental testing, as well as tests specified in MPB's (Material Process Bulletins), have been completed on three production-type azimuth and elevation indicators and on three relay receivers to be used as replacements at HADC. Preparations are under way to test a total of five sets of replacements; each set will comprise 23 components. These production-type components are replacements for R & D prototypes; their use should improve the reliability of the AN/APW-17 system in the hot-firing program at HADC.

Preparations have been made for a 1000-hour life test on a Type SC-179 (modified) spin motor for the director aircraft antenna.

B. Flight Test Program

1. SYNOPSIS

Forty-eight Rascal missiles have been expended in the flight test program at Holloman Air Development Center (HADC), New Mexico. Of these, 27 were launched from DB-50 R&D director aircraft, thereby completing the final testing of Models 56A, B, and D missiles. The remaining 21 missile launchings utilized the Model 56F configuration and either the DB-36 (R&D) or the DB-47 (operational) aircraft as directors.

During this quarter, four GAM-63A's (Nos. 4581, 4684, 4783, and 4891) were launched from DB-47 director airplanes at HADC. Details of these flight tests are presented in subsequent paragraphs of this section of the report.

2. FLIGHT TEST PLANS

Final flight test plans, including the latest changes in the Rascal program, have been completed for GAM-63A's Nos. 80, 85, 87, 88, 89, and 91. Also, preliminary flight test plans have been completed for the three gravity bomb test vehicles.

3. FLIGHT TEST REPORTS

Data reduction reports were issued during this quarter for the final flights of the following missiles:

Missile No.	Date of Flight	Report No.
4379	11-5-56	56-980-240
4482	11-27-56	56-980-241
4581	1-8-57	56-980-242
4684	1-21-57	56-980-243
4783	2-11-57	56-980-244

Analysis of data from the final flight of GAM-63A No. 4891 (launched 13 March 1957) has not yet been completed.

4. CAPTIVE FLIGHT TESTING

The R&D captive flight program at HADC is concerned primarily with flight testing guidance system improvements, independent of the hot-firing program. The testing is separated into three phases: Phase I, which was completed late in 1956, was concerned with the investigation of problems arising from the missile firing program. Phase II is under way to investigate system compatibility of electrical equipment not yet in the production phase. Phase III, not yet begun, will consist of evaluating the compatibility of extended-range electronic equipment for use in the Rascal guidance system. This last phase is scheduled to begin during August 1957.

a. Missile Release Navigational Computer (MRNC)

The MRNC vendor, AC Spark Plug, has submitted to Bell Aircraft a detailed report on the modification of the MRNC and its amplifier unit. With this modification, a signal is supplied to the autopilot so that the aircraft is driven across the release heading after the angular coincidence enabling signal is received.

Engineering Change Proposals have been prepared and submitted to the Air Force and the modifications have been incorporated in the two E&ST director aircraft.

b. GAM No. 61

Missile No. 61 was used as a test vehicle in support of the captive flight program during the first quarter of 1957. The missile is being prepared for participation in the low-power antijam radar set tests scheduled for the next quarter.

c. Test Program

Several R&D tests were planned in the captive flight program for the first quarter of 1957. Of the seven items of work scheduled, only two were carried to completion owing to cancellations or the urgency of other efforts at HADC.

The following tests were cancelled:

(1) Continuation of flight tests on the modified altitude-tracking circuit of the range computer.

(2) Flight testing of the narrow-band relay system.

(3) Flight testing of the space-stabilized automatic tracking relay antenna system.

(4) Flight testing of an improved terminal guidance system.

The status of the other three items is as follows:

(1) A photographic flight over Kansas City, Missouri, was conducted 17 January 1957. The radar photographs obtained were satisfactory; therefore, no future flights are planned for this purpose.

(2) Telemetering tests were conducted 13 and 15 February 1957. All data were forwarded to Bell/Wheatfield for evaluation. The results appeared to be satisfactory.

(3) Testing of the low-power antijam radar set is scheduled early in the next quarter.

5. PRELAUNCH TESTS

a. GAM No. 80

GAM No. 80 remained in stand-by status from late December 1956 until 20 January 1957. On this date, a special electrical mating check of GAM No. 80 and DB-47 No. 51-5219 was made. This check indicated satisfactory operation of the weapon system.

Because of marginal weather conditions which delayed the scheduled launchings of missiles Nos. 81 and 83, GAM No. 80 remained on a stand-by status. After the launch of No. 4783 on 11 February 1957, electrical pit checks were completed on GAM No. 80; during these checks, excessive leakage from the fuel oxidizer seal was noted. In an effort to meet the launching schedule, rocket engine No. 13 was replaced with rocket engine No. 14. Subsequent pit checks on 16 February 1957 indicated the proper operation of missile No. 80.

Take-off of DB-47/GAM No. 80 on an attempted launch mission was accomplished on 20 February 1957 at 0630 hours MST. During prelaunch checks, the loss of synchronization in the terminal guidance indicator was reported and the flight was cancelled. Postflight investigation of the synchronization problem revealed excessive carbon particles on the indicator commutator assembly. These particles caused intermittent short circuits in the commutator segments and faulty spacing of the reluctance wheel and its L-505 coil. This trouble was corrected on 20 February 1957 and checks again revealed normal operation of the weapon system.

On 25 February 1957, the combination became airborne, prelaunch checks were concluded satisfactorily, and the weapon system was vectored onto the firing line. During the final checkout, the turbine failed to start and the mission was cancelled.

Postflight inspection of GAM No. 80 revealed that the turbine did not start because the fuel tanks failed to pressurize during the arming period. This pressurizing failure was caused by the presence of water in the check valve of the nitrogen fill and jettison system. The water probably froze at high altitude, holding the valve closed.

The DB-47 and GAM No. 80 again became airborne at 0625 hours MST on 28 February 1957. After satisfactory prelaunch checks, the weapon system was vectored onto the firing line and the countdown proceeded normally until approximately five seconds prior to turbine start. At this time, the nitrogen source pressure gage had reached the minimum allowable value and was decaying further. As a result, the system was shut down and the mission was cancelled.

Postflight investigations revealed considerable moisture in the nitrogen tube bundles and in the nitrogen filter. The water probably froze at high altitude and caused the excessive drop in the indicated nitrogen-source pressure.

Following these postflight investigations, the power plant was removed and cleaned. The oxidizer tank was drained, flushed, leak-tested, and treated with a chronic acid solution. The entire tube bundle system was dried and reinstalled.

It is anticipated that GAM No. 80 will be ready for launch early in the next quarter.

b. GAM No. 85

GAM No. 85 was received at HADC on 26 December 1956 and receiving inspections were completed 5 January 1957. Preflight and composite checks, delayed by parts shortages, were completed 25 February 1957.

Missile No. 85 was utilized in the evaluation of GAM-63A checkout trailer. Operation of the missile system was satisfactory throughout these tests. Power plant preflight tests were initiated 12 March 1957.

On 19 March 1957, GAM No. 85 was mated with DB-47 No. 51-5220 and, on 20 March, fuel and oxidizer were loaded. An electrical pit check the next day revealed that weapon system operation was satisfactory.

Pending an investigation of the malfunction of a gas generator propellant valve at AF Plant No. 38, the launching of GAM No. 85 was postponed. The missile is in stand-by status and probably will be launched during the next quarter.

c. GAM No. 87

Missile No. 87 was received at HADC in March 1957 and passed inspection requirements on 14 March.

In view of the excellent test history of GAM No. 87 at the Wheatfield plant, it was decided to eliminate individual preflight tests on the guidance and telemetering systems.

On 15 March 1957, No. 87 was mated with DB-47 No. 51-5220 (see figure 2) for an electrical check. This check proved unsatisfactory as a result of:

(1) No command contact

(2) No radar targets beyond a range of one mile

(3) Inertial guidance test problem was short (105 seconds)

(4) Relay magnetron failed to start in the proper mode

(5) An open telemetering channel

Based upon the results of this check, the following preflight tests were initiated:

(1) AN/DPS-3 pressure checks

(2) Cursor alignment

(3) Command signal decoder

(4) Radio repeater

(5) Hydraulic system

(6) Autopilot and antenna stabilization

(7) Inertial guidance

(8) Servo functional check

These preflight tests were completed and a mated electrical check was satisfactory on 22 March 1957.

When the servo preflight tests indicated unbalance of three valves, it was decided to filter the GAM hydraulic system.

Figure 2. Loading the GAM-63A onto the DB-47 Director Aircraft

At present, GAM No. 87 is ready for power plant preflight tests.

d. Gravity Bomb 0102

This test vehicle was received at HADC on 11 March 1957. Telemetering and hydraulic systems preflight tests have been completed. It is planned that this vehicle will be launched during April 1957.

e. Gravity Bomb 0203

The second gravity bomb arrived at HADC on 25 March 1957 and hydraulic preflight tests were completed. Telemetering preflight tests were begun on 29 March.

6. MISSILE LAUNCHINGS

a. GAM-63A No. 4581

Missile No. 4581 was transferred to HADC on 30 October 1956. The attempted launch flight of 12 December was cancelled because of solid overcast and improper operation of the missile yaw gyro. A second attempted launch, on 17 December, was cancelled when the control surfaces of the missile did not respond to simulated corrections. On 20 December, normal operation of the weapon system was observed until the end of the dry run. At this point, the terminal guidance operator reported complete loss of PPI display, and the flight was cancelled.

On 7 January 1957, missile No. 4581 was launched from DB-47 airplane No. 51-219 at 1550 hours MST. The launch took place at an altitude of 39,330 feet MSL and at a Mach number of 0.75. Distance from launch point to target was 76.41 nautical miles.

The prelaunch phase was normal and a satisfactory release was accomplished at 56.0 seconds after range coincidence. At launch, hydraulic discharge pressure began to decrease and, at approximately 9.0 seconds, reached a level insufficient to operate the servopilot. At this time, the control surfaces deflected hard over and the GAM became uncontrolled for the remainder of the flight. Impact occurred approximately 5.0 nautical miles northeast of the launch point at 87.3 seconds.

Investigation of the missile debris disclosed evidence of a faulty "O" ring seal in the hydraulic disconnect. The faulty seal may have caused pump cavitation, but pressure and flow data after launch present stronger evidence of a temporary sticking of the pump compensator at a zero pressure-output level. Tests are being conducted to determine the actual cause of the malfunction.

All flight data indicate that missile operation was normal except for loss of hydraulic pressure.

The emanating guidance system operated satisfactorily until approximately 9.0 seconds. At 41.6 seconds, the relay magnetron ceased to oscillate as the relay transmitter power dropped to zero and the relay high-voltage increased beyond the instrument limit of -2000 volts.

Analysis of the power plant data indicated satisfactory performance throughout the flight. A normal start at turbine fire was followed by a smooth and stable initial by-pass phase. The transition from bypass to boost was normal, and although the missile was uncontrolled from X+9 seconds to impact, power plant performance was stable throughout the flight.

Telemetering data show that information was received until missile impact. Operation of the L-band and S-band beacons and destructor systems was satisfactory.

The sequence of events for the flight is as follows:

	Time in Seconds
Range Coincidence (Start of ACS Countdown)	-56.0
Turbine Fire	-30.7
External to Internal Power Transfer	-17.95
Enable (Angular Coincidence Circuit Armed)	- 0.66
Angular Coincidence	- 0.62
Gyro Uncage	- 0.54
Release (Automatic Checkout System)	- 0.22
Release (Umbilical)	- 0.10
Release (Lanyard)	0.0
Rocket Fire	1.8
Full Thrust Attained	3.2
Hydraulic Pressure Decrease to Level Insufficient to Operate Servopilot	9.0
Relay Transmitter Power Drop to Zero Relay High-Voltage Rise to Exceed -2000 Volts	41.6
Impact	87.3

b. GAM-63 No. 4684

Missile No. 4684 was received at HADC on 27 November 1956. After receiving inspection, the missile and DB-47 director airplane No. 51-5219 were prepared for flight in accordance with HADC procedures. Following satisfactory in-flight checks of the guidance and command systems, the launch scheduled for 14 January was cancelled when the copilot observed a low nitrogen-pressure gage reading. A postflight check revealed an instrumentation error rather than a loss of source pressure.

On 16 January 1957, at 0722 hours MST, the weapon system became airborne on a launch mission (see Figure 3). Following satisfactory checks of the weapon system DB-47 No. 51-5219 and GAM No. 4684 was vectored onto the firing line and the final countdown by the automatic checkout system was begun. The check proceeded normally and resulted in the automatic launch of the missile at 0947 hours MST. The launch took place at 38,265 feet MSL and at a Mach number of 0.79. Distance from launch point to target was 74.7 nautical miles.

Turbine arm occurred at -56.3 seconds and the turbine fired 25.5 seconds later. Operation of the power plant during the initial bypass phase was normal and a smooth transition to the boost phase was effected at 1.9 seconds. All normal pitch, yaw, and roll oscillations were damped out by 18.0 seconds, and the servopilot maintained satisfactory stability in all three planes. At 32.8 seconds, the altitude controller cut in and the missile climbed to a maximum pressure altitude of 64,290 feet. Relay contact was established between the DB-47 and the missile at 89.0 seconds. At about 90 seconds after launch, the missile maneuvered to the left and this resulted in an azimuth error of 9°. The guidance operator initiated several commands between 195 seconds and impact in an attempt to correct the azimuth error. However, since the missile heading was such that the target was out of video scope range, the operator was unable to determine exactly what commands should be sent. The missile impacted 2.9 nautical miles northwest of the target (North Impact Point).

Power plant performance was normal during the entire flight, with all phase durations in close correlation with the flight plan. The thrust chambers shut off at 153 seconds and the gas generator continued operating to impact. Following the flight, a preliminary analysis of data (telemetering S-band plots, L-band plots, director aircraft records) was completed. This analysis indicated proper operation of the IRCS and the command and servo systems.

Both barometric and impact fuzing data were obtained; however, the impact fuzing film was extremely noisy and reduction was impossible.

The sequence of events for the flight of missile No. 4684 is as follows:

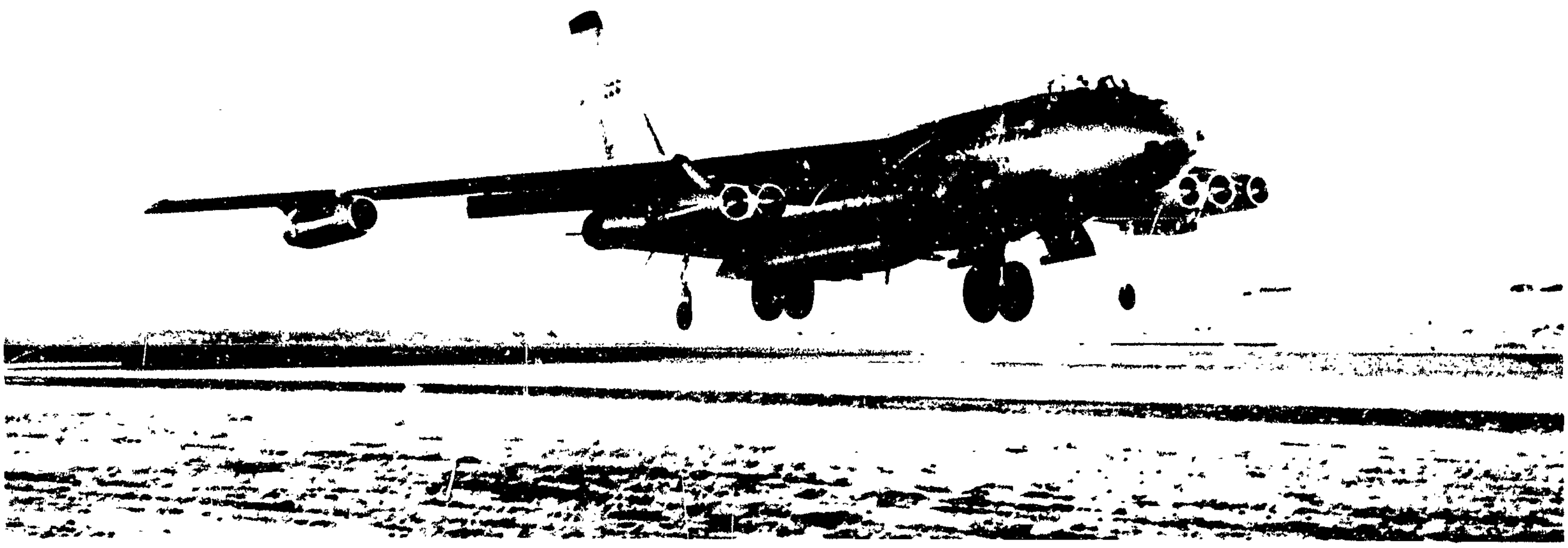


Figure 3. DB-47 Taking Off with Rascal Missile

	Time in Seconds
Range Coincidence (Start of ACS Countdown)	-56.3
IRCS Test to Normal	-54.3
Turbine Fire	-30.8
External to Internal Power Transfer	-18.1
Enable (Angular Coincidence Circuit Armed)	- 0.56
Angular Coincidence	- 0.53
Gyro Uncage	- 0.47
Release (Automatic Checkout System)	- 0.12
Release (Umbilical)	- 0.10
Release (Lanyard)	0.0
Rocket Fire	1.9
Full Thrust Attained	3.1
Altitude Controller Connected	32.8
Fuzing Safe Switch No. 1 Closed	90.2
Fuzing Safe Switch No. 2 Closed	92.2
Rocket Shutoff	153.5
IRCS Dive	196.2
Arming Baroswitch Actuated	246.2
MC-5 Baroswitch Actuated	268.6
Impact	274.9

c. GAM-63A No. 4783

Missile No. 4783 was received at HADC on 24 November 1956. Receiving inspections, preflight checks, and weapon system checks were completed in preparation for a scheduled launch flight on 12 December. However, inclement weather precluded the possibility of phototheodolite tracking and the mission was cancelled prior to take-off. An attempt was made on 17 December to launch GAM No. 83 from DB-47 No. 51-5220. Prelaunch checks were completed satisfactorily and the weapon system was vectored onto the firing line. The final countdown proceeded normally until turbine arm, when the automatic checkout system indicated a "No-Go" condition as the turbine remained in the arm position and did not fire. Following mission cancellation, a postflight investigation revealed that a fuel tank pressure-sensing switch had failed.

From 17 December to 21 January, there were five attempted launchings of missile No. 83. A Category I captive flight was attempted on 21 January to check over-all operation of the weapon system. The flight was cancelled when command contact could not be established. A second Category I captive flight, on 23 January, satisfied all flight objectives; however, at turbine shutdown, the copilot reported that the nitrogen source-pressure meter had indicated a value below the minimum specified. The weapon system became airborne three more times between 31 January and 1 February, but these missions were cancelled because of minor malfunctions of equipment.

Prior to take-off for the actual launch flight of 11 February 1957, ground checks were completed satisfactorily on the MA-8 system and adapter equipment in DB-47 No. 51-5219. The weapon system became airborne at 0700 hours MST, and, during the climb to altitude, video and command checks were satisfactory. The weapon system was vectored onto the firing line and the countdown by the automatic checkout system was begun.

Range coincidence was established at X-56.1 seconds and turbine fire occurred 25.0 seconds later. The missile was automatically launched at a pressure altitude of 36,470 feet and at a Mach number of 0.78. At 1.1 seconds after lanyard release, telemetered data indicate several irregularities in the relay and command system. At 74.9 seconds, the hydraulic flow rate began to increase, and, at the same time, telemetered data indicate the presence of power plant abnormalities. At 78.8 seconds, the electrical system shut down, followed by a shutdown of the turbine at 79.0 seconds.

The servopilot satisfactorily maintained three axis stabilization throughout prelaunch and the powered portion of the flight. The level-flight shim and climb angles agreed with planned values and the altitude controller cut in at 31.0 seconds. The missile attained an altitude of 54,710 feet MSL, and then fell from this altitude to impact (191.3 seconds) without benefit of power or guidance. Analysis of the power plant data indicated satisfactory sequencing and performance throughout the flight; the missile attained a maximum Mach No. of 1.44 at 77.2 seconds. Following launch, the transition to boost phase at 1.9 seconds was normal, with full thrust attained at 3.1 seconds. The boost phase was stable until rocket engine shutdown at 79.0 seconds. The three outputs of the d-c command package shifted at 1.1 seconds after lanyard release, and, at the same time, the relay +250-volt power supply increased from normal to a value exceeding the recording limit of the telemetering instrument. Performance of the missile's radar set was normal throughout the flight. Telemetered data show that information was received from the 20-channel telemetering system until impact and from the 4-channel system until power plant shutdown.

The sequence of events for the flight of No. 4783 is as follows:

Event	Time in Seconds
Range Coincidence (Turbine Arm)	-56.1
IRCS Test to Normal	-54.0
Turbine Fire	-31.1
External to Internal Power Transfer	-17.9
Enable (Angular Coincidence Circuit Armed)	- 0.68
Angular Coincidence	- 0.65
Gyro Uncage	- 0.55
Release (Automatic Checkout System)	- 0.22
Release (Umbilical)	- 0.1
Release (Lanyard)	0.0
First Indication of Abnormal Electrical System	0.7
Rocket Fire	1.7
Full Thrust Attained	3.1
Relay Antenna Returns to Normal Operation	10.0
Altitude Controller Connected	30.8
Electrical Shutdown	78.8
Power Plant Shutdown	79.0
MC-5 Manifold Baroswitch (12,000 ft)	172.35
MC-5 Probe Baroswitch (12,000 ft)	172.86
MC-5 Manifold Baroswitch (10,000 ft)	176.23
MC-5 Probe Baroswitch (10,000 ft)	176.33
Impact	191.3

d. GAM-63A No. 4891

Missile No. 4891 was transferred to HADC on 30 January 1957. Following receiving inspection, the missile and DB-47 No. 51-5220 were prepared for a scheduled launch flight.

The launch mission of 7 March was cancelled when command contact could not be established. The trouble was attributed to intermittent control of the director aircraft (ATRAS) antenna. On 11 March, subnormal L-band beacon tracking by the MIRAN (master ground tracking station) resulted in a "hold" being placed on the launch mission at X-3 minutes. Postflight investigations traced the problem to a defective beacon antenna connector.

On 13 March 1957, DB-47 No. 51-5220 and GAM-No. 4891 became airborne at 0625 hours MST. In the climb to altitude (Figure 4), beacon and video checks were performed satisfactorily. During the command checks, the operator experienced difficulty in retain-

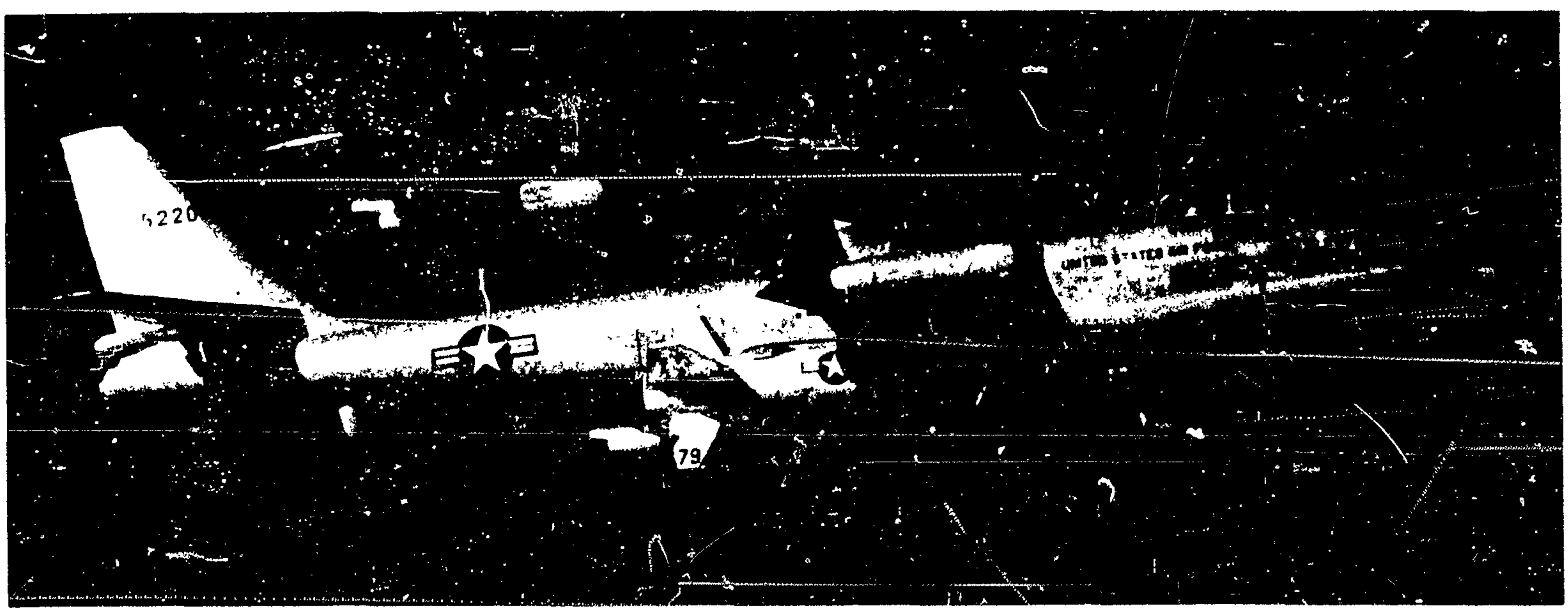


Figure 4. GAM-63A Missile and DB-47 Director Aircraft

ing the surface center light; this was due to a shift in the pitch command reference voltage. Countdown by the automatic checkout system proceeded normally, and the missile was launched at 0801 hours MST. Performance of the guidance and propulsion systems was satisfactory during the entire flight of 90.2 nautical miles. The missile attained a maximum altitude of 63,796 feet MSL and a maximum Mach number of 2.74. Approximately 6 seconds after launch, the normal oscillations of pitch, yaw and roll were damped out. At 32.3 seconds, the altitude controller connected, but the pitch angle did not change sufficiently to produce the proper climb to altitude. Consequently the missile reached the control altitude 30 seconds later than was planned. Telemetering data indicate that AGC voltage of the radar set was stable during the climb, the midcourse phase, and most of the terminal dive. The data show, at 307.4 seconds that the AGC level began to increase in the negative direction and attained a maximum bias of -2.95 volts at 334.5 seconds; this indicates satisfactory performance of the AGC circuitry.

Flight data indicate satisfactory operation of the power plant in all phases. Sequencing compared favorably with that planned for the flight, transitions were satisfactory, and the over-all performance levels were as expected. A normal turbine fire at -28.5 seconds was followed by a stable initial by-pass phase. Rocket fire was normal at 1.9 seconds, with full thrust attained at 3.0 seconds. Nitrogen pressure regulation was normal as indicated by satisfactory nitrogen pressure decay during arm, boost, and final by-pass phases. The MC-5 fuzing baroswitch actuated at 329.8 seconds. Examination of the vibrotron data revealed that the missile entered the transonic speed region (Mach 1.05 to 0.95) at 321.4 seconds.

The missile entered a 35° terminal dive at 236.2 seconds as initiated by the inertial range-computing system. Range to go at dive was 21.42 nautical miles. The missile responded to a series of azimuth and pitch commands transmitted from the director aircraft between 233.5 and 328.0 seconds. Impact occurred at a point 478 feet southwest of the target at 335.6 seconds. Missile range was 90.2 nautical miles.

The sequence of events for the flight of missile No. 4891 is as follows:

	Time in Seconds
Range Coincidence (Turbine Arm)	-53.41
IRCS Test to Normal	-51.20
Turbine Fire	-28.30
Angular Coincidence	- 0.50
Release (Automatic Checkout System)	- 0.44
Release (Umbilical)	- 0.10
Release (Lanyard)	0.0
Rocket Fire	1.9
Full Thrust Attained	3.0
Altitude Controller Connected	32.3
ATRAS Lock-On	111.1
Search Radar On	114.5
Rocket Engine Cut-Off	155.5
Dive (IRCS System)	236.2
MC-273 Arming Baroswitch Actuated	303.7
MC-5 Fuzing Baroswitch Actuated	329.8
Impact	335.6

C. Reliability Program

The Rascal reliability program encompasses all phases of weapon system development and manufacture, and extends from initial research and design phases through operational use of the finished product. Consequently, many of the specific reliability considerations and improvements realized during the quarter appear under other appropriate sections of this report. This section outlines some of the general programs of the reliability effort and discusses reliability activities and accomplishments that are not integral to specific areas of the weapon system covered separately in the publication. In addition, some specific examples of reliability improvements are given.

Detailed reliability information may be found in the System 112A Quarterly Reliability Report, Bell Aircraft Report 56-989-113, for the period ending 28 February 1957.

1. COMPONENT LIFE-TESTING PROGRAM

a. Beacons and Destructor Assembly

The S-band beacon subsystem, which includes the destructor channel, and the L-band beacon have completed the scheduled 1000-hour life test at Telerad, Flemington, New Jersey. Table III is a summary of significant test results.

Upon return of the S-band beacon to Bell Aircraft Corporation, a design analysis will be conducted on the receiver-transmitter unit to determine the cause of five repetitive failures of a 2D21 tube.

b. Servo Amplifiers

Reliability life testing of the six repackaged servo amplifiers has been completed at Federal Telecommunications Laboratory. The test is cyclical in nature and is performed under a combined temperature, vibration, and altitude environment. Design evaluation reports on this work are being analyzed at Bell Aircraft.

c. Servo Subsystem

A 1000-hour life test is being conducted on components of the following Rascal systems. The components are generally of GAM-63A No. 74 configuration and are being tested in the airframe of GAM-63A No. 72.

As of 22 March, 26 cycles of composite operation plus a check cycle conducted at the end of every 10th composite have been completed. A total of 340 operating hours has resulted in the following reliability-type failures:

System or Component	Reliability EDR's	Parts Failures
Nonemanating Guidance System (IRCS)	1	1
Flight Control System	32	17
Servo Components, Radar Set	1	1
Servo Components, Radio Set	3	2
GAM-63A Auxiliary System (includes hydraulic and fin-fold subsystem and most of electrical subsystem components)	1	1

d. Blower Motors

Twenty Western Gear F2-3 blower motors are being tested to failure under an ambient temperature

TABLE III

TEST RESULTS — S-BAND AND L-BAND COMPONENTS

S-Band Components	Reliability Goals	Observed Reliabilities	Reliability-Type Failures
Destructor Assembly	99.8%	99.8%	2 parts failures
Receiver-Transmitter	99.6%	99.2%	6 parts failures 2 adjustments
Power Supply	99.8%	99.9%	1 adjustment
Complete Unit	99.2%	98.9%	8 parts failures 3 adjustments

L-Band Components	Reliability Goals	Observed Reliabilities	Reliability-Type Failures
Receiver-Transmitter	98.8%	99.7%	4 parts failures
Power Supply	99.9%	100 %	
Complete Unit	98.8%	99.7%	4 parts failures

of 125°C. All bearings have been greased in accordance with BLC 160-1. In addition, lubricated dust caps were placed over the rear bearing on four of the motors. All motors are cycled on-off periodically, and the test will be continued until each motor has failed twice.

Thus far, 510 test hours had been accumulated. Four (uncapped) motors failed twice and were removed from test. In each case, the initial failure was due to bearing contamination and wear; the second failure, after replacing the bearings, was attributed to rotor binding in the stator.

A fifth motor, containing a dust cap, failed because of open windings at 413 hours and was removed from test. Two of the remaining 15 motors still in operation have failed once; neither had dust covers. The failure in each case was attributed to contaminated and worn bearings.

e. Completed Life Tests

The following life test programs were completed prior to this quarter. Test reports will be issued after final evaluation of data.

(1) Radio Set, AN/DSW-1, Relay and Command Subsystem (less servo components)

(2) Radar Set, AN/DPS-3, Unattended Search Radar Subsystem (less servo components)

(3) Fuzing System Components

(4) Missile Simulator Group

(5) YLR-67-BA-9 Rocket Engine

(6) Modified Servo Amplifiers

2. MISSILE LIFE TEST PROGRAM

a. GAM-63A No. 78

In the life test program, missile No. 78 has completed 80 tests, including 75 composite systems tests. A summary of testing results follows:

(1) Laboratory testing, less vibration, less power plant

Reliability for 1st 10 composites	68%
Reliability for 2nd 10 composites	77%
Reliability for 3rd 10 composites	77%
Reliability for 4th 10 composites	87%
Reliability for 5th 10 composites	83%
Cumulative reliability for the 50 composites	77%

(2) Vibration testing phase

Reliability for missile, less propulsion system, including vibrational tests	72%
Reliability for 10 vibrational tests alone	70%

(3) Propulsion testing phase (15 tests conducted at -55° to -65°F)

Reliability for missile, less propulsion system and associated GAM-63A auxiliary equipment	73%*
Reliability for propulsion system	68%
Reliability for missile, including propulsion system	50%

(4) Cumulative reliability for missile, less propulsion system, for 80 tests — 76%*

50 composites at ambient temperature

10 composites under vibration

10 composites / 5 incomplete composites (Propulsion system operating at cold temperature

5 reference composites at cold temperature

*Statistically, the 73% and 76% reliabilities are not considered significantly different.

GAM-63A No. 78 is now at the Wheatfield plant being prepared for altitude chamber environmental tests. The tests will consist of 55 composite systems tests in 11 groups of five tests each. Testing will be performed at temperatures ranging from -100° to +200°F and at altitudes up to 100,000 feet.

b. GAM-63A No. 86

The second life-test missile, GAM No. 86, is awaiting the start of the initial phase of the life-test program which will include 50 composite systems tests. These tests will provide additional data pertinent to determining the reliability of the present weapon system.

3. ENVIRONMENTAL RE-EVALUATION PROGRAM

Testing of the flight control and inertial range-computing systems is continuing in the environmental re-evaluation program. Thus far, 1612 environmental tests had been completed on electronic and hydraulic components. Of the units in test, 31 units have completed three cycles, 9 units have completed two cycles, and 14 units have completed one cycle.

4. ENVIRONMENTAL DATA-COLLECTING PROGRAM

a. Temperature and Vibrational Testing

Two reports were issued during this quarter dealing with temperature and vibration data gathered in the program. Report 56-984-034 presents the temperature data, and Report 56-984-035 the vibration data, recorded during the ground tests, and captive and final flights of GAM-63A No. 4075. Additional temperature and vibration data have been obtained from missiles Nos. 76, 77, 79, 81, 82, and 83 during ground tests, captive flights, and free flights. Missiles Nos. 80 and 97, which also contain environmental instrumentation, have not yet been flown.

In general, the vibration data recorded indicate that the aft section of the missile receives a greater degree of vibratory excitation than the forward section, and vibrations in the vertical direction are more severe than in the lateral or longitudinal directions. The data indicate that vibration intensity is affected by various flight parameters such as surface deflections, missile altitude, and power plant phase. Within some broad range of frequencies, the vibration data recorded during static composite systems tests (with propulsion) compare closely with data recorded during final flight.

Temperature data recorded thus are of the magnitude expected. Except for data recorded from two locations close to high-heat-producing components of the turbine pump, the internal ambient and component temperatures are within the range of -65° to +165°F specified for satisfactory operation of the Rascal missile. These temperature data represent the temperature environment which will be experienced during future flights of GAM-63A missiles when captive and free-flight plans are similar to those now in use.

b. Acoustical Testing

Acoustical level measurement tests have been conducted on the GAM-63A missile. Sound levels of 126 to 146 db were recorded in missile equipment compartments. Measurements of field noise patterns indicated noise levels up to 151 db in the horizontal plane of the thrust chamber.

Some parts have been subjected to nominal sound pressure levels of 145 db. The results on certain transistors, capacitors, resistors, diodes, and impact accelerometers indicated no significant effects of the high sound level. Certain tubes, relays, and baroswitches, however, have shown sufficient influence or reaction to warrant further investigation of critical parts and assemblies.

No equipment malfunctions or failures, during ground testing or captive and final flights, have been attributed to acoustical energy environments.

Further acoustical tests in the laboratories are planned on parts and assemblies to learn more about acoustical environment and its influence, and to develop testing techniques and procedures capable of coping with related potential problems. Plans for improved versions of this weapon system include the provision of instrumentation for the collection of acoustical and other environmental data during the captive and free-flight testing of missiles.

5. RASCAL RELIABILITY EDUCATION PROGRAM

Phase II of the Rascal Reliability Educational Program, which began in October 1956, was completed on 29 January 1957. This phase consisted of showing the motion picture, "No Margin for Error," to all manufacturing personnel concerned with production of the GAM-63A. Witnessing the 170 presentations of the movie were 2634 employees from the Niagara Falls and Wheatfield plants.

Following each presentation, questionnaires were distributed among the attendees so that each could express his reaction to the program. Suggestions submitted will be used as a guide in formulating the third phase of the educational program. Lists of significant comments from the 2300 questionnaires completed have been forwarded to the appropriate departments.

Almost 50% of the questionnaires urged that more emphasis be placed on proper handling of parts and components. Many participants indicated that more programs of an educational nature are needed. Such programs provide the employee with a broader view of the Rascal effort, affording each an opportunity to orient his isolated function with the whole program. With these comments in mind, phase III is being developed to emphasize care in the handling of material and will attempt to point out that each job is part of an integrated whole.

Phase III will emphasize reliability on a departmental level. A qualified man has been chosen from each department involved to help develop and to narrate a script explaining some of the acute problems concerned with that department. Colored slides will illustrate each talk and will point out some of the repetitive reliability problems encountered. Both properly handled and damaged equipment will be shown and the seriousness of a resulting malfunction to missile operation will be brought out.

As a supplement to the regular reliability presentations, large colored posters stressing the reliability concept (Figure 5) have been placed in strategic locations throughout the Bell Aircraft facilities.

6. RELIABILITY PRESENTATIONS

A reliability presentation was made, at the request of the Air Force, to USAF personnel concerned with the E&ST operation of System 112A at Eglin AFB, Florida. The presentation was of an orientational and educational nature on the subject of reliability pertinent to supply and maintenance activities at Eglin.

On 28 February, approximately 100 Air Force supply and maintenance personnel attended the presentation which included the showing of the second reliability movie, "No Margin for Error."

A second presentation, embodying more of the concept and status of the Reliability effort, was given to the Bell Aircraft service and technical representatives at Eglin.

The Reliability Control Section, Guided Missiles Division, coordinated the establishment of a reliability reporting system at Eglin. This system is similar to the one employed at Bell Aircraft testing facilities

Figure 5. Typical Reliability Posters

On 11 February 1957, at the request of the local AFPR office, a short discussion of basic reliability concepts and philosophy was presented to an audience of about 25 USAF personnel from the AFPR office.

7. MISSILE TESTING

a. More Comprehensive Factory Testing

More comprehensive factory tests are being applied initially to missiles Nos. 87, 88, and 89. The new reliability requirements are that at least 15 composite system tests be conducted on each missile during factory testing. Forty percent of the composites must be successful (no reliability-type failures) and the last two of the 15 must also be successful.

A minimum number of operating hours during missile factory testing has been established for each of the listed electrical circuits or systems. Included also are factory observed mean-time-between-failure (MTBF) figures.

	Minimum Operating Hours	Factory Observed MTBF in Hours
Master Power	125	704
Servo B-Plus	60	29
Hydraulic and Servo	50	263
Radar Low-Voltage	50	19
Relay and Command Low-Voltage	50	18
Inertial Range Computing System	20	49

Used as a basis for these figures were mean-time-between-failure data and average operating time during factory testing of missiles Nos. 75 through 85, excluding No. 78. Where practical, the minimum operating times were determined to provide sufficient assurance that the test results were significant.

b. GAM-63A No. 87

GAM-63A No. 87 has completed the full 15 composite systems tests required during the factory testing phase. The minimum operating times set up for the electrical circuits involved in the tests were met. The over-all observed reliability for the 15 composites was 76%, but for the period including the last 10 tests the missile had a reliability of 90%. Of the 15 composites conducted, 10 were completely successful, exceeding the requirement that 40% of the tests be failure-free. Of the last 10 tests, 8 were completely successful.

8. EQUIPMENT DISCREPANCY REPORT ANALYSIS

An analysis of 848 Equipment Discrepancy Reports (EDR's) covering the period to 5 February 1957 has been completed. These EDR's deal with missiles Nos. 58 through 84, AN/APW-17 systems 5 and 14, and DB-47's Nos. 219 and 220. Data were compiled during the complete field-testing phase at HADC and covering discrepancies on operational systems only. The following is a summary of problems encountered and the status of corrective action taken (whether the problem is still open or has been closed):

Type of Discrepancy	Problem Status Closed	Open	Total
Design	52	32	84
Workmanship	124	9	133
Test	146	11	157
Vendor	74	23	97
Dependent	12	0	12
Totals	408	75	483

On those problems still considered as open, interim corrective action has been taken in most cases and final corrective action is under way on each. All HADC EDR's are being carefully monitored to ensure the most expeditious completion.

D. GAM-63 Missile

1 airframe

A. SYNOPSIS

The GAM-63A missile has an over-all length of 32 feet, a maximum body diameter of 4 feet, and a gross weight of approximately 18,300 pounds. Structurally, the airframe consists of five major sections: the radome, forward body, warhead section, center body (tank section), and aft body (see Figure 6). These divisions are based upon functional requirements as well as component accessibility and ease of shipment. The structural components of the Rascal missile are shown in Figure 7.

The radome, a laminated ogive, encloses the unattended search radar antenna and is attached to the forward body by means of a splice ring. The forward body section includes the rudders, the forward wing and elevators, and houses guidance and servo units. Two large structural doors provide access to the upper compartment of the forward body. The lower compartment is accessible by removing the lower door of the warhead section.

The warhead section consists of a fixed upper half-shell and a removable lower half-shell which permits installation of the warhead. A small access door is provided at the top centerline of the upper shell for servicing the warhead.

The center body section is a ring-stiffened cylindrical shell of aluminum alloy with integral oxidizer and fuel tanks compartmented to maintain center-of-gravity control. Nonstructural tunnels running fore and aft on top and bottom of the body enclose electrical cordages, as well as propellant, nitrogen, and hydraulic lines.

The aft body section includes the vertical and horizontal tail surfaces, equipment compartment, rocket engine, and aft cowling. The rocket engine is mounted on a truss attached to, and supported by, the carry-through structure of the aft horizontal wing.

Launching provisions consist of two forged steel fittings used to attach the GAM-63A to the director

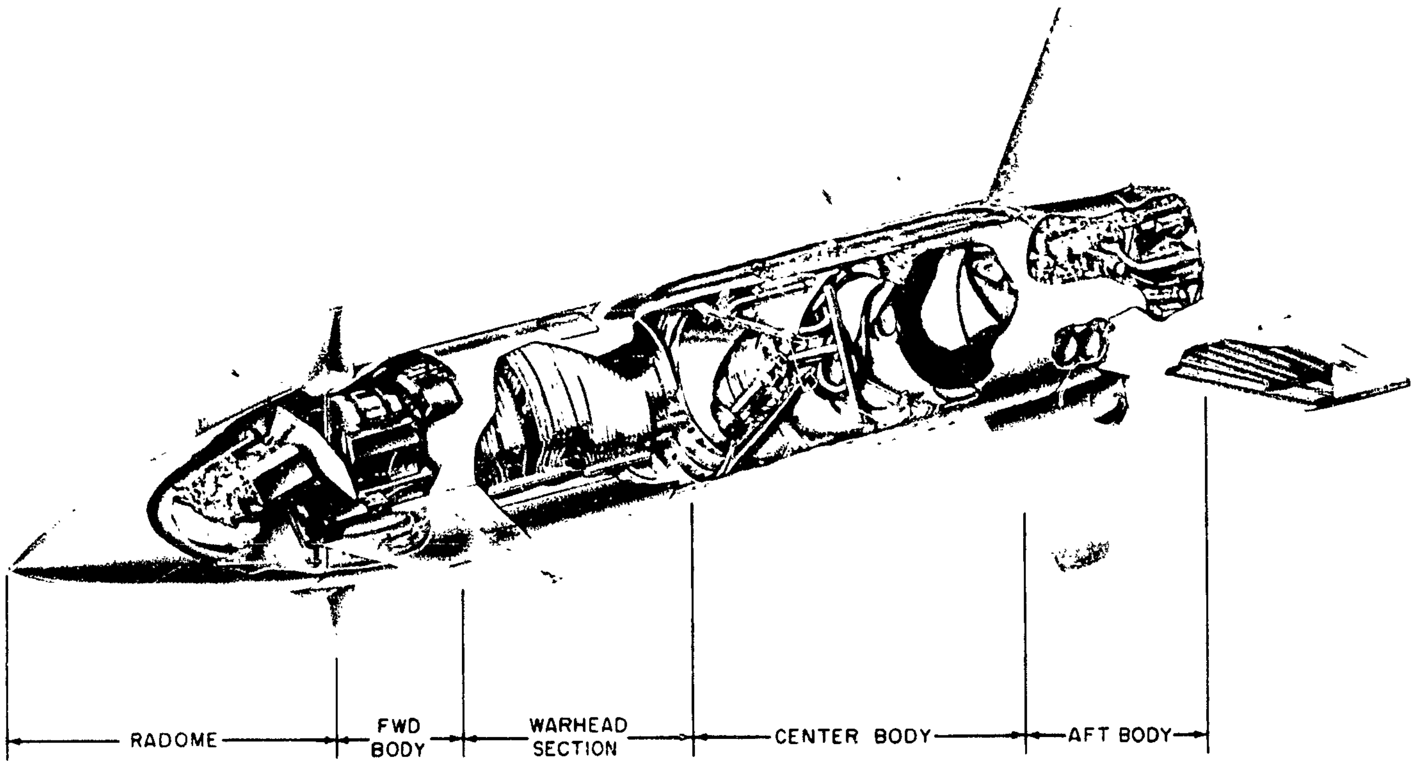


Figure 6. Cut-Away View of Rascal Missile

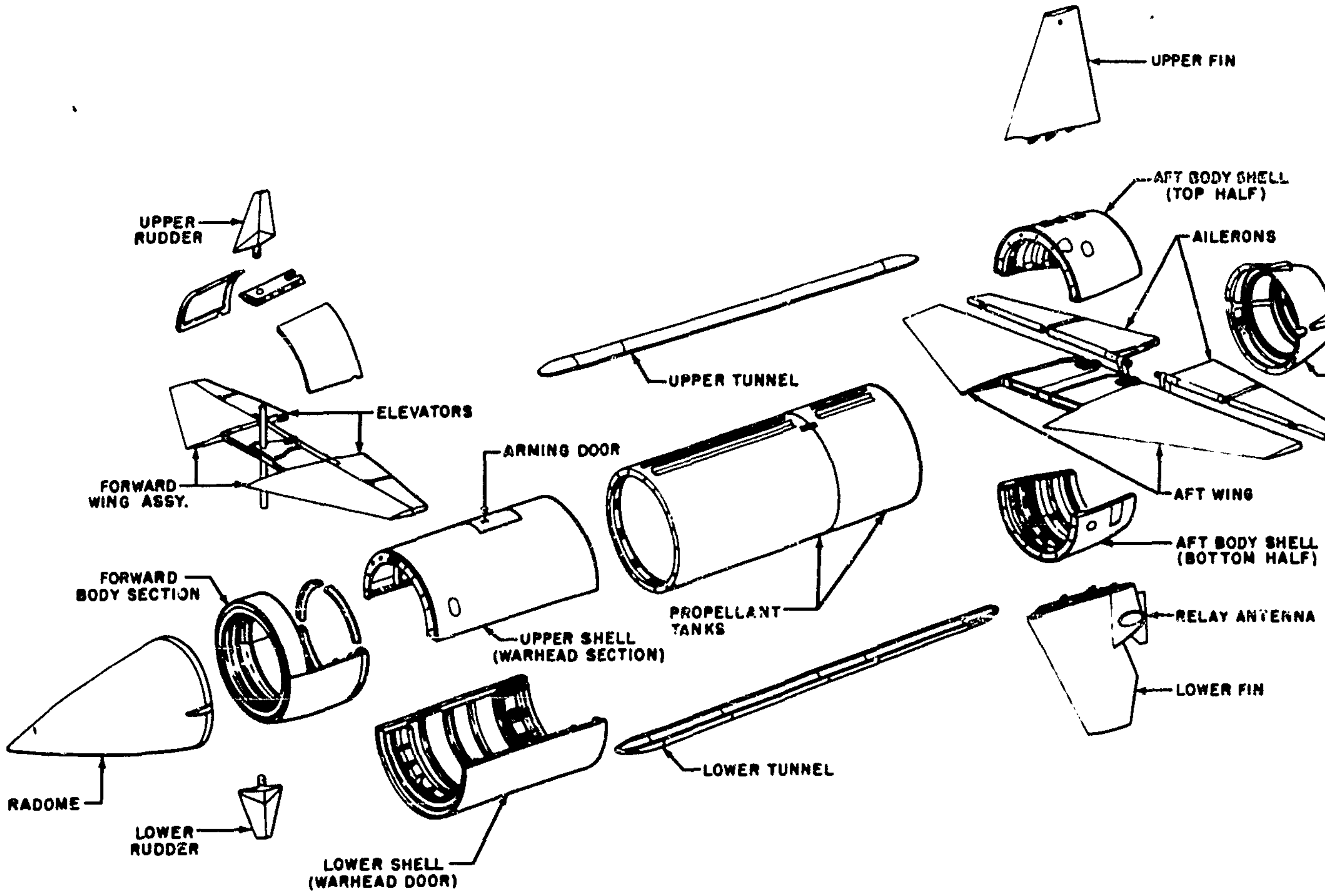


Figure 7. Structural Components of Rascal Missile

aircraft by means of shackle-type hooks. One fitting is located at the forward end of the warhead section, and the other is located in the center body between the propellant tanks.

B. STUDY PROGRAMS

1. GAM-63A Radome

The investigation of rain-erosion protection of the Rascal radome is complete. A report summarizing this effort has been submitted to the WSPO.

2. Low-Viscosity Hydraulic Fluid Investigation

Additional quantities of XF 4270 hydraulic fluid have been received from the Dow Corning Company, and the lubricity tests are being continued. In the endurance test portion of the hydraulic fluid evaluation program, more than 400 hours of running time has been accumulated using a New Lock Air Pump Model 66WA300. There has been no appreciable change in the viscosity, density, or neutralization number of the hydraulic fluid. Also, there has been no noticeable change in the performance characteristics of the pump.

3. Redesigned GAM-63A Destructor System

A proposal for a redesigned GAM-63A destructor system was presented to the WSPO late in 1956. A test program has been completed to determine the reliability of the present primacord destructor system when operated at -65°F. This program employed 10 simulated missile sections with primacord and destructor boxes installed. The test sections were subjected to environmental conditions of humidity, temperature, and vibration. Complete separation of the sections was accomplished during each test. A report is being prepared to summarize this test program.

4. Simplification of the Electrical System

Components of the GAM-63A electrical system are being studied in an effort to simplify circuitry and reduce their size and weight where possible.

Testing has been completed to determine the feasibility of using magnetic tubing as a shield for missile wiring. Test results show that the voltage induced in a wire as a result of electromagnetic fields is negligible.

An investigation resulted in increasing the dimensions of the alternator frame so that the T.K.M. Electric Corporation can meet the output requirements for this unit. Revised drawings reflecting increased dimensions were forwarded to the vendor. The first prototype of the T.K.M. alternator is scheduled for completion during the next quarter; the unit will be subjected to thorough evaluation after delivery to Bell Aircraft.

Electrical evaluations of teflon wire, treated with an etching agent of metallic sodium and liquid ammonia, have indicated that the adherence properties of the wire in conjunction with flexible potting compound is satisfactory.

C. SPECIFIC SYSTEM IMPROVEMENTS

1. Boattail Redesign

Work on the redesign of the circular aft body and engine cowling is approximately 80% complete. Further engineering of this item was terminated during the quarter.

2. Thin-Wing Design

The redesign of the aft thin wing (4% root section) has been terminated.

D. WEIGHTS REPORTS

During this quarter, weights reports were prepared for missiles Nos. 84 and 95. The Bell Aircraft report numbers are 56-942-121 and 66-942-001, respectively.

E. FLUTTER ANALYSES

Reports are being prepared to summarize the flutter studies performed for the aft horizontal surface and the rudder. These reports compare computed with test modes and frequencies.

Tests to determine experimentally the dynamic characteristics of the airframe in the pitch, roll, and yaw planes are essentially complete. These dynamic characteristics are obtained by feeding a sinusoidal input to the controls and recording the response from several points on the airframe. The experimental data, together with discussion, associated stability analyses, and conclusions, are being assembled into a report.

The program of measuring the free play of the control surfaces is continuing. Data have been examined from the flights of seven missiles with known amounts of free play. While in some cases the free play exceeded that allowed in Paragraph A-17 of Specification 66-947-011, no detrimental effects on flutter stability have been indicated. Although the free play measured, using the regular procedure, compared satisfactorily with the free play determined during the test of the controls (see Quarterly Report 56-981-021-45), improvements were noted which increase the reliability of the measurements by compensating for the effects of elasticity and friction. A revised procedure will be used to make all future free-play measurements.

2 propulsion system

A. SYNOPSIS

The GAM-63A is powered by a liquid-propellant rocket propulsion system incorporating a turbine pump drive unit. The thrust required to propel the missile to supersonic speed is provided by three identical chambers that develop 12,000 pounds thrust at an altitude of 40,000 feet. The liquid propellants are pumped to the thrust chambers by a gas-driven turbine pump which also furnishes auxiliary power to drive the hydraulic pump and alternator through suitable take-off pads. The turbine pump, utilizing the same propellants as the rocket engine, may be operated independently of the thrust chambers by passing the pumped propellants back to the tanks. Thus, the turbine pump assembly continues to furnish the required electric and hydraulic power during periods when thrust chamber operation is not required.

The propellants, JP-4 jet fuel and inhibited white fuming nitric acid (IWFNA) oxidizer, are contained in tanks that are integral parts of the airframe. The oxidizer tanks, fabricated from stainless steel for missiles through No. 4277, are presently fabricated from Type 6061 aluminum alloy. Type 6061 aluminum alloy fuel tanks, having passed the slosh and vibration qualification tests, have been installed in all missiles since No. 4176. Also incorporated in the aluminum fuel tank is the conversion to a bladder-type expulsion system. Work on the bladder-type expulsion system for oxidizer tanks has been cancelled. Tank pressurization and valve actuation is accomplished by use of nitrogen gas under high pressure, stored in tube bundles conforming with the inner circumference of the missile. The oxidizer WFNA was used for the XLR-67-BA-1 and YLR-67-BA-5 engines and IWFNA for the YLR-67-BA-9 engines. The addition of hydrofluoric acid to WFNA has reduced the rate of corrosion in the entire propulsion system and has resulted in holding the oxidizer within specifications for a considerably increased length of time during storage in the missile.

When the launching method was changed from a powered launch to free-fall launch, the protection of personnel in the director aircraft was no longer a factor during powered operation; thus, most of the safety system formerly used became unnecessary except during ground firings. As a result, the safety system was modified so that only turbine pump operation is monitored during the prelaunch period, up to the time the rocket-fire signal is given.

Missile Nos. 4581, 4684, 4783, and 4891 employing the YLR-67-BA-9 rocket engine were flight-tested at HADC during this quarter. The propulsion systems of these missiles performed satisfactorily through their respective flights.

A total of nine aborted flights was experienced with missile No. 80 during the last two quarters of 1956. Three of these were the result of propulsion system failures. The first failure, involving improper sequence valve operation, was reported in the last quarterly report. The other two failures resulted from moisture freezing in the pressurization system. This prevented fuel tank check valve operation in one instance and plugging of the nitrogen filter in the other instance. The entire nitrogen pressurizing system has been subjected to drying procedures. Missile No. 80 is scheduled for flight during the next quarter.

B. SPECIFIC PRODUCT IMPROVEMENT

1. Rocket Engines

In the course of developing a rocket engine suitable for qualification testing and subsequent production, several engine designs were tested and approved. The XLR-67-BA-1 and the YLR-67-BA-5 designs, approved for use during the initial phases of the Rascal flight test program, were used in missiles Nos. 0104 through 3964. The YLR-67-BA-9 engine, superseding the former models, has completed the Preliminary Flight Rating Test and the test reports have been approved by the WSPO. The -9 engine is employed on all flight test missiles including those for the E&ST program.

The formal Preliminary Flight Rating test program of the YLR-67-BA-11 engine has been combined with the formal qualification test program of the LR-67-BA-11 engine. These tests will be utilizing IRFNA. Specifications and test procedures for the LR-67-BA-11 engine have been submitted to the WSPO for approval. The formal qualification test program of the LR-67-BA-11 engine will begin early in the next quarter.

Five YLR-67-BA-9 rocket engines were accepted after 13 runs. One rocket engine, serial No. 25, was rejected because of low specific impulse. The major problems encountered were with the sequence valve, the gasket between the turbine manifold and manifold support, the gas generator transition duct gasket, and leakage past the turbine manifold mounting bolts. An excess of cement, used to seal the exhaust duct to the manifold gasket, caused small fires during three runs.

2. Thrust Chamber Assemblies

a. Tubular Thrust Chambers

During this quarter, 26 runs were made on thrust chambers. Eighteen thrust chambers were accepted for the YLR-67-BA-9 rocket engines. Nine of the 18 chambers were originally rejected after failure to meet the requirements of Specification 56-947-328. The data from these rejected chambers were later evaluated in accordance with AMC letter dated 2/14/57, "Acceptance Requirements and Procedures for YLR-67-BA-9 and -11 Engines — Contract AF 33(038)-15069". The re-evaluation showed that the chambers were acceptable.

Primary efforts during this quarter were directed toward determining the durability of the tubular thrust chamber. Since high chamber pressure could be a contributing factor, steps were taken to limit the throat to a minimum of 4.95 sq in. Production line dimensioned checks after each operation indicated that the major shrinkage occurred during the casting process. To reduce the shrinkage, 2.510 in. diameter steel plugs were machined to the throat contour and inserted in two tube bundles prior to casting. These plugs were not removed, except for measurement checks, until the chambers were completed. A durability fire test series was then made on each chamber. The throat area on both chambers was greater than 5.00 sq in. One chamber has completed nine 160-

second runs; the other has completed five 160-second runs. Severe tube leakage occurred during the testing of the second thrust chamber. This was due to an injector discrepancy. In accordance with these results, recommendations have been made to cast all new thrust chambers with throat plugs.

A test program is being conducted to determine the effect of between-run servicing procedures on thrust chamber durability and the adequacy of performing such operations on the test stand or motor mount. The major items involved are the flushing of the regenerative coolant tubes and the application and baking of the ceramic thrust chamber lines. The first chamber in this program had a life of eleven 160-second runs at 500 psig chamber pressure. The chamber was removed from the test stand, water-flushed, dried, recoated with ceramic, and baked in an oven prior to each run. For succeeding chambers this procedure will be varied and methylene cloride will be used as a flushing agent.

As a result of the success of the Linde Flame Plating process on the 4000-lb drilled-aluminum thrust chamber, the possibility of plating the convergent and throat sections of the tubular thrust chamber is being investigated. It is believed that, if 0.003 in. of tungsten carbide could be applied in the throat area of the tube bundle, the thrust chamber durability would be increased.

b. Drilled-Aluminum Thrust Chambers

Drawings were released to fabricate three drilled thrust chambers of 5052 aluminum alloy. These will be used to evaluate chamber erosion of aluminum when copper and silicon are not present in the alloy, and when coatings such as Hardkote, tungsten carbide, and microme are applied to chamber walls of this alloy.

Activity on the drilled aluminum thrust chamber during this quarter was again largely confined to injector evaluation. This phase of the program is covered in section 2, d, of this report.

Two thrust chambers with tungsten-carbide-coated chamber sections were fire-tested to compare the durability of the coating utilizing chrome nickel as a binder with that employing a cobalt binder. The thrust chamber with the chrome nickel binder exceeded engine qualification requirements by a considerable margin. Testing on the chamber with the cobalt binder was concluded after six 160-second runs when the regenerative coolant passages were exposed. However, this testing was not considered conclusive because the cobalt binder coating was accidentally scored during machining and failure occurred at this point. At least one additional chamber with each coating will be fire-tested to confirm these results.

c. Refractory Coatings

A drilled aluminum chamber coated with Norton Company flame-sprayed zirconia (Rokide "Z") was evaluated by firing a coated chamber on a test stand. The coating was moderately durable, but spalled near the nozzle end of the chamber. A second chamber is being coated; the coating thickness will be held to a maximum of 0.010 in. to reduce the spalling tendency.

d. Fuel Injectors

During this quarter, 29 injectors for the 75L* thrust chamber assemblies were tested and accepted. To date, 264 units of this configuration have passed preliminary acceptance tests. Nine additional injectors of the same configuration were accepted for future assembly of test engines.

Other steel injector tests included the evaluation of the effects of reducing the fuel-dome-injector fuel valve seal area to accommodate the self-contained injector fuel valve. No performance or heat rejection differences were noted as a result of this change.

Testing of injectors for use on drilled-aluminum thrust chambers continued during this quarter with durability tests on both "doublet" and standard stainless steel injectors. This program has been separated into two phases and may be classified as follows:

(1) To develop a coating for the aluminum chamber which will allow extended operation with standard production injector using inhibited acid.

(2) To develop an injector which will be compatible with the present Alumilite Hardkote thrust chamber, also using inhibited acid.

Testing on the phase I program was continued with the evaluation of an additional tungsten-carbide-coated chamber. This chamber was the first tested using a chrome-nickel binder for the tungsten carbide coating. The injector used was a standard 72-pair counterbored injector. The chamber was tested over a total duration of 3320 seconds at which time a gouge appeared in the chamber wall and invalidated further testing. Operation of this unit included 17 full-duration tests conducted at rated thrust conditions and ambient propellant temperatures. One hot test of full duration was made, as well as one 60-second test at -35°F propellant temperatures. Four additional thrust calibration tests of 60-second duration were also completed. No erosion or gouging of the chamber or coating was noted as a result of temperature or pressure variations. The average performance for all runs represented a 1.5% increase over the required I_{sp} of 243 seconds at 40,000 feet altitude.

Four duration tests were completed on a second tungsten-carbide-coated chamber (DA27) having a cobalt binder; no adverse effects were noted. Tests are continuing on this unit.

The phase II development work has been primarily concerned with the evaluation of various "doublet" configuration injectors. This injector pattern has demonstrated its compatibility of operation with the "Hardkote" coated thrust chamber. The performance level of the original injectors tested was somewhat low.

Injector R-563, incorporating an Alumilite Hardkote coating on the face of the injector, was tested for 12 full-duration firings using a standard drilled aluminum chamber. The performance averaged 2.5% over the required level. These tests also include one full-duration "hot" propellant test without chamber damage. Cold propellant tests were then made on the injector thrust chamber combination and these resulted in some combustion instability at -35°F propellant temperatures.

Further cold propellant tests were subsequently made on other injectors with slight modifications to the injector "doublets". Two of these injectors showed stable characteristics at -35°F propellant temperatures. The modifications will be incorporated into subsequent units.

The final injector modification tested during this quarter incorporated an increased impingement length on the doublet sets of the injector. Although performance of this unit has been satisfactory, only four duration tests have been completed to date. Testing will continue.

The evaluation of variations in thrust measurements at the Wheatfield plant and at AF Plant No. 38 was completed. Two standardized Baldwin load cells, calibrated and certified by the manufacturer, were used to calibrate the individual test stands. No recordable differences in the thrust measurements were found using the certified units. The deviation previously found was attributed to the slack or variation in the tensile tester used to calibrate the previously used "master" Baldwin load cells.

3. Turbine Pump Assembly

a. Turbine Pumps

During this quarter, 22 runs were made in acceptance testing six turbine pumps for YLR-67-BA-9 rocket engines. The major difficulties encountered were the same as on engine testing.

A total of 43 runs, 30 runs at ambient temperature and 13 at -35°F, were made with turbine pump assemblies numbers GP6T, GP14T, GP15T, and G-2 (qualification test pump No. 2). All of these pumps incorporated the dual-flow (fuel and oxidizer metering) flyball speed control system. Included in the 43 runs were three firings which were shut down manually because of propellant leakage in the test stand hardware, and five malfunctions. Of the five malfunctions, three were due to overspeed conditions, one was due to turbine manifold high-temperature probe burnout, and one was due to human error. A brief description explaining the runs on each of the four pumps mentioned follows:

Twenty-eight R&D runs were made with pump GP6T to obtain more data on the occasional instability, and attempt to pinpoint the cause of the instability. Results to date are not conclusive and further tests will be run.

Two runs were made with turbine pump GP14T to re-affirm the acceptability of this pump. This unit had previously been accepted, but after being incorporated into an engine, the unit operated erratically during the engine hot firings. Since performance during these two runs was within specifications, the pump was delivered to the engine group and reinstalled on engine No. 1 which is scheduled for preliminary flight rating tests. During this next series of engine runs, the pump performance was within specification, but the operation was not entirely satisfactory. The propellant seal leakage, while within the allowable limits, was rather high. This seal leakage was not considered desirable this early in the lengthy flight rating test program. Subsequent dismantling of the pump revealed a 0.0009-in. clearance between the turbine shaft and the ball bearing, as well as a static unbalance of the turbine shaft assembly of 0.114 inch-ounces at the rotor end and 0.085 inch-ounces at the impeller end as compared with a maximum allowable unbalance of 0.03-inch ounces. The severe unbalance of the turbine shaft assembly, introducing higher amplitude vibrations, contributed to the somewhat erratic pump operation, especially the high propellant seal leakage and the repeated mechanical failures of the speed control governor during the history of this pump. Spring steel lockwire will be used in the governor in place of a cotter pin to retain the fly-weight.

Seven runs were made with pump GP15T in the process of acceptance testing. This unit was considered acceptable and has been delivered for incorporation into engine No. 2 which is scheduled for preliminary flight rating tests. Since cancellation of the engine preliminary flight rating tests, pumps GP6T and GP14T have been returned to the Manufacturing Department for disposition.

Six runs were made with pump G-2 during the course of acceptance testing. This unit has been accepted and was turned over for installation into qualification test engine No. 1.

b. Gas Generators

During this quarter, 63 runs were made in acceptance testing eight gas generators. One gas generator package, serial No. 27, was destroyed in an explosion.

(1) LR-67-BA-11 Engine Gas Generators

Tests to determine the IRFNA use limits for the gas generators continue. This program was initiated to determine a plot of flame-out total steady-state mixture ratio against acid-water content. All other parameters were maintained at the most critical specification requirement. One point was described in the last quarterly report.

An attempt to determine a second point was made with gas generator HGP-113. However, flow tests made at the conclusion of these tests revealed that the injector orifice pressure drop was no longer within specification requirements, thereby invalidating the data. This change in generator performance was brought about by the corrosion-erosion effect resulting from 83 firings, the majority being made at -33°F with a 4-hour soak period. As result of this change, the percentage of the total fuel through the primary injector was less than the maximum allowed by the drawing tolerances; so the gas generator was no longer operating at the critical conditions.

Three gas generator packages, serial Nos. 1, 2, and 3, were acceptance-tested and accepted for use. Package GH-112, however, experienced flame-out difficulties during the acceptance test under critical conditions (low temperature, low mixture ratio, low power, high water content). Two different gas generators, with flow characteristics within specification tolerances, were used with package GH-112. The cause for the flame-out has not been determined; a program has been initiated on a development basis to investigate this difficulty.

(2) YLR-67-BA-9 Engine Gas Generators

To facilitate the flushing of the outlet side of the propellant value, a fitting, designed and fabricated on a product-improvement basis, will be installed at the propellant value oxidizer outlet. The present procedure provides for flushing of the system only from the pressure regulator. Nine bench tests have been made to evaluate three different flushing procedures; each has proved inadequate. A fourth procedure is not being evaluated.

During the acceptance testing of gas generator package, serial No. 27, an explosion occurred immediately after what should have been a malfunction shutdown. The closing of the propellant valve and the opening of the fuel circuit gas purge are initiated by the same electrical signal; however, when the circuit was energized, the propellant valve failed to close. The purge interrupted the combustion, but propellants continued to enter the hot gas generator and turbine manifold system resulting in the explosion. This sequence of events revealed a dangerous condition which could result from a single malfunction. If the purge had not stopped the combustion, the system would have continued to run and would have been safe. Therefore, it was decided to investigate the feasibility of either initiating the purge with the loss of gas generator chamber pressure or eliminating the purge completely. This investigation included 25 tests resequencing of the purge and 45 tests eliminating the purge. The results indicated that it would be desirable to retain the purge and resequence it by the loss of gas generator chamber pressure. This change is now being proposed.

c. Propellant Pressure Regulator

The gas generator propellant pressure regulator as utilized in the -9 engine configuration is being modified to allow more clearance in the dome spring chamber area. Tests indicate decrease of power level shifts experienced during gas-generator package and turbine-pump package acceptance testing; R&D tests also indicate that this change will tend to relieve the long transition time from boost to cruise phase experienced in the acceptance testing of some packages.

d. Fuel-Operated Sequence Valve

During this quarter, the fuel-operated sequence valve is undergoing redesign and test to eliminate dynamic poppet O-ring burnout experienced on gas generator, turbine pump, and complete engine acceptance testing. Teflon seals have been incorporated in an R&D sequence valve and evaluation of the seals indicates approximately one pint of fuel will be bypassed through the sequence valve during a normal-duration engine firing. Since Teflon seals are not positive seals, provisions have been made to bypass the leakage through the sequence valve to the fuel tank, or to vent the leakage overboard.

4. Propellant Tanks

a. Tanks

During this quarter, eight small cone aluminum oxidizer tanks and five bladder expulsion aluminum fuel tanks were received from the vendor. These tanks are scheduled for installation in missiles through No. 124. An order for 32 additional tanks has been placed with the tank vendor. These tanks are scheduled for installation in missiles Nos. 125 through 156.

Tank drawings have been prepared for a revised small-cone tank similar to the present oxidizer tank. The volume of the small cone was reduced to ensure expulsion reliability and the gas separator was eliminated. The latter change was accepted after tests had proved that the removal of the separator would have little effect on missile operation. Since the effect of vibration is not yet known, expulsion, vibration, and systems tests are required to qualify this tank for the GAM-63A.

An order for two tanks for test use was placed with Benson Manufacturing Company, Kansas City, Missouri. Delivery of the first tank is scheduled for March of this quarter. However, upon notification from the WSPO, all work on this program was stopped, and all tools, dies, and fabricated parts were stocked.

b. Fuel and Oxidizer Tank Pressure Relief Valve

The fuel and oxidizer pressure relief valve is undergoing redesign and test to incorporate an improved poppet spring to alleviate the spring buckling problem. Preliminary tests show that the new spring is adequate for the intended purpose. A further extensive and complete program is under way to evaluate the relief valves under all operating conditions.

c. Regulator Pack Assembly

This pack is a two-stage nitrogen gas regulator providing gas flow to the propellant tanks and imposing a suction head into the turbine pump.

The design ullage volumes have been increased from 26 to 75 gallons in the oxidizer tank, and from 11 to 34 gallons in the fuel tank. The latest requirements place the regulating characteristics of the pack in the no-regulation boundary. Because of this tendency of no-regulation, a new approach was sought which could effect regulation when severe demands are made upon the regulator. Investigation revealed the possibility of a Bernouilli suction creating a void beneath the poppet during flow conditions. This destroys the necessary Δ P across the poppet, causing the tanks to overpressurize, and subsequently popping the relief valves. Tests have been made with a limited stroke of the poppet in the second-stage regulator.

Because of the critical sensitivity of the regulator to demand requirements, extreme tests have been imposed on the regulator for evaluation. These tests consisted of flowing the regulator into an empty fuel tank and full oxidizer tank, full fuel tank and empty oxidizer tank, and both tanks empty. All test results were favorable. However, further testing will be conducted to ascertain the limits of the regulator pack.

C. STUDY PROGRAMS

1. Expulsion Bladders

Evaluation of Goodyear 2162-50 material for IRFNA bladders has been completed. Test samples indicate bladders made from this material will be satisfactory in IRFNA at 70°F for a period in excess of 70 days; at 120°F the expected life is about three days.

The first full-size oxidizer bladder for the GAM-63A was received from Goodyear during this quarter. However, funding problems have precluded additional work on planned expulsion tests. Goodyear has been notified not to start fabrication of the remaining two bladders on order.

2. Detonability of Fuming Nitric Acid/n-Heptane/ Nitrogen Mixtures

The major hardware items for Shock Tube II have been received. When piezoelectric gage mounts have been completed, the entire apparatus will be ready for installation in the research test area.

Detonation velocities and detonation limits of FNA/n-heptane gas mixtures at an initial pressure, p_o = 0.5 atmosphere, have been determined. Results of this investigation are summarized in Figure 8. The limits found at p_o = 0.5 atmosphere were not detectably different from those found at p_o = 1.0 atmosphere. These mixtures were ignited with shocks from the detonation of equimolar oxygen/acetylene mixtures.

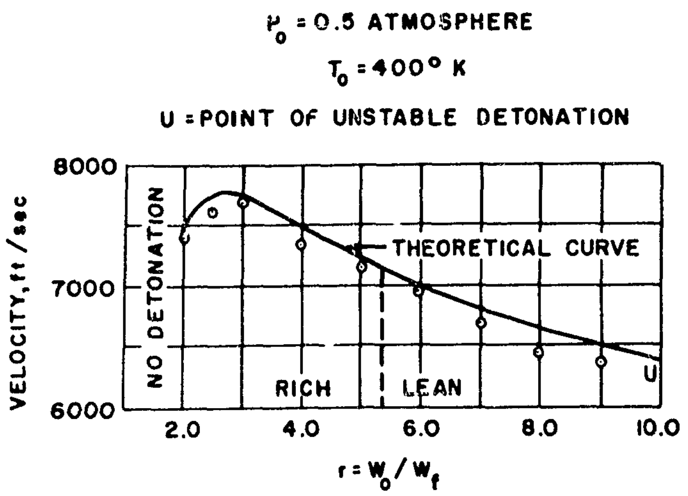


Figure 8. Detonation Velocity vs Mixture Ratio — FNA/n-Heptane

Detonation velocities and detonation limits of FNA/n-heptane/nitrogen gas mixtures at p_o = 0.5 atmosphere have been determined for FNA/n-heptane mixture ratios of 5.0 and 6.0. These mixtures were ignited with both oxygen/acetylene detonation shocks and with helium shocks. The data obtained are summarized in Figure 9. At p_o = 0.5 atmosphere, detonations were sustained in FNA/n-heptane/N_2 gas mixtures with up to 55 mole percentage N_2 at r = 5.0, and up to 60 mole percentage N_2 at r = 6.0. At p_o = 1.0 atmosphere, detonations were sustained in FNA/n-heptane/N_2 gas mixtures with up to 65 mole percentage N_2 gas mixtures with up to 65 mole percentage N_2 at

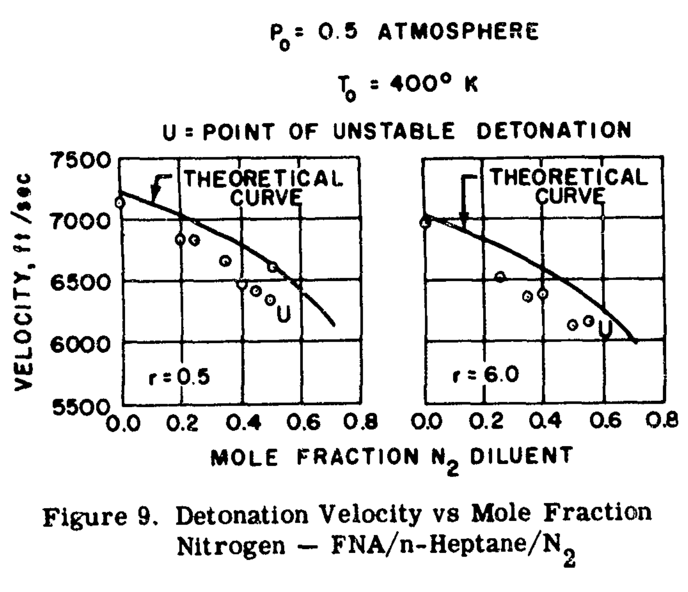


Figure 9. Detonation Velocity vs Mole Fraction Nitrogen — FNA/n-Heptane/N_2

r = 6.0. These nitrogen dilution experiments are part of a program to establish the inert gas dilution required to prevent FNA/n-heptane gas mixtures from detonating as the initial pressure is increased toward the thrust chamber pressure. The next experimental series will be made at p_o = 2.0 atmospheres.

3. Air Pressurization

The program designed to test the feasibility of substituting air for nitrogen as the pressurizing medium in the Rascal propulsion system was concluded with four full-scale engine firings. The first run, where air was used for all purposes for which nitrogen is normally used (except thrust chamber purge, not normally used on flight systems), was stopped after 105 seconds because of a thrust chamber malfunction. At shutdown, some pops occurred in the gas generator. The second run, of 170 seconds duration, exhibited the same behavior on shutdown. However, the explosions in the gas generator were more severe; pressures of about 300 psia were recorded. Also, two pressure transducers in the oxidizer feed line of the gas generator were damaged.

These last results were evidence that a dangerous condition existed on shutdown of the gas generator. To eliminate specific hardware responsibility for these explosions on shutdown, two runs were made with nitrogen as the pressurizing medium. Both were normal. Results of the program are presented in Bell Aircraft Report 56-982-043. It is concluded that air pressurization of the YLR-67-BA-9 engine in its present configuration is not safe.

4. Burner Studies

Preliminary experiments have been completed to determine the flame temperature of the first step in the combustion of nitric acid and hydrocarbons. A Smithells separator was used to lift off the outer flame mantles, and a sample of the interconal gases was taken for analyses; their temperatures were also recorded. The flame was of nitric acid-propane and the mixture ratio was 3.54. The interconal gases had the following composition:

	% By Weight
NO	32.8
CO_2	5.5
CO	6.2
N_2	23.9
Condensable Material	27.1 (mostly H_2O)

The thermocouple gave a temperature of 1165°K, whereas an enthalpy balance between the reactant and product gases yields a temperature of 1300°K.

Equipment for spectrographic investigation of these flames, as well as equipment for studying the pressure dependence of nitric acid-hydrocarbon flame speeds, is being readied.

5. Hypergolic Gas Generator

A test series has been made to determine the flameout mixture ratio versus water content of IRFNA in generator No. HGP-113, pack No. GH-105. With acid containing 2.33% by weight of water, the flameout mixture ratio at -33°F was 0.565. This generator has a fuel distribution of 20.6% in the primary, and the balance as secondary fuel flow. The manifold pressure was 210 psia. The program was halted before other water concentrations could be investigated.

6. Acid Storage

A drum of Type III RFNA, modified with a corrosion inhibitor, ammonium hexafluophosphate, has completed four months of field storage. The original and latest analyses are presented in Table IV.

7. Rocket Engine Flushing Procedures

In support of the rocket engine flushing procedures program, three experiments were performed with chromic acid. Two involved the use of water acidified with 0.1% chromic acid, and the third involved the use of chromic acid crystals. Using the aqueous solution, it was shown that methylene chloride, when added, sinks to the bottom without reaction. This affords a simple, safe way of removing chromic acid solution. In a second experiment, an aluminum beaker was rinsed with chromic acid solution and allowed to dry. The yellow film remaining on the beaker was unaffected by subsequent addition of methyl alcohol. However, when methyl alcohol was added to chromic acid crystals, the alcohol burst into flame. Therefore, the chromate film is compatible with the alcohol; the acid crystals are not.

On two occasions, a -800 regulator was deliberately filled with WFNA, then held at 140°F for 40 hours to induce salt formation. The contaminated regulator was then submitted to the Test Department for evaluation of a current flushing procedure.

A -800 regulator, whose interior had been chrome-plated, was filled with WFNA and held at 150°F for 18 hours. Contrary to usual experience, no corrosion was found. To test reproducibility, the experiment will be repeated with another similarly plated regulator.

8. Propellant Analyses

In the Quality Control Program for Rascal propellants, 480 samples of IFNA were analyzed. In addition, 12 JP-4 samples were analyzed and 47 hydrometer calibrations were made.

A nitric acid analyzer (SRI-FP) has been evaluated as a means of determining the NO_2 content of IRFNA. To this end, 60 samples of IRFNA were analyzed by titration and with the SRI-FP. Agreement was ±0.5%. Preliminary work done with the instrument currently in use (SRI-DU) indicates that better accuracy can be obtained with the SRI-DU. Accordingly, future work will utilize the latter instrument.

Seven samples of IWFNA were adjusted to a water content of 2.3 to 2.6% and submitted for special rocket engine firings. An additional 16 samples were analyzed in support of research studies with an acid evaporator. Also, in support of this latter program, 1500 cc of acid-analyzing 99% HNO_3 were prepared.

The freezing point of a sample of IWFNA was determined by two methods. First, a conventional potentiometric method was used. The freezing point was -44°F. Then, a thermometric method was used and the following observations were made. At -53°F, the first crystals appeared. The temperature then quickly increased to -46°F as more crystals formed. This is the well-known supercooling phenomenon. The system was slowly warmed and the last crystals

TABLE IV

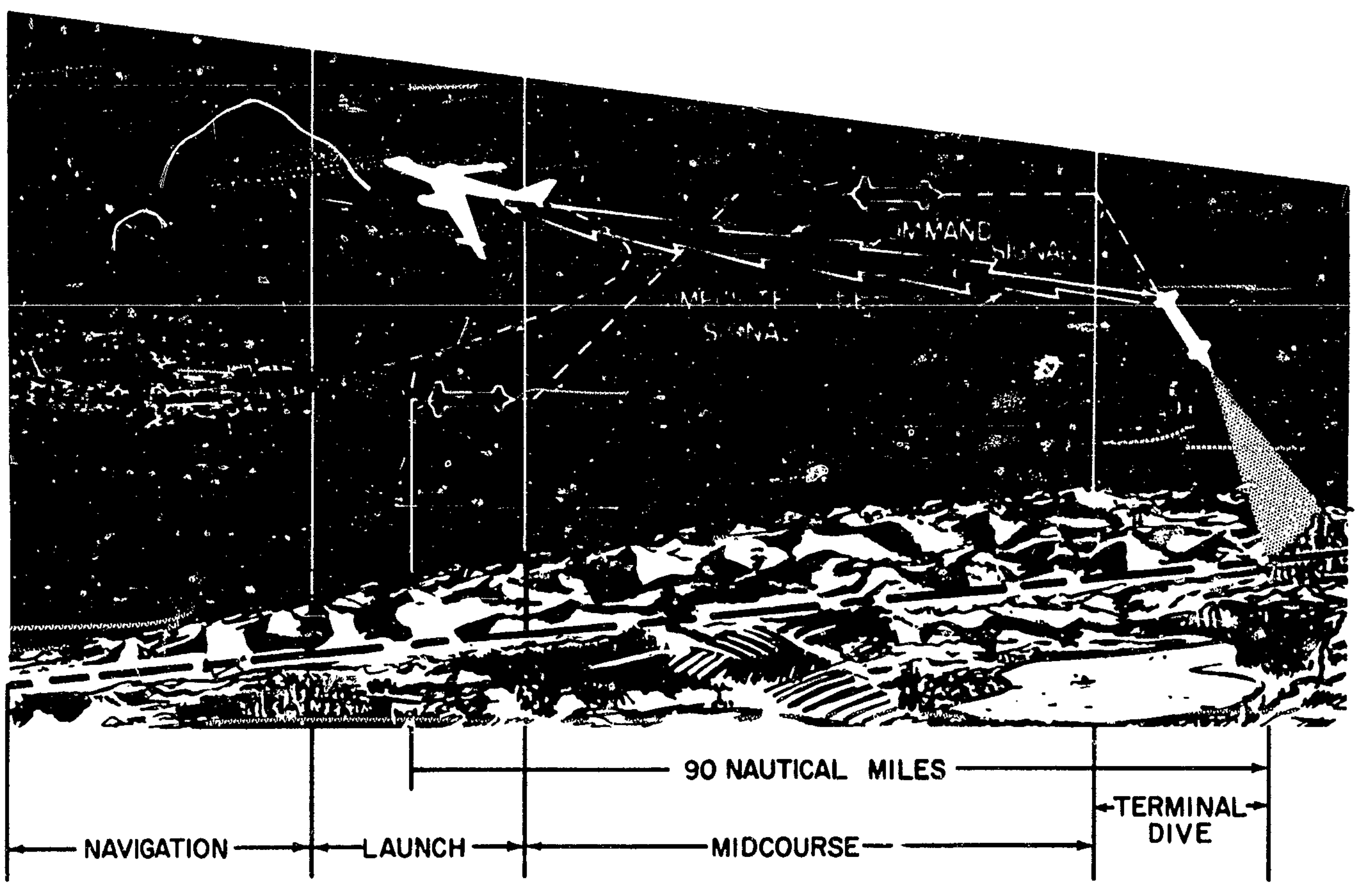
ANALYSES OF ACID STORAGEABILITY

Date	% HNO_3	% NO_2	% $NH_4PF_6 \cdot NH_4F$	% H_2O	% Fe	% Al
11-15-56	84.22	12.99	0.34	2.43	0.001	0.001
3-21-57	84.11	13.21	0.33	2.35	0.001	0.001

disappeared at -42°F. The composition of the acid used for these experiments was: 1.64% H_2O, 0.61% NO_2, 0.55% HF, and 97.20% HNO_3. The true freezing point of the acid is taken as -44°F.

A small amount of fluorolube/molycote lubricant was added to IRFNA. No reaction took place at room temperature, but, at 160°F, the lubricant and acid were incompatible. Heat and NO_2 were evolved through a vigorous reaction.

3 guidance system



A. SYNOPSIS

During the early stages of the Rascal guidance program, research and development efforts were directed toward a radar-relay and command guidance scheme for directing air-to-surface missiles to a target. In essence, this development was concerned with a radar scanning system housed in the nose of the missile by means of which a radar picture of the area ahead of the missile is relayed via a microwave link to the launching aircraft. On the basis of this video information, commands from the launching aircraft could be sent to the missile to direct it to the target. (The name RASCAL was coined from the first letters of the words RAdar SCAnning Link.)

At first, two B-17 aircraft were utilized in guidance development, one simulating the launching aircraft and the other the missile. Later, data from tests of this first experimental radar-relay and command link led to an improved guidance system which was installed in an F-80 and a B-17 aircraft to simulate more closely the guidance performance of a missile and director aircraft in flight.

Guidance for the Rascal Weapon System comprises an inertial range-computing system (IRCS), an autopilot, and a radar-relay command link. Components of the command link are located both in the missile and in the director aircraft. Basically, the system operates as follows: The DB-47 director aircraft carrying the GAM-63A is navigated to the launch area by means of its modified bombing-navigation (MA-8) system which employs a long-range search/tracking radar and computers. Immediately prior to launch, initial condition data as computed by the MA-8 system (i.e., director aircraft velocity and heading, and changes in range-to-target) are fed into the missile. After launch, the IRCS measures ground-range-to-target by double integration of a signal from a pitch-stabilized accelerometer. At a predetermined range from the target, the IRCS initiates a signal which overrides the autopilot and places the missile in a pre-set terminal dive. By controlling the flight in this manner, the guidance and control systems establish a direct course to the point of detonation.

The search radar in the nose of the Rascal missile, a vital element of the relay and command link, is included to improve the accuracy of target acquisition. Just prior to terminal dive, the radar is turned on automatically by the inertial range-computing system. This radar scans a 150° sector ahead of the missile, and radar video is relayed to the director aircraft. Here, the radar information, displayed on a PPI, enables the guidance operator to monitor the flight and to initiate course-correcting commands (both pitch and azimuth) which are transmitted via the microwave link to the missile. Should the guidance operator desire to observe the progress of the missile prior to terminal dive, a command can be transmitted to energize the search radar of the GAM-63A. The operator can also control the initiation of the terminal dive.

A JB-50 aircraft and a laboratory terminal guidance control station are being utilized to evaluate guidance improvements before incorporating them into the missile or the director aircraft. (The Rascal portion of the director aircraft guidance is referred to as the AN/APW-17 radar course-directing central). Also, missile guidance equipment is installed in a JF-89 airplane to permit flight testing at altitudes and speeds simulating those of the GAM-63A. This work is discussed in more detail in Section II, E, Support Aircraft.

B. EMANATING GUIDANCE

The progress reported here is for the missile equipment portion of the emanating guidance system. The status of development on director aircraft guidance (AN/APW-17 Radar Course-Directing Central) is reported in Section II, E, Support Aircraft.

1. General

In the radar set and radio set, crystal diodes and blower motors have failed at higher rates than anticipated. Considerable study has been conducted on the major factors involved. Recommendations have been prepared for use by the various Rascal test organizations. The recommendations outline specific additional tests designed to provide a high confidence level for the radio and radar sets so that these units will fulfill their functions satisfactorily.

2. Radar Set

At the request of Bell Aircraft, the receiver-transmitter and the modulator power supply are being modified by Texas Instruments to ensure a substantial improvement in reliability. Coordination with the vendor on the many details of this improvement program has been completed. Texas Instruments has already accomplished much of the work and the equipment delivered in the future is expected to be significantly more reliable.

Test results from the launching of GAM No. 4891 provided further evidence that the changes incorporated in the electrical synchronizer during 1956 have effectively improved automatic-gain-control performance.

3. Low-Power Antijam Radar Set

Work on the low-power AJ radar set has progressed to the point where the ground testing of a set of service test hardware has been completed. The equipment was subsequently transferred to HADC for flight testing. Prototype drawings have been completed for the test hardware.

4. High-Power Antijam Radar Set

Work on the high-power AJ radar set has been discontinued in accordance with a recent USAF directive. Inventories have been prepared covering drawings, models, parts, specifications, and reports.

5. Radio Set

Detailed investigations have continued on the applicability of the QK-553 carcinotron power-transmitting tube as a replacement for the A1016 relay magnetron. The QK-553 backward-wave tube was developed by Raytheon primarily for airborne ECM application. Preliminary studies have indicated that the QK-553 is satisfactory for Rascal relay application, even though there are certain features of the Rascal requirements for which definitive QK-553 test data are not yet available. Two of the tubes have been received from Raytheon and a tube application study program is under way to determine in detail the QK-553 applicability. Construction of laboratory power supplies and test equipment for this program is nearly complete.

In an effort to improve the reliability and life of the RCA A1016 relay magnetron, conferences have been held with the vendor and a program is being finalized to accomplish this goal. Under present conditions, the more reliable magnetrons received from the vendor are sent to HADC in support of the flight test program, and it is sometimes necessary to use substandard tubes at the Wheatfield facility for initial testing of the radio repeater set. The ferrite load isolator being added between the magnetron and its load is expected to improve the operating environment of the tube.

Marginal operation has been experienced with the saturated output level of the i-f amplifier. A minor circuit change has been processed to provide an ample safety factor.

Design of the case assemblies for the command signal decoder and the radio repeater has been modified to improve performance and to facilitate manufacture. Drawing changes are being processed.

C. NONEMANATING GUIDANCE

Inertial Range-Computing System (IRCS)

The IRCS measures range in the horizontal plane in the direction of the longitudinal axis of the missile. Directional control is maintained by the autopilot keeping the missile aligned to a gyroscopic reference heading.

An accelerometer is oriented on the stable platform so that it senses accelerations along the longitudinal axis of the missile. The output is double-integrated and compared with the initial range-to-go valve, thereby giving an instantaneous range-to-go value. This output signal is compared with a preset voltage corresponding with the desired dive initiation point in the dive angle computer. Upon coincidence, a dive command is given to the pitch autopilot and a signal is sent to turn on the search radar in the nose of the missile.

Accurate information on range-to-go and velocity from the director aircraft navigation system is transmitted to the IRCS prior to launch. With this information, the platform is leveled and the necessary initial conditions are inserted into the inertial system of the missile.

An improved sensitive relay for the dive angle computed proved satisfactory during evaluation tests. The relay has since been incorporated in production assemblies.

Preliminary evaluation of an improved chopper has indicated that this unit is satisfactory for use in the range and velocity computers. Further evaluation is required for adequately qualifying this new chopper.

A preliminary working model of the repackaged computer for the IRCS is undergoing tests. Vibration testing has indicated that the unit is structurally satisfactory. This repackaging will provide improved assembly techniques, ease of testing and maintenance, and operational reliability under extreme environmental conditions.

Because of the low reliability of the d-c filament supply procured from an outside vendor, Bell Aircraft designed and developed a filament supply to be used as a direct replacement. Several vendors have been asked to fabricate a filament supply with the same characteristics as the Bell design. Samples evaluated thus far have failed to qualify. One vendor is redesigning a filament supply and will furnish samples for evaluation.

Fluid leakage from the accelerometer used in the IRCS has been investigated. A suitable sealing method has been developed and referred to the vendor for use on future units.

4 control system

A. SYNOPSIS

Following early design studies that included experience gained from the Shrike missile program, laboratory development of the autopilot system for the missile portion of the Rascal Weapon System was put on a full-scale basis in January 1951. In September of 1952, the first Rascal missile was delivered to HADC for flight testing.

The autopilot systems for the first Rascal missiles were similar to that used in the Model 59 Shrike missiles. Design of the autopilot for subsequent GAM-63's, however, show a significant increase in complexity when such capabilities as acceleration limiting, guidance loop tie-in, antenna stabilization, and altitude control were added. These features were included in the basic Model B and D configurations (missiles 11 through 35). The Model F configuration of subsequent missiles is further modified to accommodate the inertial range-computing system designed to meet the requirements of the weapon system.

With the development of this basic autopilot system, major emphasis has been shifted to the simplification of products and to the improvement of reliability and design characteristics. This program is proceeding satisfactorily. Concurrently with autopilot development, a series of terminal guidance control studies was conducted and this contributed significantly to the over-all design of the autopilot system.

The two main servo systems of the GAM-63A are the servopilot and the antenna stabilization systems. These systems utilize electronic amplifiers, an azimuth computer, potentiometers, hydraulic valves, actuators, a single-axis stabilized platform, and associated hydraulic plumbing and electrical wiring. The power supply is common to both systems.

The servopilot stabilizes the GAM-63A missile about its three axes: longitudinal (roll), lateral (pitch), and vertical (yaw). The roll system maintains the lateral axis of the missile horizontal throughout its flight. During portions of the flight, the pitch and yaw systems are programmed and receive guidance commands which direct the missile to the target.

The antenna stabilization systems perform three functions: (1) maintain the search antenna horizontal about the pitch axis with respect to the earth's horizon (since the search antenna is fixed to the roll-stabilized airframe, a separate antenna roll servo is not required); (2) maintain the rotating search antenna at a constant angular velocity in space; and (3) orient the relay antenna in pitch so that its major lobe is aimed toward the director aircraft.

B. FLIGHT CONTROL SYSTEM

The environmental re-evaluation program on the Rascal flight control system and the inertial range-computing system is continuing.

Thus far, 1612 environmental tests had been completed on electronic and hydraulic components. Of the units presently undergoing tests, 31 units have completed three cycles, 9 units have completed two cycles, and 14 units have completed one cycle. The remaining units are in various stages of testing.

The mechanical coupling tests on missile No. 46 were completed during this quarter. A report is being written to summarize this activity.

The investigation of the spin drive system for the missile search antenna has proceeded to the point where revised specifications have been prepared to ensure a minimum of difficulty with this system in the future.

Reliability testing of the Phase I repackaged amplifiers has been completed at Federal Telecommunication Laboratories. Preliminary results indicate that the amplifiers performed reliably during these tests.

Development work on the Phase II redesign of the flight control system was carried to a conclusion during this quarter. No further work is planned on this program until a specific missile effectivity is established for the redesigned equipment. Reports on the activity have been forwarded to the WSPO.

An analytical report on the platform leveling system is nearly complete.

The feasibility of transistorizing the Rascal flight control system is being studied. This work has not yet progressed to the point where specific conclusions can be made.

C. SERVO VALVES

Development work on the double-nozzle, dry-first-stage servo valves for the Phase II redesign effort is being held in abeyance until a specific missile effectivity is established for the new servo valves.

D. HYDRAULICS

The search for more-reliable filters, accumulators, and seals is continuing.

5 warhead and fuzing system

A. SYNOPSIS

Sufficient test planning is included in the over-all development program to ensure proper functioning and to obtain ultimately a high degree of accuracy and reliability for the GAM-63A warhead and its fuzing system. At the direction of the WSPO, work on secondary warheads was discontinued some months ago. Armament system specification, No. 66-947-501, was released after references to secondary warheads were deleted.

B. WARHEAD

The GAM-63A is designed to accommodate a 2800-pound special warhead. The warhead is located within the Rascal missile between the forward wing and the oxidizer tank (see Figure 10). The lower part of the airframe at this location serves as a structural door for warhead installation. Another door, approximately 14 inches square, at the top centerline of the airframe, provides access for arming the warhead. The warhead compartment is essentially cylindrical, with a maximum diameter of 44 inches and an over-all length of 75 inches.

A demonstration of loading a simulated warhead into a Model 56F (prototype operational airframe) missile was held late in 1954 at Bell Aircraft's Wheatfield facility. No major difficulties were encountered. The warhead cleared the missile structure and equipment installations satisfactorily. This demonstration was witnessed by personnel of both the Air Force Special Weapons Center and the Sandia Corporation.

Early in 1955 it, was determined during tests at Holloman Air Development Center that no electrical or electronic interference exists between the warhead and its instrumentation, and the other systems of the missile.

Simulated warheads have been tested in six GAM-63A's. Operation of the warhead system in missiles Nos. 3044, 3441, 3643, and 3748 was considered successful by the Sandia Corporation.

Late in 1955, a new warhead with increased yield was introduced into the Rascal program. Provisions for the new warhead were accomplished with a design that was compatible with both the original and the new

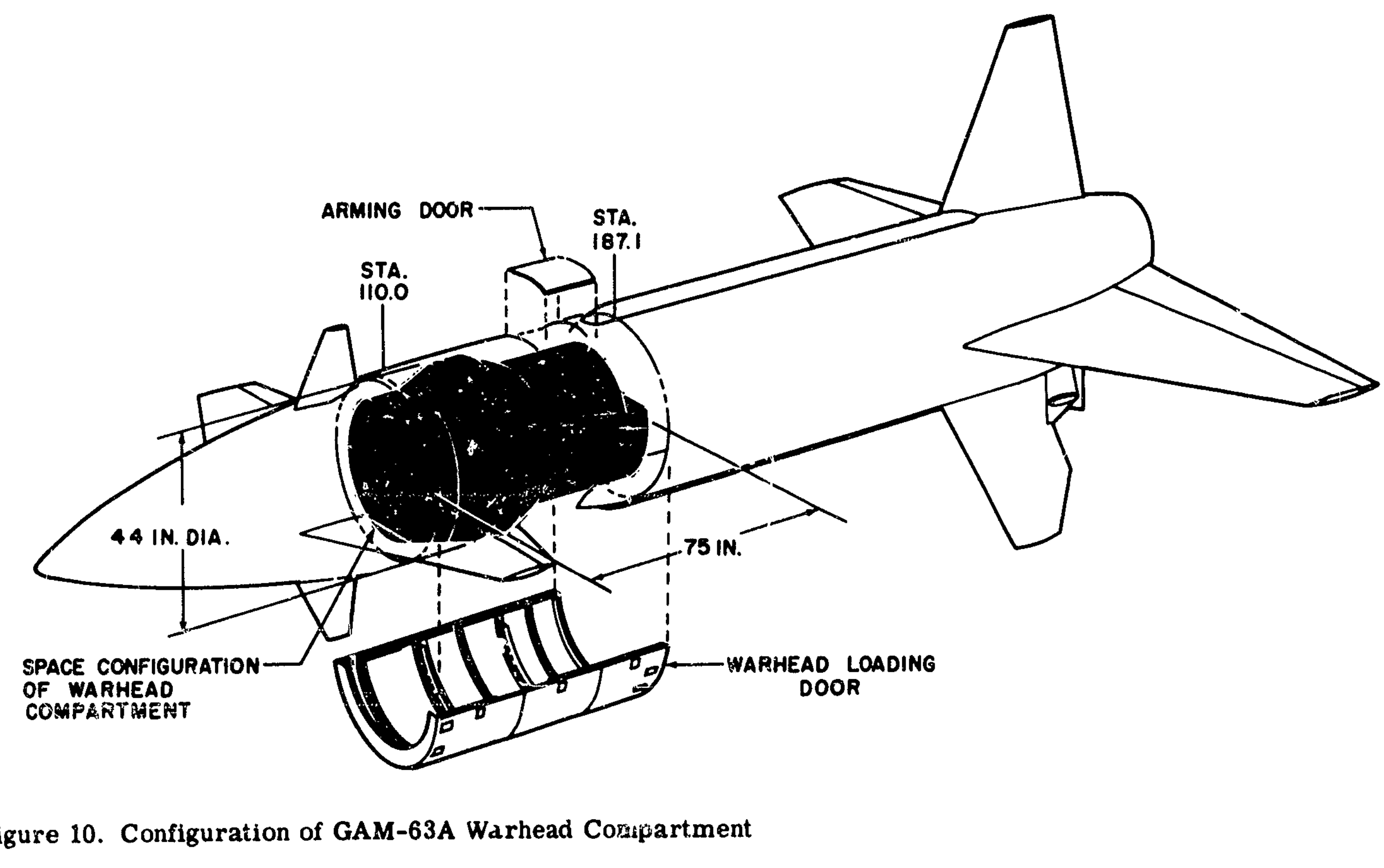


Figure 10. Configuration of GAM-63A Warhead Compartment

warheads. The warhead compartment that had been forwarded to Sandia Corporation for the original warhead was returned to Bell Aircraft for modification to the dual-capability configuration. After preliminary checks at Bell Aircraft with a warhead mock-up, the warhead compartment was returned to Sandia.

Subsequent to the release of the engineering for the dual capability, the WSPO decided to eliminate the provisions for the original warhead and to consider the new configuration as the prime warhead. The elimination of the dual capability has been only partly accomplished by removal of the MC-300 impact fuzes. The redesign to remove the dual capability completely will be effective after missile No. 112.

The elimination of the DB-36 as an operational director aircraft instigated the relocation of the warhead arming door from the top centerline to the right-hand side of the GAM-63A upper warhead compartment. This allows accessibility to the warhead compartment and especially the fuzing batteries when the missile is attached to the DB-47 operational director aircraft. This change is effective on missile No. 112.

Sandia Corporation will participate in the flight test program at HADC to assist in evaluating the new prime warhead together with associated instrumentation in the GAM-63A. Early in 1957, electrical noise and interference tests were performed on the first of these warheads, installed in missile No. 4891, with completely satisfactory results. This missile was subsequently fired and operation of the warhead was considered successful by Sandia Corporation. As presently planned, 11 more missiles will be fired as warhead test vehicles.

C. FUZING

The fuzing system arms and detonates the warhead. Detonation is triggered by a firing baroswitch that can be preset for operation at the selected pressure altitude. Detonation is also triggered upon impact. Remote selection of a pressure altitude setting for the firing baroswitch can be made from the director aircraft during the prelaunch phase. Burst mode selection is also made from the director aircraft.

A requirement was established for a fuzing system to be operational with the new warhead. At conferences with Sandia and Special Weapons Center personnel, the necessary technical and background information was made available. Preliminary mock-up and testing of the fuzing system was then initiated with available components. This preliminary review indicated that the proposed circuitry and component selection was acceptable. The new system uses the existing type of lanyard switch, an MC-384 arm-safe switch, an MC-5 fuzing baroswitch, and an MC-273 arming baroswitch. The fuzing power supply is derived from MC-271 batteries. The arming control panel is a T-249 type. Impact crystals with higher levels of voltage output are also provided.

A separation timer was not proposed for the system because such a unit is not compatible with a free-fall type of operation. Monitoring indications of system adequacy are not available, but failure monitoring may be accomplished by a red light displayed on the T-249 panel. The red light indicates malfunctions of the arm-safe switch and high-voltage battery actuation in series with high-voltage switch actuation.

Work is continuing on the evaluation of baroswitches from an alternate vendor. This vendor has produced switches that are adequate except for occasional freeze-up of the setting motors at low temperatures and high relative humidities. This trouble is similar to that encountered with the MC-5 fuzing baroswitch.

Preliminary environmental evaluation tests on ten MC-394 baroswitches indicate a quality and performance comparable to the MC-5. Design work is continuing on a vibration isolation mount that is compatible with both the fuzing baroswitch and the missile before the mount can be designated for use in an E&ST missile.

Components for the fuzing system are obtained through the USAF as Government-furnished Property. At the request of the Air Materiel Command, Bell Aircraft has initiated action to obtain these components directly from the AEC vendors. Preliminary investigation into the possibility of such direct procurement indicates that in most cases these vendors will be able to supply the components directly.

Work is also under way on the evaluation of newly developed fuzing components so that higher quality components may be installed on later missiles.

6 Instrumentation system

A. SYNOPSIS

Four groups of telemetering systems have been designed for Rascal missiles. Group I was used in Model 56B and 56D missiles and in eight of the Model 56F missiles. Group II systems were used in the early Model 56F missiles, and Group III systems are being used in all the remaining GAM-63A's. Group IV systems are installed in a limited number of R&D Model 56F missiles to supplement the Group II or Group III systems.

1. Group I System

The Group I system has been used to transmit both qualitative and quantitative data on vital components and systems. The number of continuous telemetering channels has been varied from six to eighteen. By commutating as many as four of these channels, data transmission of up to 94 functions has been obtained. Telemetering instrumentation for Group I on early XGAM-63's included accelerometers, angle-of-attack and sideslip vanes, various pressure pickups, rate gyros, position potentiometers, and numerous a-c and d-c voltage-measuring units. In addition, special flights with Group I telemetering instrumentation included vibration pickups, flowmeters for measuring hydraulic flow, strain gages for measuring control surface hinge moments, and oscillographic recorders for obtaining structural data on control surfaces and airframe. Also, special provisions were incorporated for recording impact data obtained from fuzing accelerometers.

2. Group II System

Group II telemetering systems employed four subcarrier channels, three continuous and a fourth commutated to provide 27 subchannels. Automatic decommutation was incorporated whenever ground-gating was available. In this system, accurate pressure-altitude data were transmitted on a continuous channel. In general, most end instruments supplied only qualitative data.

3. Group III System

The Group III telemetering system is electrically similar to the Group II system in that four subcarriers channels are used, three of which are continuous and one commutated. Automatic decommutation is incorporated when ground-gating is available. This system, unlike the Group II system which is battery-operated, is powered by a 400-cycle rectifier-type power supply. A thyratron assembly is included to provide qualitative data from impact accelerometers.

4. Group IV System

Group IV telemetering systems are reworked Group I systems which provide a dual r-f system with 16 or 19 subcarrier oscillator channels. This system has been added to provide additional environmental, power plant, and reliability data on some of the R&D Model 56F missiles. Provisions are made for telemetering two information commutators, two temperature commutators, and two vibration commutators. Wherever used, the Group IV system is in addition to a Group II or III system.

B. OPERATIONAL RESULTS

Of the four GAM-63A's launched at HADC during this quarter, Nos. 4581 and 4783 contained both Group III and Group IV telemetering systems. The other two missiles, Nos. 4684 and 4891, contained only four-channel, a-c, Group III systems.

Although the records obtained from these systems during the flights was generally of good quality, there were some cases of instrument or channel failure. A detailed analysis of the operation of these telemetering systems will appear in the final flight test reports for the missiles.

C. TELEMETERING DESIGN AND DEVELOPMENT

1. Groups I and II Telemetering Systems

All Group I and Group II telemetering systems have been expended in the R&D flight test program at HADC.

2. Group III Telemetering Systems

a. 62-535-001 Telemetering Assembly

Detailed investigations on this assembly and its subsystems have resulted in the following progress.

Specification control drawings have been released for the Bendix subcarrier oscillators and filter to provide better control of parts and to enhance reliability of the units.

A 500-megacycle power oscillator tube tester was fabricated, tested, and delivered to the manufacturing test area. The special unit is being used to test MIL/5703WA tubes for conformance with specifications. This testing procedure ensures an adequate supply of tubes that meet the r-f power output requirements for use in the telemetering transmitter assembly (Bell Dwg. 62-535-070).

Many transmitter units have failed to meet noise specifications on alternator evaluation channels during vibration tests. As a result, a design change has been initiated to shift from the AM system to a straight-forward technique utilizing a subcarrier oscillator in a FM/FM system.

Efforts to improve the frequency stability of the 62-535-070 transmitter to 0.01% in accordance with MIL-T-26985 have been unsuccessful.

Several transmitters that can be purchased outside, have been investigated. None of these units will meet fully the requirements of frequency stability, spurious radiation, low distortion level, and resistance to environment. Moreover, no available unit will meet Bell Aircraft's reliability requirements as applied to electron tube power dissipation.

b. 56-535-430 Pressure Transducers

The major source of repetitive trouble with the Giannini pressure gages has been due to improper filling and sealing techniques and inadequate expansion cavity for the damping fluid. Corrective action has been initiated to rework these gages at Bell Aircraft. A survey is being made of instruments from various vendors to determine if units that meet all specifications can be obtained.

To obtain additional propulsion system data, test lines will be used between the power plant and the pressure instruments during static firings. The test lines will eliminate the clogging of the gage orifices as caused by the presence of ferric fluoride salts subsequent to test firing (the WFNA oxidizer is inhibited with hydrofluoric acid).

c. Instrumentation Changes

The following changes in instrumentation channel assignments were effected during this quarter:

A nitrogen-source pressure gage was incorporated in missile No. 4891 (launched 13 March 1957).

The chamber pressure function for the gas generator was changed from a commutated to a continuous channel in missiles 87 through 90.

The cruise chamber pressure function for the rocket engine was changed from a continuous to a commutated channel in missiles 87 through 90.

The relay high-voltage function for No. 91 and subsequent missiles was extended from 2200 to 4000 volts. The basic accuracy of this new transducer is in the order of 1%.

3. Group IV Telemetering Systems

A six-channel, high-frequency, vibrations-survey system has been packaged, tested, and installed in GAM-63A No. 97. All drawings and servicing instructions have been prepared and issued. This system consists of 8 crystal-type and 10 velocity-type vibration pickups. Fourteen of the pickups are sampled by two slow-speed (0.1 rps) commutators. Six high-frequency subcarrier oscillators (two each of 22, 40, and 70 kc), with a ±15% deviation, are used to modulate two r-f carriers. An automatic, seven-step, a-c calibration is provided in the system for all channels.

Preliminary analyses have been made on the requirements for a multi-channel system to instrument four R&D missiles equipped with the LR-67-BA-11 rocket engine. A system similar to the 20-channel kits incorporated in missiles 79 through 83 should be adequate for this requirement.

D. BEACON AND DESTRUCT SYSTEM

Several potential wide-spectrum noise sources within the missile have been isolated and made ineffective by the use of filters.

A study of the L-band beacon revealed that the shield covering the oscillator-mixer portion of the receiver could cause spurious triggering when moved slightly. A grounding strip was added between the shield cover and the receiver chassis to eliminate this condition.

E. Support Aircraft

1. SYNOPSIS

The director aircraft that form an integral part of the Rascal Weapon System are converted B-47 strategic bombardment airplanes, redesignated as DB-47. Their primary mission is to carry the GAM-63A missile to an area within 90 nautical miles of a target, to launch the missile at a particular altitude and heading, and to provide guidance control of the missile after launch.

In the Rascal flight test program, three types of carriers are being utilized. Two JB-50D airplanes are used to ferry GAM-63A missiles and related equipment from the Wheatfield plant to various test installations. Two JDB-36H and two DB-47E director aircraft are used at HADC for flight testing GAM-63A missiles. In addition, two DB-47E's are assigned to the E&ST program; one of these airplanes is at Eglin AFB and the other is at HADC.

Also, one JB-50D, one JF-80B, and one JF-89C are assigned to the Rascal program for R&D flight testing guidance components and subsystems of the missile and director aircraft.

In addition to modified MA-5 or -8 navigation gear, the director aircraft are equipped with an AN/APW-17 radar course-directing central. This equipment is used for navigating the director to a predetermined launch area, for preparing the missile prior to launch, for launching the missile, and for correcting the flight path of the missile during its midcourse phase (if necessary) and its terminal dive to the target.

2. DIRECTOR AIRCRAFT

a. DB-47 Operational Directors

Detailed data for installation of the GAM-63A in the DB-47 have been issued in Bell Aircraft Report 110-947-199, "Installation of Guided Air Missile-63A." The GAM-63A when loaded on the DB-47 is attached to a pylon protruding from the fuselage and is mounted in an attitude so that the angle of yaw is zero, the angle of attack is as small as possible, and the angle of roll does not exceed 13° (see Figure 11).

Late in 1954, the DB-47E (USAF No. 51-5219) airplane and a simulated GAM-63A missile were

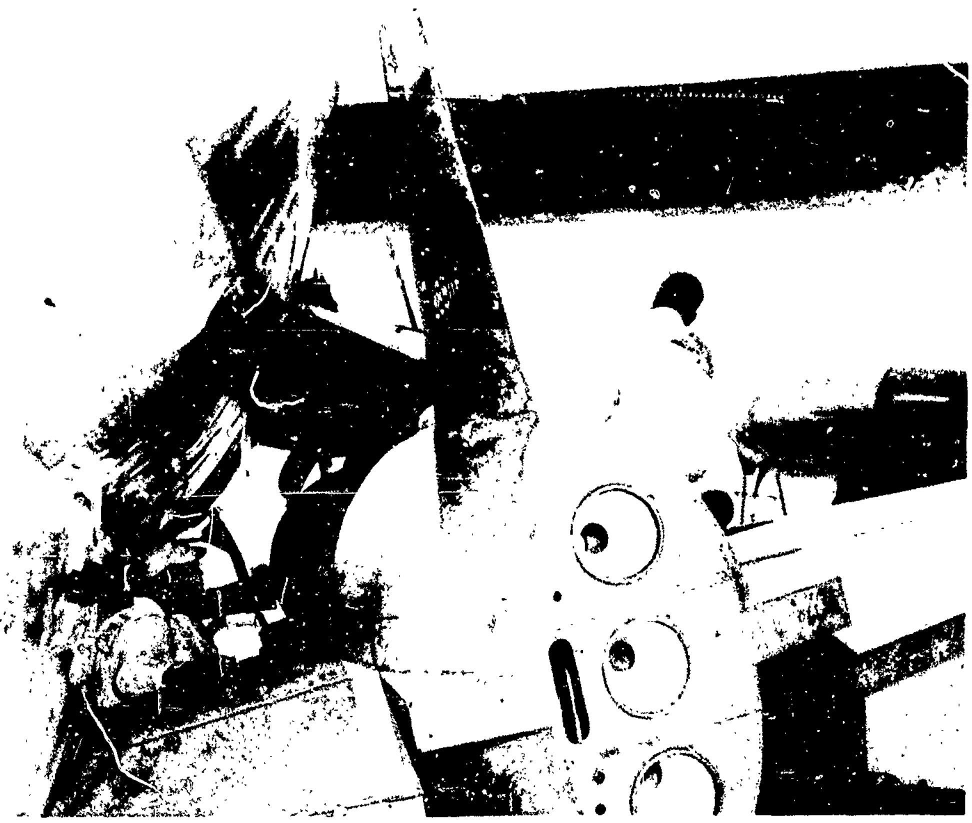


Figure 11. GAM-63A Being Attached to the DB-47

transferred to Edwards AFB for extensive flight testing by the USAF. The launching mechanism on this DB-47 was tested by dropping the simulated missile; motion picture coverage indicated satisfactory operation. Subsequently, AN/APW-17 guidance equipment and a flight test recording system were installed in the airplane. During this quarter, eleven flights of the DB-47 were flown in support of the missile firing program, including the launch flights of missiles Nos. 4581, 4684, and 4783. In addition, the DB-47 has undergone a periodic inspection at Biggs AFB, El Paso, Texas, and is presently being modified for the alternate warhead capability and profile missions.

Another DB-47E (USAF No. 51-5220), complete with Rascal guidance components, was delivered to HADC in August 1954. Instrumentation was subsequently installed for recording missile and director aircraft guidance performance, and missile power plant and airframe operation. Following missile mating and captive flight testing, hot firings of GAM-63A's with the airplane as director began in July 1955. During this quarter, eight flights of the DB-47 were flown in support of the missile firing program, including the launch flight of missile No. 4891. Also, three engineering test flights were made in connection with aircraft maintenance. In addition, the DB-47 was flown to Biggs AFB, El Paso, Texas for an inspection.

The DB-47 (USAF No. 53-2345), complete with Rascal guidance components, was delivered to HADC in January 1957. Receiving inventories and inspections were completed and outstanding service kits were installed. In addition, a modification was accomplished which incorporated the Sandia telemetering control circuitry. The DB-47 systems were preflighted in accordance with HADC procedures and, on 25 March 1957, the aircraft was mated with GAM-63A No. 85. The aircraft will ultimately launch at least one R&D missile.

b. DB-36 R&D Directors

The JDB-36H director airplane (USAF No. 51-5710), equipped with AN/APW-17 guidance, was transferred to HADC in July 1954. Following the installation of a flight test recording system, this DB-36 was used for captive flight tests and for launching GAM-63A's. During this quarter, the DB-36 was flown five times in support of the R&D Captive Flight Program.

A second JDB-36H airplane (USAF No. 51-5706), equipped with AN/APW-17 guidance, was delivered to HADC in December 1954. Following the installation of a flight test recording system, the DB-36 was utilized for captive flight tests. Utilization of this airplane in conjunction with the Radar Bomb Scoring (RBS) program at HADC was completed successfully. The aircraft was subsequently transferred to Convair, Fort Worth, for a major overhaul. Since its return to HADC, this DB-36 has been participating in the Electronics Vulnerability Test (EVT) Program with the JF-80 simulated missile (see Section II, H, Weapon System Investigations). During this quarter, the EVT program required thirteen flights of this aircraft.

3. DIRECTOR AIRCRAFT EQUIPMENT

a. General

The DB-47 director aircraft used with the Rascal Weapon System are equipped with an AN/APW-17 radar course-directing central and an MA-8 bombing-navigational system. Director guidance equipment may be divided into four major systems: (1) the MA-8 is a bombing navigation system designed for either gravity bombing or providing prelaunch initial conditions data for the GAM-63A; (2) the automatic checkout system, working in conjunction with the MA-8 and auxiliary components, is used prior to missile launching to check selected critical items in sequence and to launch the missile automatically, (3) the relay link system establishes and maintains a microwave radio link between the missile and director aircraft; and (4) the guidance control system which enables a trained operator to send azimuth corrections during the midcourse phase, and azimuth and pitch corrections during the terminal dive.

Three amendments to Specification 110-947-188, Revision B, were submitted to the WSPO during this quarter. This specification defines the bench, installation, preflight, and flight tests of the AN/APW-17 and MA-8 systems.

Eight prototype AN/APW-17 director aircraft guidance systems have been modified to incorporate the latest design changes; six of these systems have been returned to HADC. One system is being retained at the Wheatfield plant and will be set up in the laboratory. The system which was sent to Eglin AFB in support of the E&ST program has been returned to Bell Aircraft Corporation (Wheatfield). This system will be installed in the ground support bench set. Two indicators and two receivers reflecting the latest production version have been sent to HADC for use in the firing program. Three more units of each are scheduled to be delivered to HADC during the next quarter.

Production AN/APW-17 systems Nos. 117 through 123 have been delivered to Boeing/Wichita.

Plans are being formulated to conduct a more comprehensive systems test and a debugging test on the production systems. To ensure system compatibility and performance, and to facilitate installation, preflight testing, and flight testing in a DB-47, each AN/APW-17 system must pass a functional test as described in Bell Aircraft Specification 110-947-044.

b. Radio Repeater Set

(1) Automatic Tracking Relay Antenna System (ATRAS)

Evaluation of the new spin drive motor for the ATRAS is continuing with success at the Dalmotor Company. Evaluation testing is under way on three motors recently received at Bell Aircraft.

(2) Polycode Driver

System measurements, including the polycode driver and command transmitter, are being made to determine compatibility with the GAM command system under various environmental conditions. This work is being done in conjunction with the evaluation of hermetically sealed pulse-forming networks. Although the testing has not yet been completed, sufficient data have been obtained to provide tentative changes in the design center requirements of the command link.

(3) Command Transmitter

The microwave discriminator for the AFC circuit of the command transmitter has been redesigned to eliminate false cross-overs in the discriminator characteristics. A laboratory model is being fabricated for test.

(4) Relay Receiver

A redesign program is being negotiated with the vendor to improve the reliability and stability of the NU 5857 tube used in the i-f amplifiers of the relay receiver.

In accordance with a recent USAF directive, all work on the narrow-band relay link, and thus on the narrow-band relay receiver, has been discontinued. Inventories have been prepared for drawings, models, parts, specifications, and reports.

c. Terminal Guidance Control System (TGCS)

(1) Azimuth, Range, and Altitude (3-D) Offset Computer

Contractual requirements are being clarified and redefined. As a result, a program will be designed to meet commitments which now specify the fabrication of one developmental model. Also, plans will be made to complete the development of the 3-D offset computer. If these plans are approved by the WSPO, the development effort will be continued.

(2) Indirect Bomb Damage Assessment (IBDA)

Additional models of the marker unit for IBDA are being built for final environmental testing. These models incorporate the design changes established as a result of environmental testing on two earlier models.

The first experimental model of the detector head mount and the servo amplifier have been fabricated and are being subjected to limited environmental and life testing.

(3) Improved TGCS

Work on the improved terminal guidance control system has been discontinued.

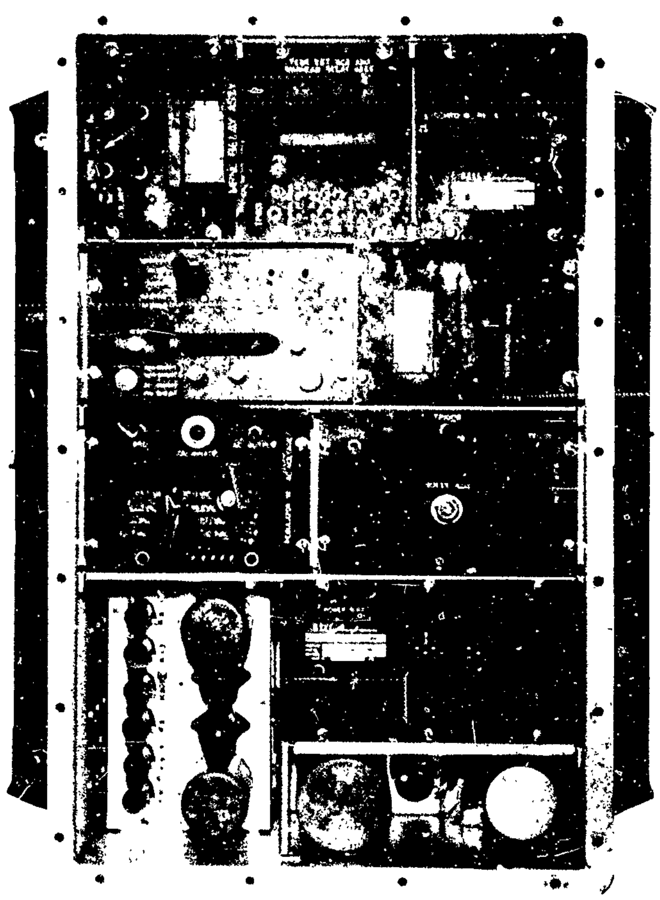


Figure 12. Rascal Group Simulator - Top View

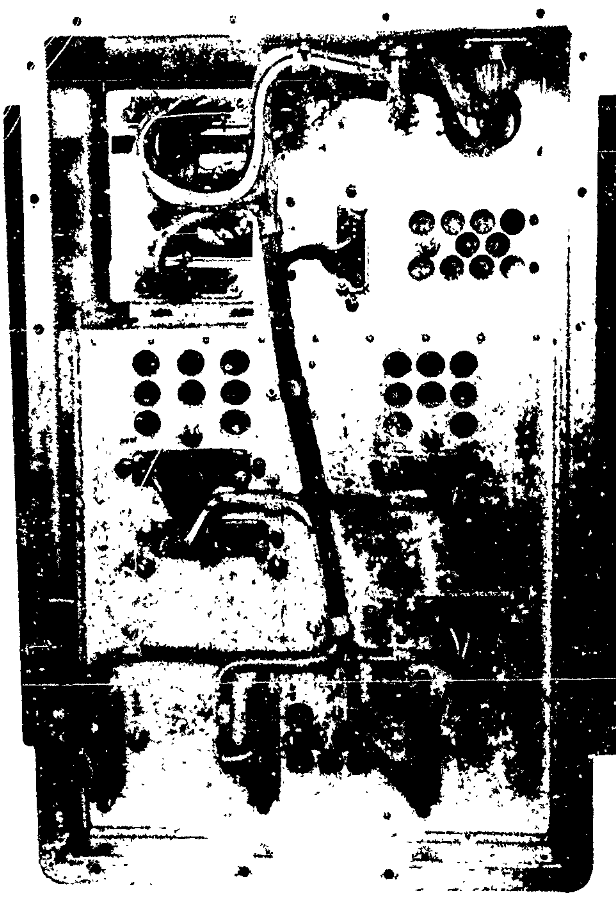


Figure 13. Rascal Group Simulator - Bottom View

d. Automatic Checkout System (ACS)

The redesign of the automatic checkout system was stopped during the early part of this quarter owing to lack of contractual coverage.

Group simulators, Part No. 112-542-500-5 (see Figures 12 and 13), are being shipped to Boeing Airplane Company. Schedule delays, encountered in the -5 program, were caused by a heat-rise problem and the inability of vendors to furnish satisfactory filters for the a-c regulator which would permit stable operation within specification environmental limits. This condition was rectified through use of a Bell-designed filter assembly which met specification requirements.

One complete -5 simulator has been shipped to Boeing/Wichita. Also, one -5 kit has been shipped, a second kit has passed acceptance testing and is in the process of being shipped.

4. FERRYING AIRCRAFT

Two JB-50D ferry airplanes (USAF Nos. 48-069 and 48-126), equipped with GAM support fittings and bomb bay cargo platforms, are assigned to the Rascal program. These aircraft are operated from the main plant at Wheatfield, New York, to deliver GAM-63A missiles and related equipment to various test installations.

5. RESEARCH AIRCRAFT

a. Guidance Flight Testing

(1) JB-17G No. 44-83439

The JB-17G airplane (USAF No. 44-83439) has been phased out of the Rascal R&D effort and is being replaced by the JB-50D airplane (USAF No. 48-111). The B-17 was grounded on 6 February 1957 and, after removal of all guidance and associated equipment, a satisfactory engineering check flight was performed. On 12 March 1957, the aircraft was returned to the Air Force without the normal periodic inspection having been performed. The inspection was omitted on the basis of Air Force approval to return the aircraft in an "as is" condition.

Previous to grounding of the B-17, two laboratory video relay flights were made to evaluate the R&D model of the narrow-band receiver. System parameters for this test were: PRF-2022; code type-3 pulse; relay link carrier deviation -5 mc. Satisfactory performance was achieved in the second flight, but there are regions which should be evaluated more fully at HADC.

(2) JB-50D No. 48-111

The low-power antijam radar set, Model 56 TGCS, and the missile radio set have been installed in the JB-50D aircraft (USAF No. 48-111). Operational trouble shooting is under way to eliminate minor troubles resulting from installation.

Major areas of modification work include: removal of launch gear; installation of bomb bay doors; mounting of low-power antijam radome and antenna (see Figure 14) in the aft bomb bay area; installation of the 400-cycle primary power system; modification of the aft tail area to contain the missile radio set (see Figure 15); removal of all director guidance equipment in the aft pressure area; installation of operator's tables, benches, and seats (see Figures 16 and 17); fabrication of cables, control boxes, and junction boxes; and depickling the aircraft and performing a periodic inspection. The periodic inspec-

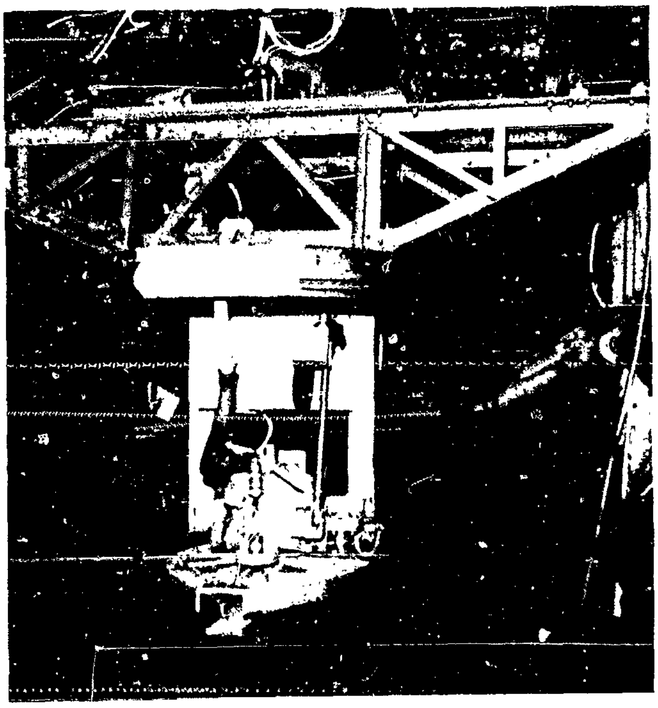


Figure 14. Mounting of Low-Power Antijam Radar Antenna in JB-50

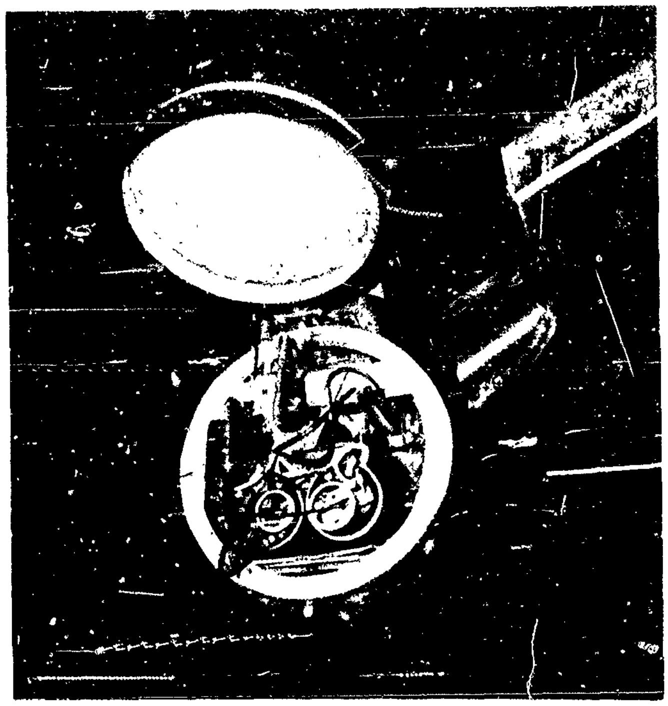


Figure 15. Missile Radio Set Installation in JB-50

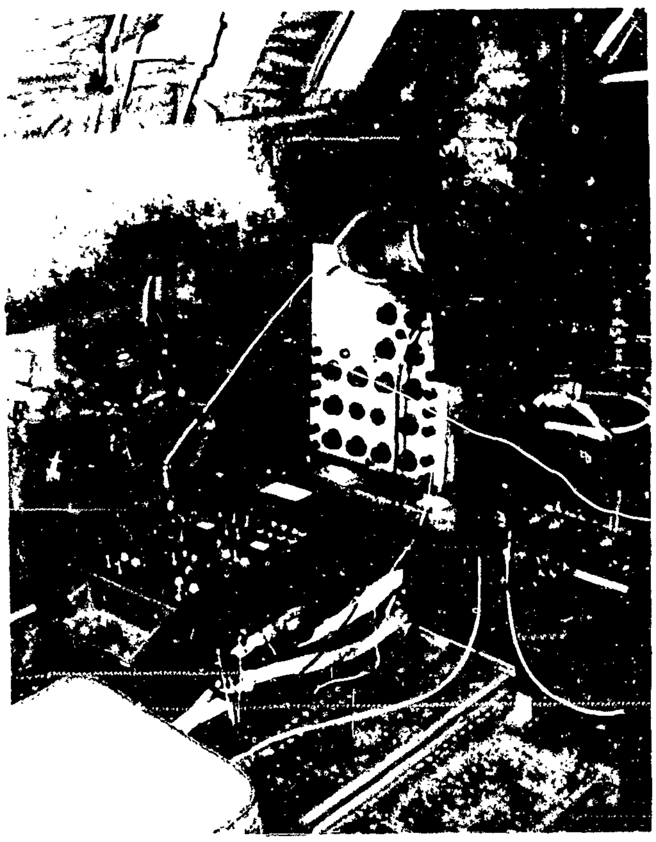


Figure 16. Operator's Position for Low-Power Antijam Radar in JB-50

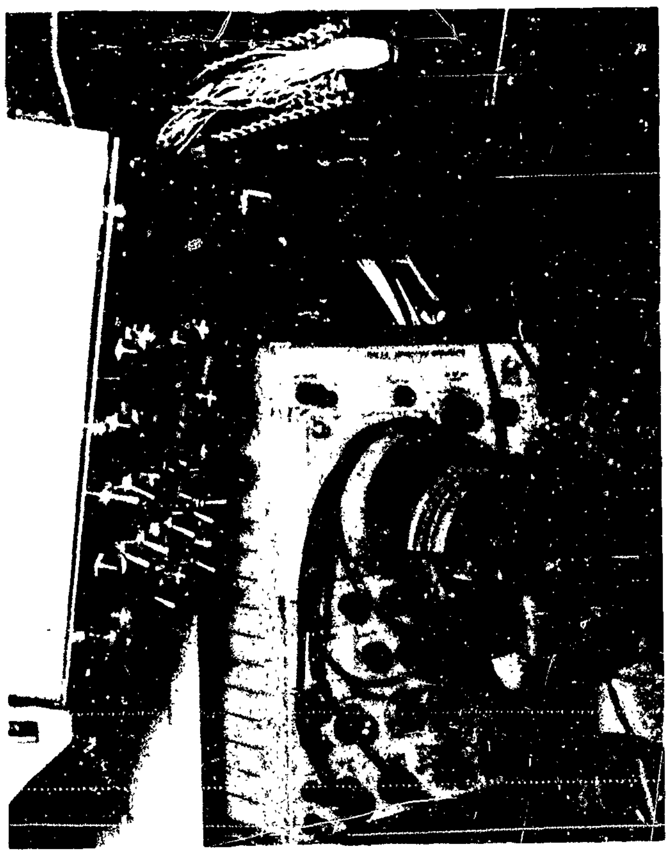


Figure 17. Operator's Position for Radio Set (Relay and Command) in JB-50

tion is 50% complete. Replacement turbos are on order and it is estimated that the airplane can be prepared for the initial engineering check flight two weeks after these parts are received.

(3) JF-80B No. 45-8485

The missile guidance equipment in the JF-80B has been modified to include the latest antijamming features. After flight testing the modifications, the simulated GAM-63A was transferred to HADC for use in the Electronic Vulnerability Test Program. Data concerning this program are presented in Section H, Weapon System Investigations. During this quarter, thirteen missions were accomplished with this aircraft in support of the EVT program.

(4) JF-89C No. 51-5814

The JF-89C was delivered to HADC in March 1957 for use in flight testing the narrow-band relay system. Also in March 1957, a support crew of seven persons arrived at HADC. During this quarter, the unattended search radar system in the JF-89 was modified to make it compatible with the narrow-band relay system, and four pilot checkout flights were accomplished. When the flight tests of narrow-band relay system were cancelled, the unattended search radar system was returned to its original configuration. The aircraft is presently in a standby status awaiting disposition from Bell/Wheatfield.

b. Laboratory Ground Station

The obsolete receiver and command transmitter (Model 56) was replaced with AN/APW-17 units. A new laboratory control panel was completed which encompasses in one unit all components that must be operated in the laboratory during flight test evaluation.

F. Ground Support Equipment

1. SYNOPSIS

The ground support equipment for the GAM-63A Weapon System encompasses all equipment not an integral part of the missile or director aircraft, but which is required to service, repair, test, and prepare the weapon system before mission take-off. Support equipment, therefore, includes handling and transporting devices, assembly stands and slings, special loading and fueling units, checkout/test equipment, and special templates and tools.

Over-all planning relative to support equipment for the weapon system is divided into two major categories. The first includes plans for equipment needed to conduct Bell Aircraft's ground and flight test programs, and the other includes planning pertinent to the Rascal support equipment required by the Air Force to conduct testing of the weapon under operational conditions.

2. SUPPORT EQUIPMENT FOR THE R&D PROGRAM

The R&D support equipment is required for use in the contractor's ground and flight test programs to prove new designs, model improvements, and added capabilities being developed continually in an effort to optimize the over-all weapon system concept. Each of these new developments undergoes extensive test and evaluation prior to submittal by the Air Force for operational use.

a. Handling Equipment

Engineering design of a warhead pan stand was completed during this quarter. The stand will facilitate transportation of the warhead pan, complete with warhead door and warhead, by fork-lift truck.

b. Service Equipment

Design of a tri-flush unit is progressing, and the drawings are 80% complete. The unit will be utilized for cleaning the propellant pressure regulator (liquid feed valve) in the propulsion system, after the regulator has come in contact with oxidizer. Cleaning will be accomplished by purging the regulator with a tri-liquid solution, followed by dry nitrogen gas.

c. Checkout/Test Equipment

Design work is under way to modify existing rocket engine pressure test equipment and electrical test equipment for R&D usage with the latest rocket engine configurations.

The design effort to repackage the missile group simulator (Bell Dwg. 112-945-500-5) for use as director aircraft checkout equipment has been completed. Technical approval for future procurement was granted by the Air Force to ECC GAM-63-D-1701 covering the repackaged simulators, Bell Dwg. Nos. 112-542-180-1 and -3.

3. OPERATIONAL GROUND SUPPORT EQUIPMENT

Engineering design has been completed for all operational ground support items. Contractual data drawings have been revised to the latest weapon system configuration and released to the Manufacturing Department. Engineering efforts during this quarter have been concentrated on engineering liaison, evaluation, and test of operational ground support equipment to expedite fabrication and delivery. Engineering discrepancies disclosed in manufacturing, and others resulting from evaluation and test programs, are being processed immediately upon receipt to maintain established delivery schedules.

Project personnel are located at Eglin AFB to provide technical assistance in the E&ST program and at HADC in support of the Evaluation Program on ground support equipment. In addition, liaison units are assisting several subcontractors that are fabricating operational ground support items.

The following ground support equipment was fabricated during this quarter and forwarded to HADC for evaluation and test:

Item	Part No.
Test Set, GAM-63A/Warhead	112-542-138-1
Boom Hoist Support	112-789-912-1
Sling, Warhead Pan Door	112-789-101-33
Checkout Equipment, Director Aircraft (Mobile)	112-795-001-9

As requested by the WSPO, Bell Aircraft is preparing a proposal for a telemetering and beacon rack to be used in conjunction with the rack-mounted checkout equipment, Bell Dwg. No. 112-542-400. The proposed design effort will include repackaging, into a rack configuration, the present telemetering and beacon equipment portions of the missile checkout trailer, a telemetering ground station, and additional calibration equipment.

The design of a liquid-level float switch has been completed. The new float switch will replace probe-type indicators formerly used in the acid tanks of the flush and disposal trailer. Crystal build-up of acid fumes caused the probe-type units to short out and give faulty indications.

4. SPECIAL PROGRAMS

a. Automatic Checkout Equipment

Four equipment manufacturers have submitted design proposals for automatic checkout equipment for the GAM-63A. This equipment is specifically intended for the Assembly and Alignment Area, but it is envisioned that a considerable portion, if not all, of the equipment will be applicable for use in the Ready-Storage Area. An informal presentation of this material, together with Bell Aircraft's recommendations, was made at WADC early in this quarter. The data submitted were considered by the Air Force to fulfill sufficiently the requirements of the item of work. The WSPO suggested that other companies recommended by WADC laboratory personnel be contacted, if desired, for additional ideas and proposals. However, any continued effort on the part of Bell Aircraft must be accomplished with Corporate funds.

b. Development Engineering Inspection

A Development Engineering Inspection (DEI) on operational ground support equipment was conducted at Bell Aircraft's Wheatfield facility on 15 through 17 May 1956. The following Form 68's were submitted:

Category		Quantity
I	Inspection Items (to be accomplished so that equipment will meet USAF requirements)	35
II	Mandatory Changes (engineering Change Proposals)	13
III	Study Changes (of a nature which require a study)	23
IV	Not applicable or acceptable	17
	Total	88

Of the 88 discrepancies, engineering on all but eight has been completed. The remaining eight items are scheduled for completion during the next quarter.

The reliability test program is being expanded to include certain items of operational ground support equipment. Rough draft copies of the test conditions to be imposed have been published in Material Process Bulletins (MPB's). The items to be tested are as follows:

GAM-63A Checkout and Test Equipment

Director Aircraft Bench Set and Checkout Trailer

Emanating Bench Set

Nonemanating Bench Set

Calibration Equipment

Fuzing Bench Set

c. Ground Support Evaluation Program

As part of the Rascal work effort, programs are under way at the Wheatfield facility and at HADC to evaluate operational ground support equipment. The evaluation consists of actual usage of each item in accordance with the applicable handbooks. In addition, the handbooks associated with each item are evaluated for suitability and accuracy in describing operation and maintenance. Of the 21 items scheduled for evaluation at the Wheatfield facility, 19 have been evaluated.

At HADC during this quarter, the primary effort on ground support equipment has been concerned with the evaluation of the missile and director aircraft checkout trailers and associated handbooks. A major part of this evaluation has been a review of the GAM-63A Guidance System Handbook, T.O. 1M1-GAM-63-2-8. Since this program has been conducted on the basis of noninterference with the missile firing program, progress has been interrupted by the needs of the flight testing effort for hardware and manpower.

The director aircraft checkout trailer has been evaluated on an individual component basis and is now ready for evaluation of the AN/APW-17 system in DB-47 No. 53-2345.

The status of evaluation of the primary weapon system handbooks is as follows:

T. O. No.	Title	Status
1M1-GAM-63-6	Inspection Requirements	Being revised
1M1-GAM-63-2-1	General Missile Handbooks	Completed
1M1-GAM-63-2-2	Ground Handling, Servicing, and Airframe Maintenance	50% complete
1M1-GAM-63-2-3	Electrical System	30% complete
1M1-GAM-63-2-4	Hydraulic System	20% complete
1M1-GAM-63-2-5	Propulsion System	5% complete
1M1-GAM-63-2-8	Guidance System	5% complete, 90% pre-evaluated
M1-GAM-63-2-9	Fuzing System	50% pre-evaluated
1M1-GAM-63-2-11	Wiring Handbook	Completed
2K-LR-67-6	Power Plant (Rocket Engine & Package Accessories)	10% complete
11G-2-3-3-2-1	AN/APW-17 Gen. Systems	Pre-evaluation complete
11G-2-3-3-1	AN/APW-17 Operating Instructions	50% pre-evaluated
11G-2-3-3-14	AN/APW-17 Organizational Maintenance	Pre-evaluation complete

The evaluation of these handbooks will be completed as the opportunity to perform this evaluation occurs in the firing program.

Individual items of ground support equipment evaluated with the associated handbooks during this quarter include:

Item	Part No.
Warhead Loader	112-789-374-1
Warhead Door Pan	112-789-051-1
Templates and Gages	112-789-800-3
Forward Body Stand	112-782-012-1
Aft Body Stand	112-782-045-1
Warhead Door Pan Sling	112-789-101-1
Adapter, MA-7 Cooler	E.O. 39181-3 (Partial)
Pressurizing Kit, DB-47 Hyd. Reservoir	112-809-492-1
Special Tools (Partial)	112-789-801-J
Final Assembly Test Equip. (Partial)	112-542-138-1

Only minor discrepancies occurred in the evaluation of these items. Where necessary, changes were incorporated to make the items compatible with the weapon system and changes were made to the associated handbooks to make them compatible with the items or their operation or performance.

Figure 18 shows the warhead loader, Bell Dwg. No. 112-789-374-1, positioned beneath GAM No. 80 during the Warhead Loader Evaluation. In Figure 19, the aileron gages are in position on GAM No. 85 during the Templates and Gages Evaluation.

The platform assembly, Bell Dwg. No. 112-789-908-1, is used for leveling the missile in pitch and roll. The platform assembly is mounted on the left wing at the centerline, with two machined surfaces of the assembly resting on the wing's skin. When this device was attached to GAM No. 85, the machined surface did not contact the skin forward of the centerline (see Figure 20). This is being corrected.

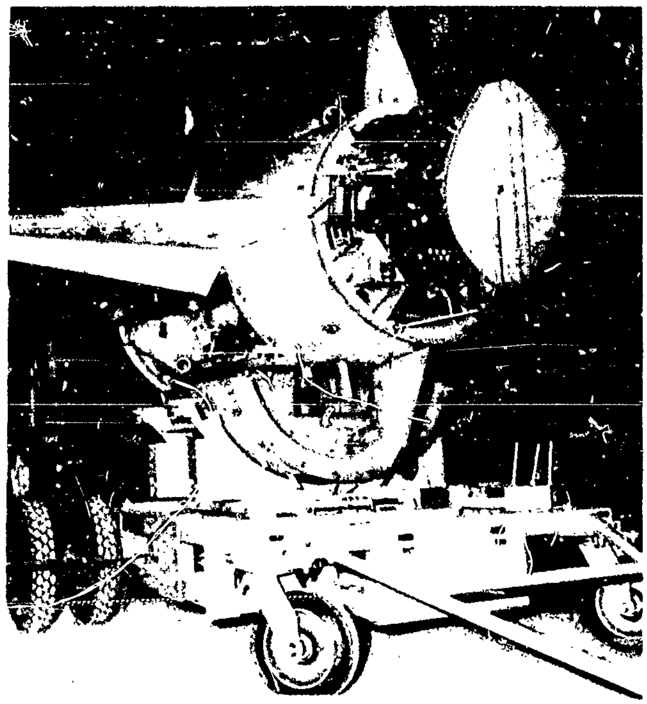


Figure 18. Warhead Loader Positioned Beneath GAM No. 80

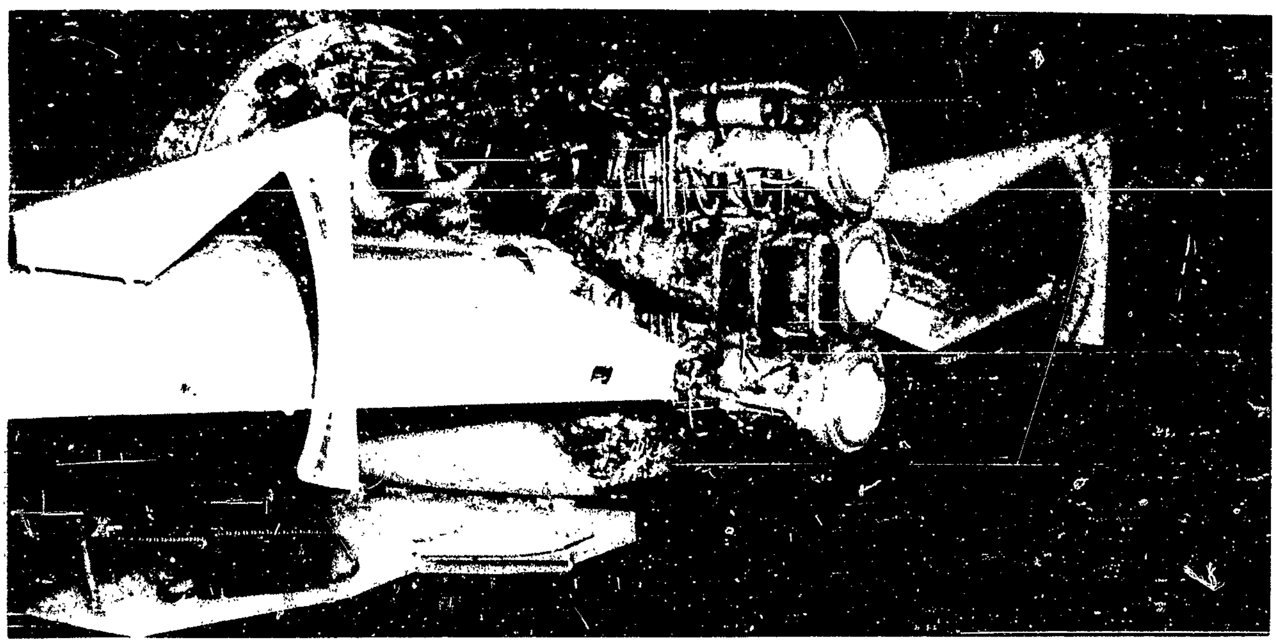


Figure 19. Aileron Gages Positioned on GAM No. 85

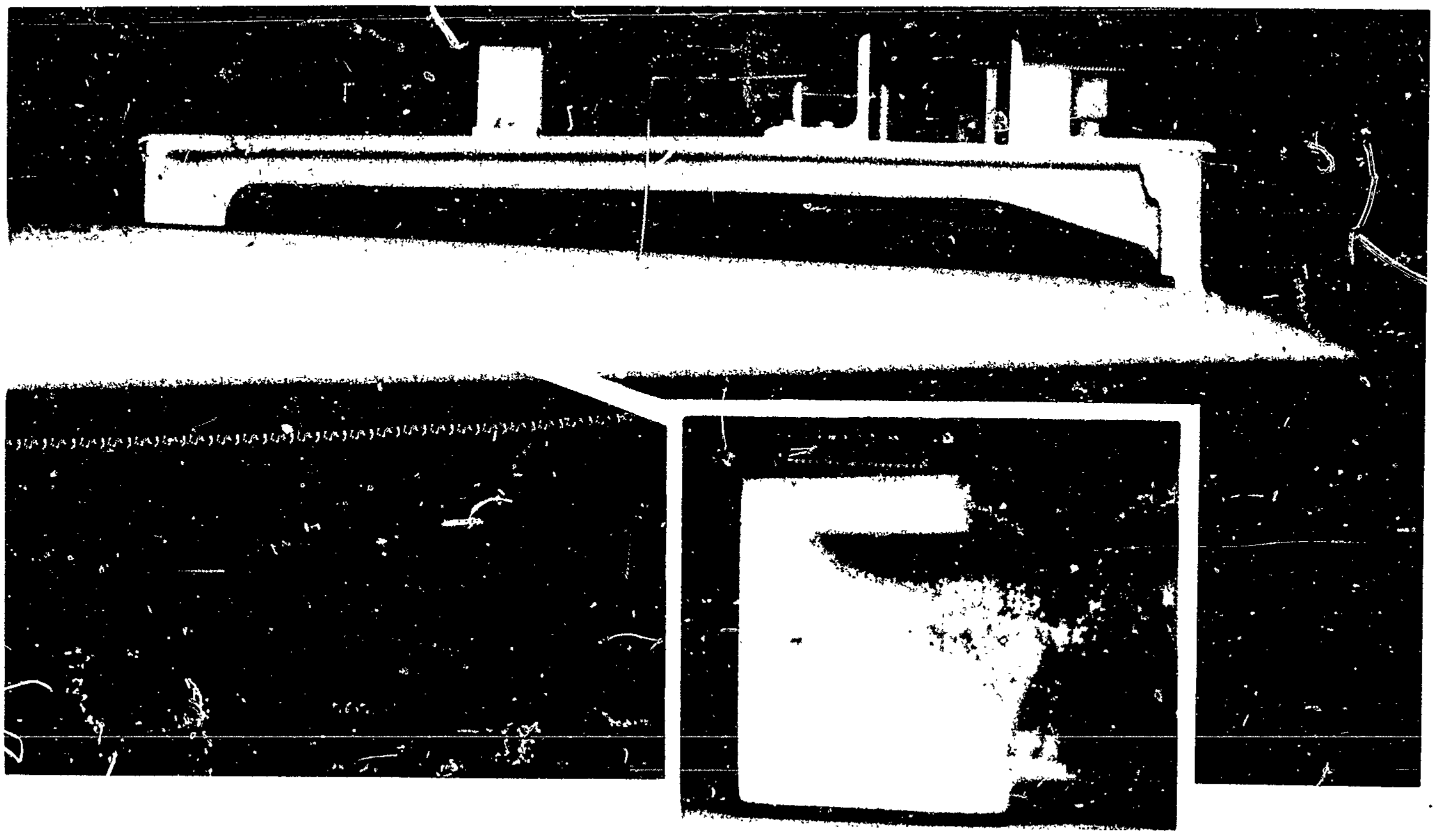


Figure 20. Platform Leveling Assembly Attached to GAM No. 85

G. Training Equipment

1. SYNOPSIS

The training equipment element of the Rascal Weapon System comprises that equipment for training maintenance and operational Air Force Organizational Personnel assigned to the weapon system.

Early in the Rascal program, classroom demonstrators for the GAM-63 missile systems and for the AN/APW-17 radar course-directing central in the DB-47 were designed, fabricated, and delivered to the USAF. These demonstrators were designed for the indoctrination and for the maintenance and proficiency training of Air Force personnel. In addition, an F-80/B-50 aircraft team, modified and instrumented to simulate the GAM-63/DB-47 weapon, was delivered to the Air Force for training operations personnel.

Recent efforts have been directed toward the development of a Mobile Training Unit and an improved Rascal Guidance Operator Trainer. Figure 21 presents the status of training equipment programs.

2. MAINTENANCE TRAINING AIDS

The Mobile Training Unit (MTU) is especially designed for use in the field. The unit consists of functional component systems of the missile and the director aircraft mounted on a series of highly mobile panels.

The MTU is divided into two main categories: the missile portion comprises systems and components of the GAM-63A; the director aircraft portion comprises all systems and components which are normally found in the DB-47 and are peculiar to the Rascal weapon system.

The major systems of the MTU are portrayed on vertical wooden panels designed according to Air Force

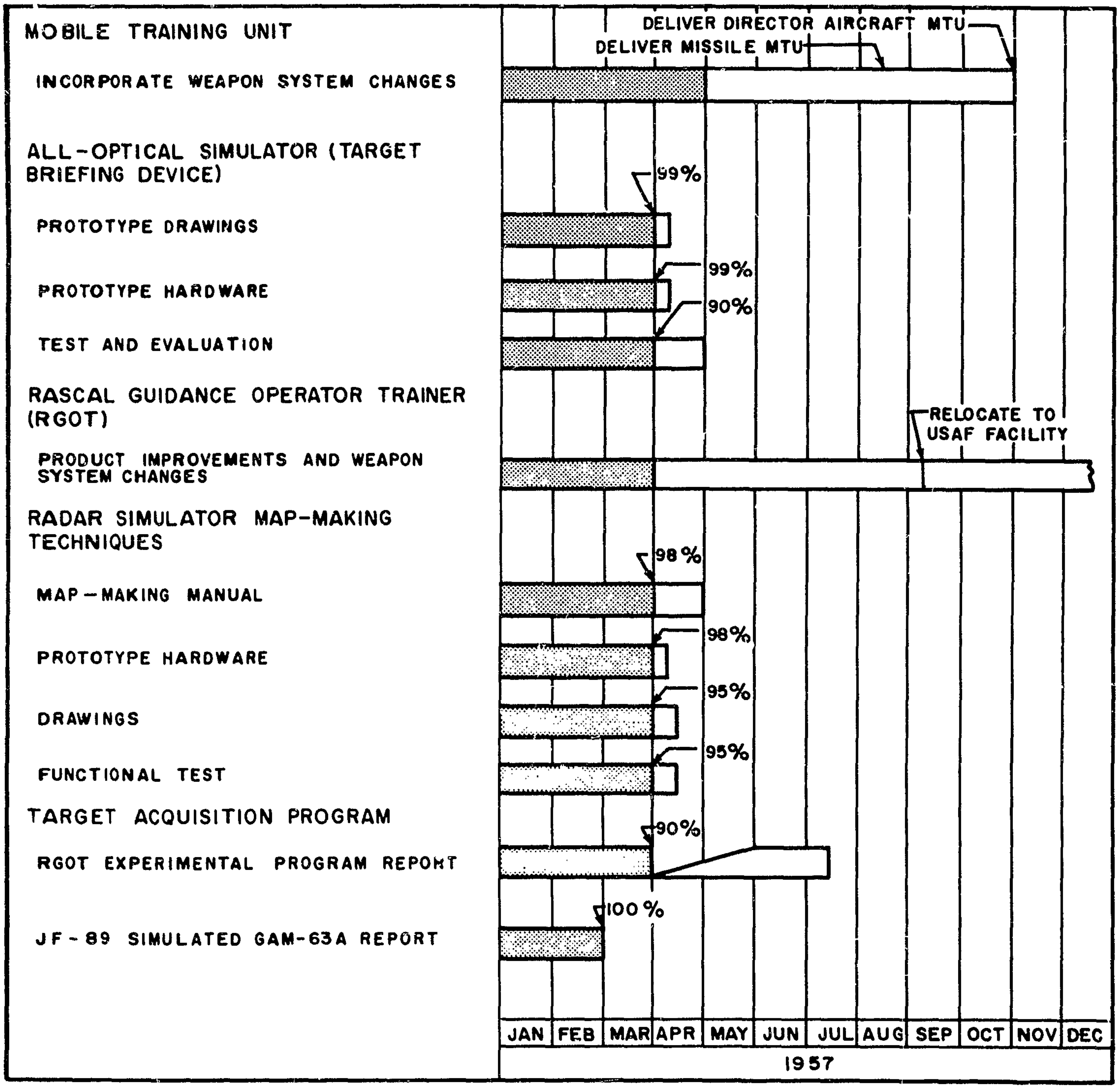


Figure 21. Status of Training Equipment Programs

Exhibit WCE-280, including Amendment IV, and feature sectionalized, plasticized, or actual operating components. The smaller systems and items pertaining to arrangement, access, ground handling, and inspection will be presented on a series of approximately 150 multicolored transparencies suitable for projection in a classroom.

The missile portion of the MTU consists of 14 units. Seven of the units portray systems in the missile, while five others contain checkout and test equipment for those systems. The remaining two units supply power for operating the complete set. The design of all missile units of the MTU has been completed and fabrication of the units is under way.

The director aircraft portion of the MTU consists of 11 units. Six of these portray Rascal systems located in the DB-47, three are test equipment, and the remaining two units supply power for operating the complete set. All director aircraft units of the MTU have been designed and are being manufactured.

3. OPERATOR TRAINING AIDS

The Rascal Guidance Operator Trainer (RGOT) accurately simulates the operator's environment in the DB-47 director aircraft. Consequently, the trainee learns to identify panels and knobs in the operator's compartment and becomes familiar with the operations required in launching and guiding a GAM-63A missile.

The RGOT is undergoing a general improvement in readiness for relocation to an Air Force facility. New panels, incorporating the latest weapon system changes and nomenclature, have been fabricated and installed in the instructor's console. Larger junction boxes and cables have been added to provide additional spare wires and terminals. A new optical system has been installed in the radar simulator, which is undergoing alignment and adjustment. Owing to improved light-transmission efficiency of the optics, the light source must be redesigned. Final optical adjustments must be completed before the new light source requirements can be firmly established.

During this quarter, the RGOT was utilized in a refresher training program for Air Force operators. The training was particularly beneficial since it offered these operators the opportunity to use the new DB-47 guidance station which is an exact replica of the production configuration in the DB-47 aircraft.

An all-optical target briefing device has been designed and is being fabricated. The design objective is to produce, on a simulated radar screen, a picture that is as realistic as possible with an all-optical system. This device, a valuable target study tool, is designed for portability and can easily be handled and assembled by one or two men without the need of mechanical handling equipment.

Except for the light source, fabrication of the all-optical device was completed in January 1957. The unit is now being tested and debugged.

4. TARGET ACQUISITION AND RGOT MAP EVALUATION PROGRAM

Contract Change Notification No. 27, received in November 1955, defines and authorizes the Target Acquisition and RGOT Map Evaluation Program. Progress on the various phases of this program are presented in the following paragraphs.

The target acquisition investigation conducted by AORL, Mather Air Force Base, was based upon scoring experienced Air Observer Bombardiers (AOB's) on the Bomb Run Simulator which contains properly modified Rascal scope photographs of Kansas City, Missouri. Prior to the use of the Bomb Run Simulator, the personnel were briefed both on scope photographs obtained with the RGOT and on enlarged artwork predictions furnished by Bell Aircraft.

The target acquisition investigation conducted at Bell Aircraft Corporation using the RGOT and SAC AOB's was completed during the first quarter of 1956. The report on this investigation will be issued during the next quarter.

The third phase of the Target Acquisition Program was completed at Phoenix, Arizona, on 31 August 1956. This program utilized a JF-89 (simulated GAM-63A), under the control of SAC AOB's situated in a DB-36 director aircraft and performing under realistic operational conditions. Eighteen dives were accomplished at Phoenix. Scoring results have been obtained from 10 dives and, in general, the objectives of the program were attained. The objectives include target acquisition information, guidance system evaluation, and open-loop control system evaluation. Results of this phase of the program were published during this quarter.

The SAC evaluation report of RGOT Map-Making Techniques was submitted to ARDC at Dayton, Ohio. At the request of ARDC, Bell Aircraft Corporation submitted comments on the SAC evaluation report. The SAC comments indicated that the map-making techniques are good.

5. HUMAN ENGINEERING

Efforts in human engineering have been incorporated into the preparation and writing of the Target Acquisition and Guidance Operator Capability reports. The latter report has been delivered to the Air Force.

H. Weapon System Investigations

1. GRAVITY BOMBING CAPABILITY

In the gravity bombing capability program, three full-scale Rascal missiles will be released from a DB-47 under typical launch conditions. Structural modification of the three airframes, Nos. 02, 08, and 29, assigned to this program has been completed and instrumentation has been installed. (In the flight test program, the missiles have been renumbered 0102, 0213, and 0304, respectively.) After laboratory systems testing, the first test vehicle was transferred to HADC where it is being prepared for a scheduled launch early in April. Missile 0203 was also ferried to HADC during this quarter; both 0203 and 0304 are scheduled to be launched in May 1957.

Evaluation of the cartridge-actuated devices in the gravity bombs is complete. Design of the auxiliary systems for free-floating the rudder and elevators, and for locking these surfaces in neutral, has progressed to the point where detail working drawings of prototype hardware are being prepared; fabrication of test hardware is scheduled to begin in the next quarter. The roll actuation mechanism, which was tested under a separate evaluation effort, has been installed in the three vehicles.

2. ALTERNATE TARGET AND AIMPOINT CAPABILITY

To increase the flexibility of the weapon system, the rocket engine cut-off time will be remotely controlled to ensure satisfactory missile performance as the missile range is varied. The proposed system incorporates a master timer in the DB-47; this timer can be adjusted to accommodate the full range of rocket engine operating periods. A second timer will be installed in the GAM-63A and slaved to the master timer; this second timer will replace the K-23 sequence timer that is now used in the missile to control rocket cut-off.

Laboratory testing of the new timer system will be completed during May 1957. The tests are being performed according to Bell Aircraft Report 56-989-157, "Ground and Flight Tests of Alternate Target/Aimpoint Capability Features." Flight testing of the rocket cut-off control system is scheduled to begin at HADC in September 1957.

3. CAPABILITY STUDIES

A document is being prepared to reflect the results of studies that have led to the selection of the present Rascal weapon. The document will set forth recommendations for improvements to the weapon system.

The status of these analyses and their respective reports is as follows:

(1) A report has been prepared to describe the requirements imposed by the relay link on the missile's autopilot.

(2) In the study of the effects of structural coupling on the autopilot, data have been obtained from tests on airframe No. 48, which was ballasted to simulate the weight of warhead and power plant. Results of this effort are being compiled in a report.

(3) Margins of autopilot stability — 30% complete.

(4) Requirements imposed on the autopilot by the radar set antenna — 60% complete.

(5) In the analysis of requirements imposed on the autopilot by the inertial range-computing system, a separate study is under way to determine the terminal guidance capabilities of the present Rascal system. Although this supporting work has essentially been accomplished, the over-all study is about 75% complete.

(6) A report of the analysis of platform leveling is in work and is scheduled to be completed early in the next quarter.

4. WEAPON SYSTEM ANALYSES

The problems relating to the Rascal Weapon System in operational status are being investigated. The effort during this quarter has been directed toward the Ready-Alert/Alert-Maintenance cycle of squadron activity. Initial studies were concerned with general analyses of the interrelationships among such parameters as types and quantities of weapon system checks performed in each area, discrepancy rates, number of servicing stations, rate of servicing at each station, and status of each area in terms of numbers of weapon systems on alert status, on ready-alert status, and in maintenance. The generalized results of these analyses have been summarized to provide an indication of data requisite to performing an adequate analysis of squadron activities. Work is under way to determine the sensitivity of this model to changes in assumptions relative to average maintenance times and frequency distribution of repair times associated with system discrepancies.

In anticipation of a more thorough analysis of squadron activities in areas relating to spare parts requirements and stockpiling, pertinent studies available in the literature are being reviewed. In particular, the following Rand Corporation reports are being analyzed for applicability of methods to the Rascal system studies:

RM-1357	"Confidence Intervals for Poisson Parameters in Logistics Research"
RM-1413	"The Prediction of Demand for Aircraft Spare Parts Using the Method of Conditional Probabilities"

To correlate assumed defense levels, survival probabilities obtained from earlier studies employing uniform defense assumptions are being compared with results obtained from the use of discrete intercepter and/or surface-to-air missile mock-engagements. However, this problem is complicated by the lack of specific data regarding expected number of engagements, apportionment of engagements as to types (long-range SAM's, short-range SAM's, and interceptors), and relative enemy defense effectiveness for each engagement.

Additional investigations and calculations have been completed on the geodetic quantities relating the Bell Aircraft complex target to a number of other stations in the HADC area. To assure mutual consistency in the results of this work, facilities at White Sands Proving Grounds and at HADC were visited to discuss these geodetic problems.

5. LOW-ALTITUDE LAUNCH CAPABILITY

Studies have been initiated to investigate the compatibility and capabilities of the Rascal missile when employed with director aircraft utilizing the Low-Altitude Bombing System (LABS). The main emphasis has been to determine airplane prelaunch flight paths that are compatible with both DB-47 capabilities and System 112A restrictions. Consistent with these requirements, two tentative flight paths have been determined. The following assumptions have been made:

(1) DB-47 can be maintained at a constant velocity of 715 ft/sec up to the time of missile launch
(2) DB-47 gross weight will not exceed 135,000 lb during LABS maneuver

(3) During prelaunch maneuver, a 2g horizontal acceleration will not be exceeded

(4) Throughout entire prelaunch flight, 3g of normal acceleration will not be exceeded

(5) Initial pull-up of director aircraft will occur at 1000 ft MSL and missile launch will occur at 6000 ft MSL

The two flight paths investigated differ only in the initial pull-up maneuver. One path assumes an initial 3g maneuver and the other an initial 2g maneuver. These maneuvers are based upon the afore-mentioned assumptions and will require revision as more realistic data become available.

6. MISSION PLANNING DATA REPORT

A preliminary document, "GAM-63A/DB-47 Weapon System Mission Planning Data," Report No. 66-989-021, was published in January 1957. Effort on the 90-day revision to this report is continuing.

Flight planning information is being prepared specifically for use during the E&ST Program. These data will be delivered to Eglin AFB early in the next quarter.

The final draft of the "Operational Utilization Summary Report," No. 66-989-001, is nearly complete. Review is scheduled for early in April 1957.

7. ELECTRONIC VULNERABILITY TESTS

As part of the System 112A R&D work effort, an Electronic Vulnerability Test (EVT) Program is under way at HADC utilizing the JF-80C (USAF No. 45-8485) and the JDB-36H (USAF No. 51-5706) aircraft (see Figure 22). This program is being conducted by the USAF with Bell Aircraft support to determine the susceptibility of the Rascal Weapon System to interception and analysis, and the degree of interference of missile performance that can be introduced by jamming and deception.

During the quarter, the following systems were evaluated.

Radar Set — Two tests have been conducted successfully on the radar set: (1) sweep-jamming against the antijam mode of operation and (2) noise-modulated CW spot-jamming against the fixed frequency system. While at least two additional tests must be accomplished, several more would be desirable pending availability of suitable jamming equipment.

Relay Receiver — The techniques of sweep-jamming and spot-jamming have been attempted against the relay receiver. Only the sweep-jamming

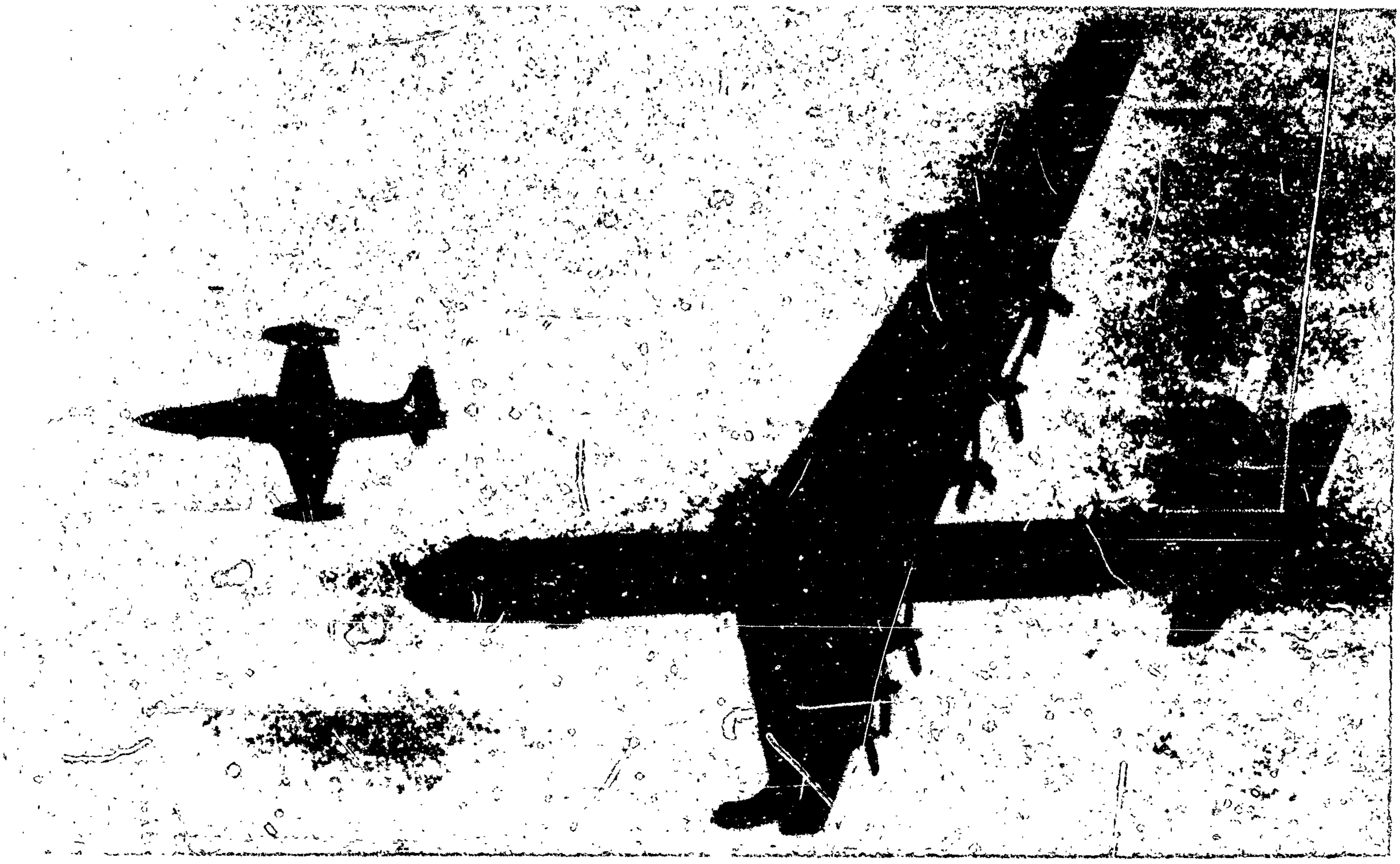


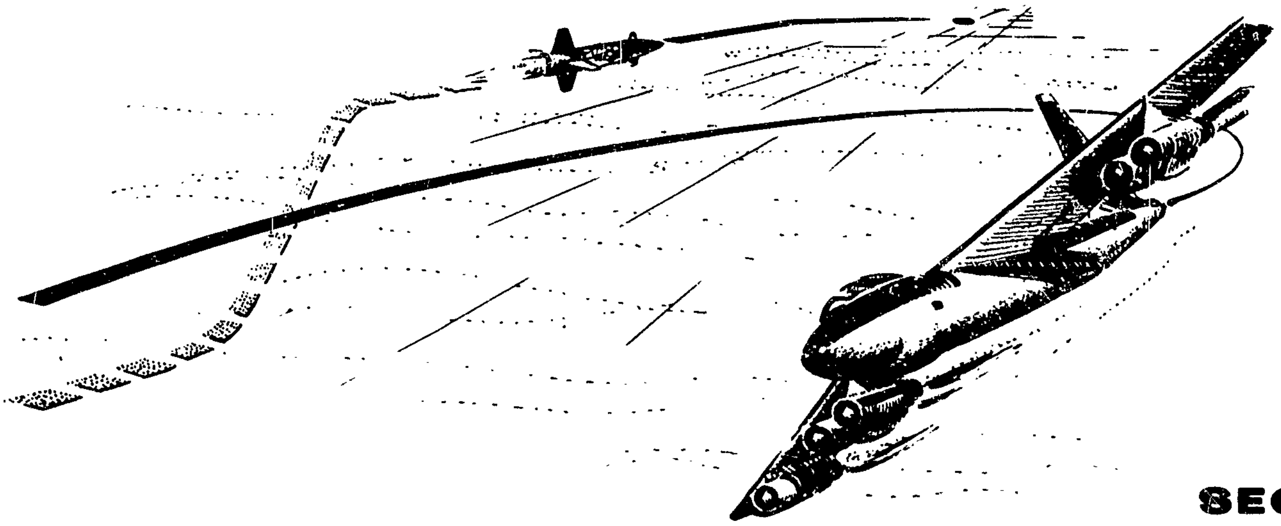
Figure 22. JF-80 and JB-36 Aircraft Assigned to EVT Program

test was valid. Two additional valid tests were required.

Command Receiver — A spot-jamming technique utilizing noise-modulated CW has been used against the command receiver. The tests were considered valid.

8. ANALYSIS OF PACKAGING REQUIREMENTS

The System 112A packaging analysis, Report No. 66-989-028, and packaging proposal, Report No. 02-945-155, are undergoing final engineering review prior to publication.



SECTION III
AIR FORCE PROGRAMS

A. Employment and Suitability Testing

The operational suitability testing of Air Force guided missiles is under the provisions of AFR 80-14 which designates this function as the prime responsibility of the Air Proving Ground Command (APGC).

The Air Force On-the-Job-Training (OJT) program at Eglin Air Force Base preceded the ground phase of Employment and Suitability Testing (E&ST). Sufficient GAM-63A weapon system hardware is available at Eglin Air Force Base and the ground phase of the E&ST program is under way. Upon completion of the ground phase OJT/E&ST effort, a preflight program will be undertaken and this will lead to actual missile launchings by the APGC test team during 1957.

Performance computations necessary to the compilation of a handbook for the E&ST program are nearly complete. The results will be presented as curves of boost-timer setting as a function of detonation altitude and range. Detonation Mach numbers from 1.1 to 1.3 will be covered. Also being computed are detrimental range losses resulting from degraded launch conditions and ranges of the terminal dive.

B. Logistic Depot

Bell Aircraft Corporation submitted a facility proposal to Headquarters, Air Materiel Command, on 8 August 1955 covering the requirements for establishing a GAM-63A Logistics Depot at Air Force Plant No. 40 in the Town of Tonawanda, New York. On 29 September 1955, AMC approved this proposal as Appendix A to Facility Contract AF33(600)-31197 which was awarded to Bell Aircraft on 12 September 1956.

On 5 October 1955, Bell Aircraft was awarded Contract AF36(600)-2667 for the overhaul, repair, and/or modification of components and related equipment, and Contract AF36(600)-2666 for the storage and distribution services of spare parts for the GAM-63A Weapon System. These contracts have been extended to 30 June 1957.

Space occupied by the Depot at AF Plant No. 40 constitutes 56,000 square feet, or 50% of ultimate requirements under the present USAF program. The Depot is equipped with 400-cycle (single and triple phases), 28-volt, d-c motor generators and distribution system, as well as a compressed-air system, repair shops, and stock rooms. The Depot space is a "closed area" under the surveillance of Bell Aircraft security police.

Accountability records have been established and this system reflects daily the increasing number of items received and shipped in support of the GAM-63A weapon system. More than 5500 items of Common AF Tools and Equipment, of an ultimate 18,000 items, are in stock. There are 4000 line items of the weapon system in stock, as provisioned to the Depot under Contract AF33(038)-15069.

The GAM-63A Logistics Depot has been increasing its working force to coincide with the increase of workload both in the field and at the Depot repair facility. A sufficient number of personnel are at the Supply Depot to support the existing Air Force program in its entirety. The Maintenance Depot is at 60% of full operational capacity to support the USAF program both in the field and at AF Plant No. 40.

Field service teams have successfully completed DB-47 airplane retrofit installations at HADC, at Boeing, Wichita, and at Eglin AFB. Additional reparables and modifications resulting from Air Force operations have been accomplished at the Depot on 30-day turn-around schedules.

Methods and procedures employed in both the Supply and Maintenance Depots are established in accordance with AFM67-1 and AFM66-1, respectively. Air Force forms are used wherever practicable. The effectivity of these procedures is regularly reviewed by the USAF from the reports submitted by Bell Aircraft.

To meet contractual demands and to assure compliance with Depot responsibility of adequately supporting the Rascal weapon, certain complementary functions have been initiated. These services include coordinated but independent centers for shipping and receiving, an integrated communication and recording system, and a segregated mailing arrangement.

The Depot also operates a Logistics Control Section that maintains up-to-date attrition and failure records from which are forecast the requirements for parts and equipment to uphold the Depot workload. This Section also controls Depot participation in the USAF Product Improvement Program and the Rascal Reliability Program of Bell Aircraft.

C. Technical Training and Support

1. AIR FORCE TRAINING

As a result of three Air Force training conferences at Bell Aircraft Corporation (one from 10 through 19 March 1953, one from 31 March to 9 April 1953, and the other on 9 and 10 February 1954), a training program for System 112A was formulated. The conferences were attended by representatives of AMC, WADC, ARDC, SAC, TTAF, and USAF Commands.

For these conferences, an outline of a training course was established, length and number of classes were agreed upon, and the categories of training, classification of trainees, and number of Air Force Commands that would participate were determined. Training of Air Force personnel (staff, E&ST, and instructors) was accomplished in three parts:

PART I - AF Staff Familiarization

PART II - AF Technical Training

PART III - On-the-Job-Training

PART I - The AF staff familiarization program extended from 12 July through 22 October 1954. A total of 175 USAF staff personnel attended a 40-hour academic program at Bell Aircraft Corporation.

PART II - A technical training program for approximately 95 USAF personnel began on 13 April 1955 at Lowry AFB, Colorado, and on 11 May 1955 at Chanute AFB, Illinois. This first class of trainees completed training on 28 June 1955. All training was completed on 8 November 1955.

PART III - A letter from WADC, dated 18 November 1953, requested that Bell Aircraft review the on-the-job training proposal outlined in HADC letter to ARDC, dated 19 August 1953. The WSPO and Bell Aircraft subsequently agreed upon the necessity for an OJT program at Eglin AFB. This phase of training has been completed.

To supplement the training programs already accomplished, additional approved and proposed USAF training programs are planned. The System 112A Program Planning Report, No. 56-989-003, reflects the planning for these projects.

2. TECHNICAL REPRESENTATIVE SUPPORT

In support of the ground phase of the Air Force E&ST Program, Bell Aircraft Corporation has assigned technical and service representatives to Eglin AFB, Valparaiso, Florida.

A proposal has been submitted to SAC Headquarters covering contractor technical support for squadron activation and operation of the Rascal Guidance Operator Trainer.

D. Handbooks

1. SYNOPSIS

A complete set of maintenance and overhaul handbooks is required for the end-items of the Rascal weapon system: the missile, the AN/APW-17 director aircraft guidance system, and the ground support equipment.

The handbooks cover the organizational (flight-line) and the depot levels of maintenance, as well as the operation and maintenance support data for these levels. Data in the handbooks for the airborne elements of the weapon system at organizational and field levels include all necessary and recommended operating and servicing procedures to maintain the equipment successfully. A full maintenance capability is available for airborne elements when supplemented by the overhaul handbooks, which include information for complete repair or rebuild.

The respective maintenance handbooks for ground handling and test equipment contain full procedures for the appropriate level of maintenance.

Illustrated Parts Breakdowns (IPB's) and Time Compliance Technical Orders are provided as supporting data for all weapon system elements at all maintenance levels.

2. GAM-63A MISSILE

All systems maintenance handbooks for the missile, except the Inspection Requirements Handbook and the List of Applicable Publications, have been delivered to the USAF. The remaining two technical orders will be delivered when requested by the Air Force. Illustrated Parts Breakdowns for the missile are scheduled for completion by 30 June 1957.

3. GROUND SUPPORT EQUIPMENT

Delivery of handbooks for ground support equipment is required 30 days prior to delivery of the related equipment. These handbooks are being delivered ahead of schedule.

Illustrated Parts Breakdowns for ground support equipment are scheduled for completion by 30 June 1957.

4. AN/APW-17 DIRECTOR AIRCRAFT GUIDANCE

Maintenance handbooks on the AN/APW-17 Radar Course-Directing Central have been delivered on schedule. All IPB's, except one awaiting vendor data, have been delivered on schedule.

5. OVERHAUL HANDBOOKS

The completion date for overhaul handbooks on the Rascal Weapon System will be determined by AMC with respect to the operational date of the contractor-operated GAM-63A Logistics Depot at Air Force Plant No. 40 (see Appendix I, Facilities).

6. HANDBOOK REVISIONS

A program has been initiated in which handbooks already delivered will be revised to reflect: (1) additional component configurations (dash numbers added to Bell drawings); and (2) changes resulting from handbook/equipment evaluation programs under way at Bell Aircraft facilities.

APPENDIX I
FACILITIES

1. SYNOPSIS

Various facilities are operated by the Bell Aircraft Corporation in developing, manufacturing, and testing the Rascal Weapon System. Principal activities and functions are: research, development, and research flight testing at the Wheatfield Plant near Niagara Falls, New York; rocket engine and GAM-63A systems testing at nearby Air Force Plant No. 38; and final testing of the Rascal Weapon System at Holloman Air Development Center, New Mexico.

2. FACILITIES IN THE NIAGARA FRONTIER

Rascal weapon activities at Bell Aircraft facilities in the Niagara Frontier area include the design, development, fabrication, and testing of:

(1) GAM-63A missiles and missile systems
(2) Equipment for R&D and trainer aircraft
(3) Rascal guidance equipment for operational director aircraft
(4) Ground support equipment
(5) Classroom demonstrators and other training aids

Also among the activities in the Niagara Frontier are the training of Air Force personnel, a GAM-63A training program, and operational weapon support equipment studies.

a. Wheatfield Plant

The Bell Aircraft facility at Wheatfield, New York, Figure 23, is the nerve-center of the System 112A program. This plant, together with other engineering and manufacturing facilities, fulfills the requirements for both developing and producing elements of the GAM-63A Weapon System. The Wheatfield Plant is located adjacent to the Niagara Falls Municipal Airport where extensive development flight testing of electronic systems is conducted. The administrative offices of the Rascal Program, as well as functional laboratories and sections covering the fields of aerodynamics, dynamics, structures, electronics, servomechanisms, and rockets are located here. In support of research and manufacturing activities are additional facilities such as rocket test cells, environmental chambers, vibration equipment, a wind tunnel, analogue computers, and automatic computation equipment. Other supporting activities, such as purchasing, subcontracting, estimating, and accounting, are also situated here.

An Electronic Data Center is being erected west of the Administration Building at the Wheatfield Plant (see Figure 24). The one-story structure,

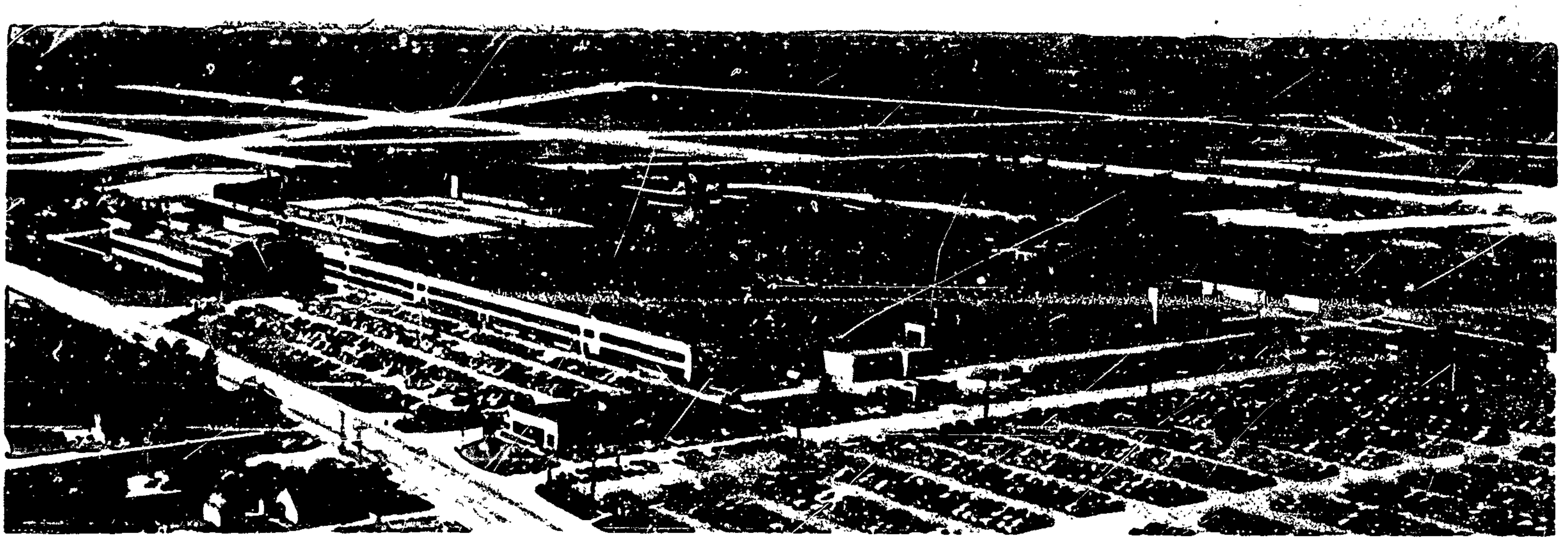


Figure 23. Bell Aircraft Plant at Wheatfield, New York

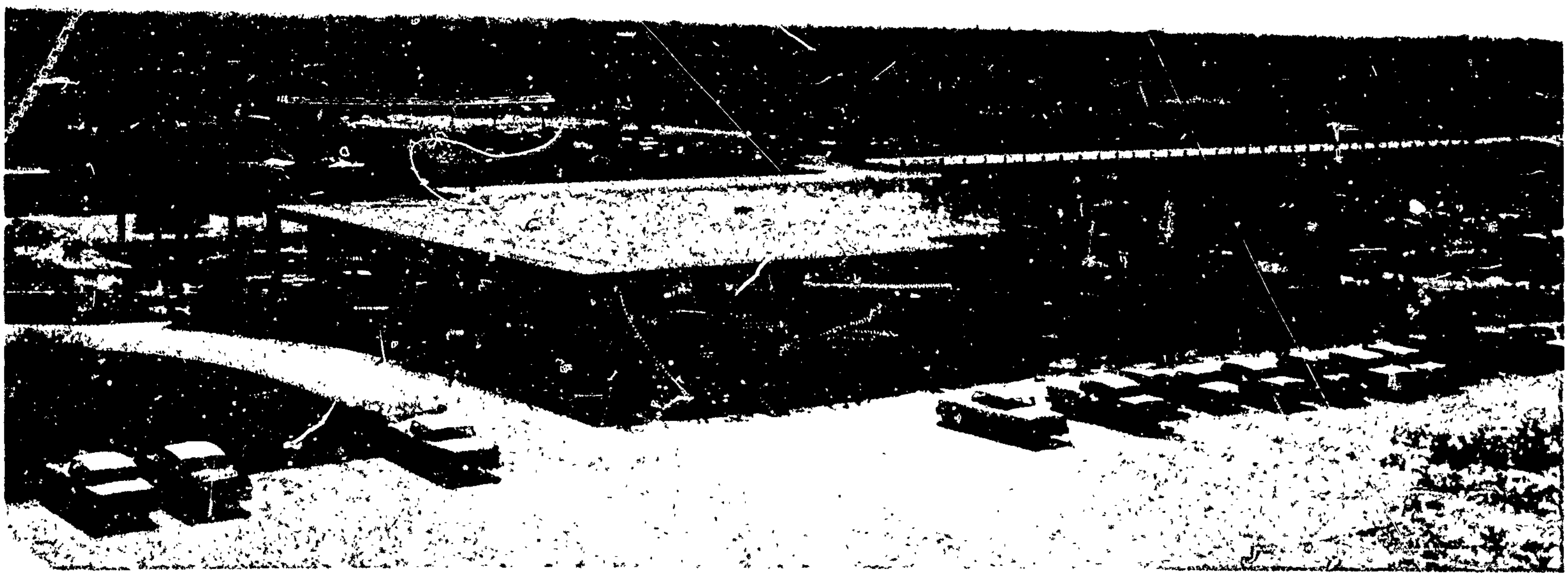


Figure 24. Construction of the Electronic Data Center, Wheatfield, New York

measuring 182 x 170 feet, will house electronic computer and data processing equipment. Late in July 1957, Bell Aircraft's Type 650 magnetic-drum computer will be moved into the Center from the Advanced Analysis Laboratory. As presently planned, the Type 650 computer will be replaced during October 1957 with an IBM Type 704 magnetic-tape computer.

The Electronic Data Center will process problems involving flutter analysis, rocket engine design and combustion analysis, aeroelastic studies, trajectory studies, and reduction of test data from missile flights or wind tunnel testing.

b. Niagara Falls Plant

Located approximately seven miles from Wheatfield, New York, the Niagara Falls Plant is a Bell-leased facility comprising more than 165,000 square feet of floor space. Primarily, this facility is used for the assembly and testing of electronic components and subsystems.

In support of the Rascal reliability effort, a portion of the Niagara Falls Plant is being employed in a debugging program aimed at eliminating marginal parts and assembly discrepancies prior to conducting more extensive environmental and acceptance tests.

c. Air Force Plant No. 38

A major testing facility operated by Bell Aircraft, Air Force Plant No. 38 is situated approximately 12 miles from the main plant at Wheatfield, New York. This area, formerly utilized for the manufacture and storage of TNT during World War II, is a site for testing GAM-63A missiles, rocket propulsion systems, and other components. The plant consists of 68 earth-covered concrete igloos, test cells, offices, railroad sidings, surfaced roadways, power lines, and supporting installations. This facility is used chiefly for the production acceptance-testing of Rascal power plants and for checking the component systems of each GAM-63A prior to shipping the missile to Holloman Air Development Center. Air Force Plant No. 38 is also used as a proving ground for Rascal ground support equipment.

The cafeteria has been moved from the Service Building, north of Balmer Road, into a new area in the Manufacturing Building. During the quarter, additional laboratory space will be provided in the area formerly occupied by the cafeteria. Test equipment has been ordered to increase the scope of activity in the laboratory. This new laboratory area will increase the capability or rate of calibration of pressure transducers and, diminish inaccuracies. The new equipment will include an analogue-to-digital conversion unit for processing the calibration data.

Preliminary tests and installation of test stands are 90% completed in the area designated as E-10 and E-11. Acceptance-testing of Rascal thrust chambers, turbine pumps, and rocket engines will be scheduled into these new test cells during the next quarter. The chassis of the mixture-ratio computer for the new high-speed data-handling system is scheduled for delivery during the next quarter. Delivery of the high-speed flowmeters is about 50% complete.

The temporary installation of the MB Type C-100 Vibrator test assembly has been completed and checkout testing has been initiated. By transferring the vibration testing from the Wheatfield facility to the Manufacturing Building at AF Plant No. 38, testing time between final assembly and final acceptance-testing should be greatly reduced.

d. Air Force Plant No. 40

Following negotiations with Headquarters, Air Materiel Command, Bell Aircraft was granted right-of-entry to a portion of Air Force Plant No. 40 to establish a Logistics (Maintenance and Supply) Depot for the Rascal Weapon System. Located in the Town of Tonawanda, New York, this contractor-operated facility, Figure 25, comprises approximately 56,000 square feet of floor space. The Air Force approved a proposal for rehabilitating and equipping this facility for the storage, maintenance, and distribution of GAM-63A missile components and related equipment. Appropriate areas of the plant have been partitioned and outside fencing has been erected in the interest of military security. Deliverable depot items are being stocked and procurement of facility equipment to operate the depot is well under way.

3. HOLLOMAN AIR DEVELOPMENT CENTER

The final flight testing of GAM-63A's is conducted at the missile test range, Holloman Air Development Center (HADC), New Mexico. Also conducted here are captive flights of missiles; guidance tests and evaluations with DB-36, DB-47, and JF-80 aircraft; and flights to familiarize Air Force personnel with various aspects of the Rascal Weapon System.

Included in the Bell Aircraft facilities at HADC are laboratory, shop, warehouse, and missile assembly and servicing stations (see Figure 26). The flight test program is supported by the HADC range instrumentation which includes Askania cinetheodolite stations, radar tracking stations, a radar network, a telemetering ground station, a mobile telemetering relay station, and motion picture camera installations. Data collected from GAM-63A captive flights and hot firings are reduced and forwarded to the Wheatfield plant so the pertinent information affecting design,

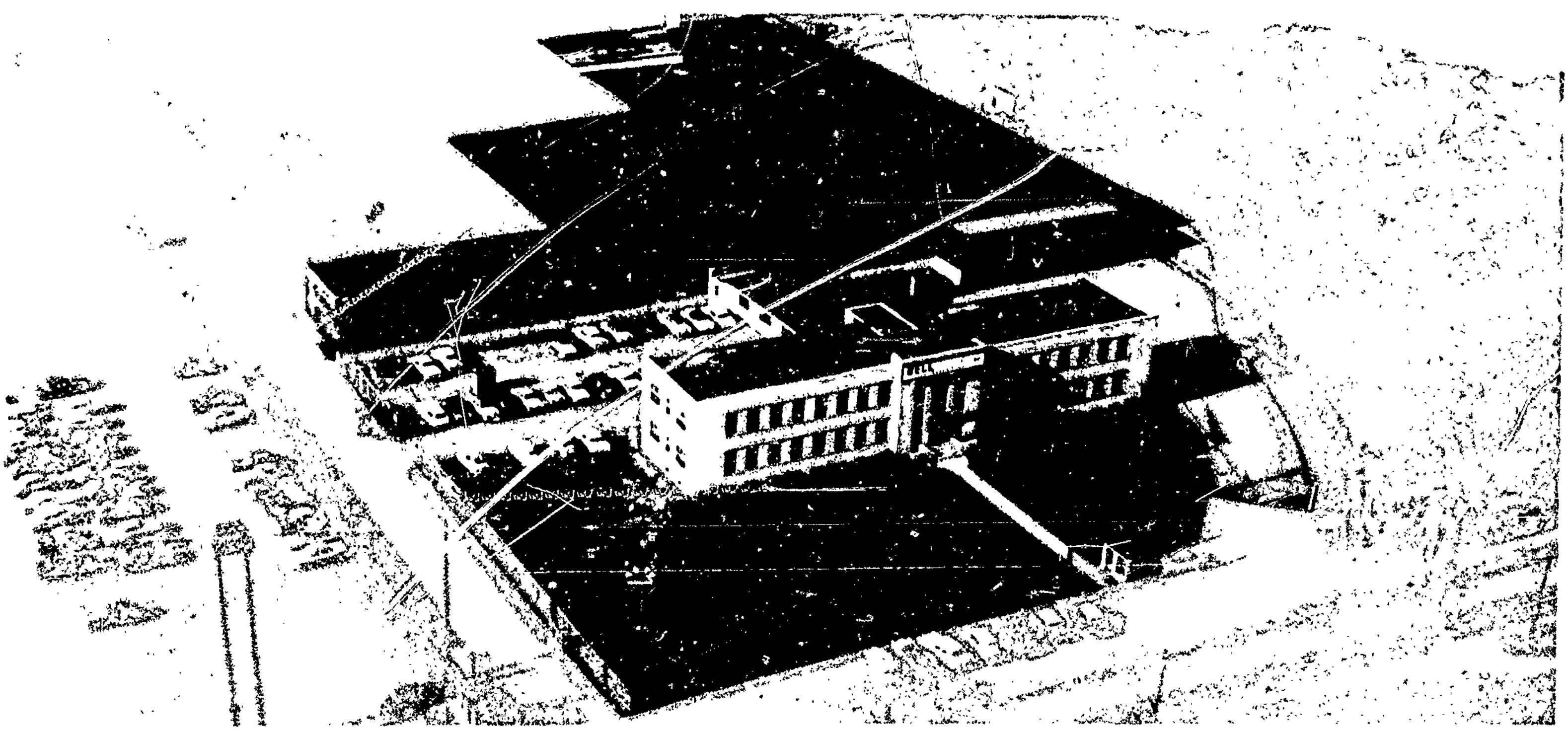


Figure 25. Contractor-Operated Logistics Depot, Air Force Plant No. 40

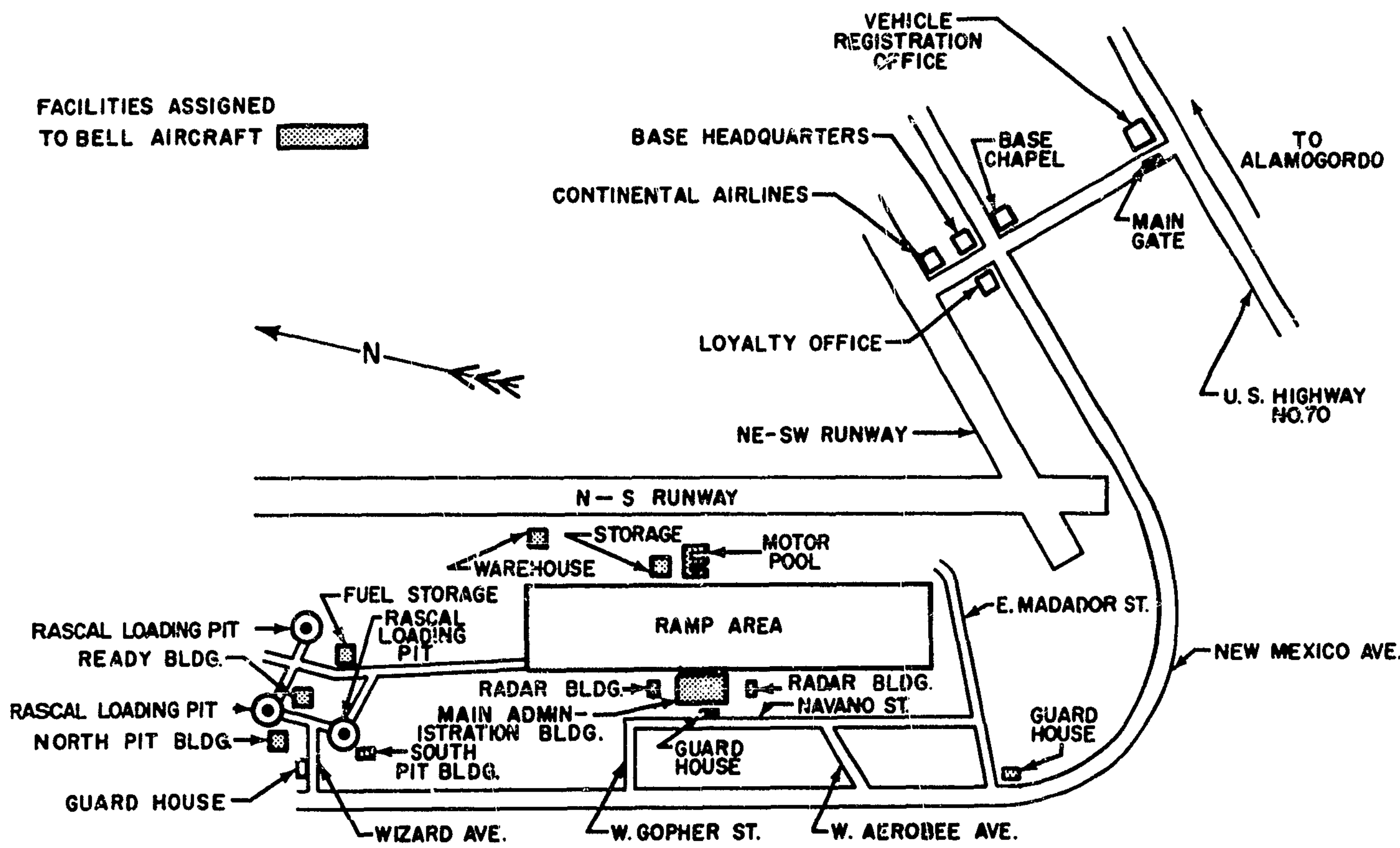


Figure 26. Planview of Installations at Holloman Air Development Center

performance, reliability, and safety of the weapon system may be quickly noted and integrated into the development program.

In the effort to ensure the proper quality and functioning of GAM-63A's, the Quality Control Department maintains 18 missile test stations (positions). Four of these positions, Stations F, G, X, and Y, are located at HADC (see Table I). A new position, Station N, is essentially complete. When fully activated, Station N will accommodate the various subordinate programs under way at HADC.

Station X is being modified to a configuration compatible with Missile No. 87 and subsequent. The relocation of test position Y was completed during this quarter.

APPENDIX II

LIAISON

1. CHRONOLOGICAL LISTING OF TRIPS

Organization Visited	Date	Topics Discussed
Leland Electric Company Dayton, Ohio	2/4	Voltage Regulators, Generators Environmental Testing
ACF Industries Berwick, Pennsylvania	2/5	Missile Handling Carriage
Arnolt Corporation Indianapolis, Indiana	2/5	Flush and Disposal Trailer
WADC Dayton, Ohio	2/7	Ground Support Equipment Specifications
Pentagon Washington, D. C.	2/8	Phoenix Target Acquisition Report
HADC New Mexico	2/11	Profile Mission, Complex Target, Boeing Passive Ferret
HADC and Albuquerque, New Mexico	2/12	Fuzing Symposium, Warhead Interference Tests
ACF Industries Berwick, Pennsylvania	2/17	Missile Handling Carriage
Eglin Air Force Base Valparaiso, Florida	2/18	Calibration/Verification Equipment
HADC New Mexico	2/25	Warhead Interference Tests
HADC New Mexico	3/4	Coordination for CTCI
Purdue University Lafayette, Indiana	3/4	Packaging Institute
Kirtland Air Force Base Albuquerque, New Mexico	3/8	Warhead Engineering Evaluation Test Conference
HADC New Mexico	3/9	Director Aircraft Inspection
WADC Dayton, Ohio	3/12	Radar Target Study Device
WADC Dayton, Ohio	3/13	Testing LR-67-BA-11 Rocket Engine
ARDC Dayton, Ohio	3/14	Institute of the Aeronautical Sciences, Flight Propulsion Meeting
Eglin AFB Valparaiso, Florida	3/15	Ground Support Equipment
IRE Convention New York City	3/18	Aeronautical Electronics, Engineering Management Viewpoints and Techniques

2. SUMMARY OF TRIP REPORTS

a. Wright Air Development Center

(1) Specifications

At a meeting with WADC personnel on 7 February, copies of ground support equipment Specifications 112-947-001, -004, -057, and -069 were presented for discussion and review. These specifications will probably be accepted as submitted while further conference is desirable on Specification 112-947-06C.

(2) LR-67-BA-11 Rocket Engine

Conferences were held on 13 and 18 March to discuss the integration of the Preliminary Flight Rating Test (PFRT) and the Qualification Test of the -11 rocket engine. It was agreed to revise Specification 66-947-403 to state that the PFRT will constitute partial fulfillment of the Qualification Test requirements.

(3) Radar Target Study Device

A conference was held on 12 March to discuss requirements contained in AMC letter of Inquiry, No. 7-28-7093. Bell Aircraft representatives outlined proposal "A" as fulfilling all of the specific requirements of the AMC letter and proposal "B" as a simpler Target Study Device. The WADC Equipment Laboratory recommended that Bell Aircraft rewrite proposal "A" based upon a 100 x 100 nautical mile map, and rewrite Proposal "B" to include motor drives for positioning the map.

b. Holloman Air Development Center

(1) Boeing Passive Ferret Mission

During the week of 11 February, discussions were held concerning the profile Mission, Gravity Bomb Capability Program, Complex Target Acquisition Program, and the Boeing Passive Ferret Mission.

Boeing representatives will work out the intercept geometry and other details so that the mission will not interfere with the Bell Aircraft flight plan.

(2) Fuzing Symposium and Warhead Tests

A fuzing symposium sponsored by the Armed Forces Special Weapons Project was held on 12 through 14 February. The presentations covered past, present, and some future developments in the area of fuzing nuclear warheads.

On 18 February, a meeting was held with personnel from Bell/HADC and Sandia to discuss detail plans for the warhead interference tests.

After the meeting, preparations were made to install the warhead door complete with the warhead and instrumentation into the missile for further tests.

(3) Warhead Interference Tests

The trip on 17 February was to observe and to coordinate warhead interference tests conducted on Missile No. 91 by Bell Aircraft and Sandia Corporation. After the first test, Sandia personnel reported all warhead functions present with no evidence of interference. Results of the second test were also completely satisfactory, and the last two days of the visit were spent in reviewing the telemetering records.

(4) Coordination Trip for CTCI

The purpose of the trip on 4 March was to discuss the facilities, manpower, and equipment available for holding a Contractor Technical Compliance Inspection (CTCI) at HADC.

(5) Airplane Inspection

The purpose of this visit from 17 February to 9 March was to examine the installations and modifications being performed on five director aircraft assigned to the Rascal program.

c. Eglin Air Force Base

(1) During the week of 18 February, a team of Bell Aircraft personnel investigated certain reported calibration equipment problems. It was decided that the new verification/calibration check information for all test equipment would be made available to Eglin AFB in the form of "pink sheet amendments."

(2) B-2 Acid Trailer and Ground Support Equipment

The purpose of the conference of 13 and 14 March was to verify that the B-2 acid trailer is satisfactory and should be procured as a production item. Customer Service is providing action to remedy several ground support equipment problems encountered during this conference.

d. Miscellaneous

(1) Warhead Engineering Evaluation Test (EET) Conference

On 8 March at Kirtland Air Force Base, a conference was held to review the proposed changes resulting from a one-month evaluation of the Warhead EET Program. Bell Aircraft will review all items and resolve a disposition to be reviewed with the WSPO.

(2) Purdue Packaging Institute

The purpose of this course held at Purdue University in March was twofold: to provide packaging personnel with a basic knowledgj of engineering fundamentals as related to packaging; and to introduce new materials and new methods of application of these materials in packaging equipment for protection from corrosion, deterioration and physical damage during shipment, handling, and long-term storage.

APPENDIX III
SUMMARY OF GAM-63A'S- DELIVERY AND DISPOSITION

Bell Serial No.	AMC Delivery Date	R&D Launch No.	R&D Launch Date	R&D Other Used For	R&D Other Date	USAF Serial No.	Other Disposition E&ST	Other Disposition ATC	Other Disposition Rework	Remarks
01	11 Jan 52	-	-	Power Plant Mock-up	11 Jan 52	AF51-17581				
02	11 Jan 52	-	-	Servo/Guid. Mock-up	11 Jan 52	AF51-17582				
03	11 Jan 52	-	-	Drop Test (MUROC)	23 Nov 54	AF51-17583				DB-47 launch mechanism test at AFFTC
04	16 Jul 51	0104	27 Sep 51			AF51-17584				
05	4 Dec 51	0205	18 Dec 51			AF51-17585				
06	25 Nov 52	-	-	Aborted	5 Sep 51	AF51-17586				Accidental drop over N. Y. State
07	5 Sep 52	0307	30 Sept 52			AF51-17587				
08	16 Sep 52	-	-	Mock-up	16 Sep 52	AF51-17588				
09	18 Dec 52	0409	15 Jan 53			AF51-17589				
10	5 Feb 53	0510	13 Mar 53			AF51-17590				
11	18 Dec 53	-	-	Exploded	16 Mar 54	AF51-17591				N_2 tube bundles exploded in loading pit
12	13 Jan 54	0812	12 May 54	Jettisoned	12 May 54	AF51-17592				Faulty turbine operation
13	2 Jun 53	0713	12 Jan 54			AF51-17593				
14	15 Mar 54	0914	22 Jun 54			AF51-17594				
15	8 Sep 53	0615	5 Oct 53			AF51-17595				
16	29 Mar 54	1016	27 Jul 54			AF51-17596				
17	5 May 54	1117	9 Aug 54			AF51-17597				
18	23 Dec 53	-	-			AF51-17598		X		Environmental test at APGC; then to ATC 19 Mar 55
19	16 Jun 54	1319	14 Oct 54			AF51-17599				
20	2 Dec 54	2120	17 Dec 54			AF51-17600				
21	28 Jul 54	1221	8 Oct 54			AF51-17601				
22	4 Aug 54	1522	28 Oct 54			AF51-17602				
23	4 Nov 54	1923	3 Dec 54			AF51-17603				
24	27 Aug 54	1424	22 Oct 54			AF51-17604				
25	12 Nov 54	1825	29 Nov 54			AF51-17605				
26	14 Oct 54	1626	4 Nov 54			AF51-17606				
27	26 Nov 54	2027	8 Dec 54			AF51-17607				
28	18 Oct 54	1728	10 Nov 54			AF51-17608				
29	28 Dec 53	-	-	Test and modification		AF51-17609				Aerojet engine
30	18 Jan 55	2430	12 Feb 55			AF51-17610				
31	19 Nov 54	2231	13 Jan 55			AF51-17611				
32	16 Dec 54	2332	28 Jan 55			AF51-17612				

Bell Serial No.	AMC Delivery Date	R&D Launch No.	R&D Launch Date	R&D Other Used For	R&D Other Date	USAF Serial No.	E&ST	ATC	Rework	Remarks
33	7 Mar 55	2733	29 Mar 55			AF51-17613				
34	11 Feb 55	2634	1 Mar 55			AF51-17614				
35	31 Jan 55	2535	16 Feb 55			AF51-17615				
										Serial Nos. 36 through 45 not used by Bell Aircraft
46	31 Mar 55	-	-			AF51-17616			X	Aerojet engine; rework
47	29 Apr 55	3247	5 Aug 55			AF51-17617				
48	27 Dec 54	-	-			AF51-17618			X	Aerojet engine; rework
49	16 Mar 55	2849	5 May 55			AF51-17619				
50	28 Apr 55	2950	11 Jun 55			AF51-17620				
51	27 Apr 55	3451	30 Aug 55			AF51-17621				
52	27 May 55	3552	2 Sep 55			AF51-17622				
53	26 May 55	3653	29 Sep 55			AF51-17623				
54	31 May 55	3054	14 Jul 55			AF51-17624				
55	23 Jun 55	3155	19 Jul 55			AF51-17625				
56	29 Jun 55	3356	16 Aug 55			AF52-10984				
57	30 Sep 55	-	-			AF52-10985			X	Aerojet engine; rework
58	29 Jun 55	3758	7 Mar 56			AF52-10986				
59	-	-	-			AF53-8194				
60	4 Aug 55	-	-			AF53-8195			X	Aerojet engine; rework
61	8 Sep 55	-	-			AF53-8196			X	Aerojet engine; rework
62	-	-	-			AF53-8197				
63	29 Sep 55	3863	24 Apr 56			AF53-8198				
64	5 Apr 56	3964	3 May 56	Jettisoned	3 May 56	AF53-8199				Smoke and liquids issuing from boattail
65	-	-	-			AF53-8200				
66	-	-	-			AF53-8201				
67	-	-	-			AF53-8202				
68	-	-	-			AF53-8203				
69	-	-	-			AF53-8204				
70	-	-	-			AF53-8205				
71	-	-	-			AF53-8206				
72	-	-	-			AF53-8207				
73	30 Dec 55	-	-			AF53-8208	X			To Eglin AFB on 3 Jan 56 for OJT
74	30 Mar 56	-	-			AF53-8209	X			To Eglin AFB on 1 May 56 for OJT
75	16 Jan 56	4075	11 Jun 56			AF53-8210				First R&D test of Bell turbine pump

Bell Serial No.	AMC Delivery Date	R&D				USAF Serial No.	Other Disposition			
		Launch		Other			E&ST	ATC	Rework	Remarks
		No.	Date	Used For	Date					
76	29 Mar 56	4176	6 Aug 56			AF53-8211				
77	17 Apr 56	4277	11 Sep 56			AF53-8212				Destruct system triggered by unknown outside source few seconds after launch
78	25 May 56	-	-	Test to failure	25 May 56	AF53-8213				Continuing in ground tests to failure
79	22 Jun 56	4379	5 Nov 56			AF53-8214				
80	27 Jun 56	-	-			AF53-8215				On hand for R&D
81	20 Jul 56	4581	7 Jan 57			AF53-8216				
82	8 Aug 56	4482	27 Nov 56			AF53-8217				
83	31 Aug 56	4783	11 Feb 57			AF53-8218				
84	24 Sep 56	4684	16 Jan 57			AF53-8219				
85	13 Nov 56	-	-			AF53-8220				On hand for R&D
86	31 Oct 56	-	-	Test to failure	31 Oct 56	AF53-8221				Continuing in ground test to failure
87	16 Nov 56	-	-			AF53-8222				On hand for R&D
88	27 Dec 56	-	-			AF53-8223				On hand for R&D
89	28 Dec 56	-	-			AF53-8224				On hand for R&D
90	14 Jan 57	-	-			AF53-8225				On hand for R&D
91	22 Oct 56	4891	13 Mar 57			AF53-8226				
92	20 Oct 54	-	-	Static test	20 Oct 54	AF53-8227				
93	4 Feb 57	-	-			AF53-8228				On hand for R&D
94	18 Feb 57	-	-			AF53-8229				On hand for R&D
95	29 Nov 56	-	-			AF53-8230	X			To Eglin AFB on 30 Nov 56 for OJT
96	28 Feb 57	-	-			AF53-8231				On hand for R&D
97	12 Mar 57	-	-			AF53-8232				On hand for R&D
98	28 Mar 57	-	-			AF53-8233				On hand for R&D
99	27 Mar 57	-	-			AF53-8234				On hand for R&D (DEI missile 16-18 Apr 57)

Fiscal Year of Procurement Contract	Quantity Ordered	Not Yet Delivered	Delivered	R&D Launched	R&D Used Other	Delivered to E&ST	Delivered to ATC	On Hand R&D Usable	Delivered Need Rework	
1951	45	0	45		7					Serial Nos. 36 thru 45 deleted and quantity added as Nos. 115 thru 124
				35		0	1	0	2	Rework Nos. 46, 48 (see also Note 4)
1952	3	0	3							
				2	0	0	0	0	1	Rework No. 57
1953	66	35	31							Not yet delivered Nos. 59, 62, 65 thru 72, 100 thru 124 (see Note 3)
				11	3					Test to failure Nos. 78, 86; static test No. 92
						3				To OJT/E&ST program Nos. 73, 74, 95
									2	Rework Nos. 60, 61
								12		On hand for R&D Nos. 80, 85, 87 thru 89, 90, 93, 94, 96 thru 99
1956	22	22	0							
Total	136	57	79	48	10	3	1	12	5	Planning for 57 missiles not yet delivered: 2 for R&D 14 for E&ST launch 41 for Squadron

NOTES

(1) Serial No. 08 (a mock-up) and Serial No. 29 (for test and modification) are shown as expended to "R&D used other"
(2) Bell Aircraft plans to deliver old Serial Nos. 36 thru 45 as new Serial numbers 115 thru 124
(3) Bell Aircraft plans to deliver old Serial Nos. 59, 62, and 65 thru 72 as new Serial Nos. 125 thru 134
(4) SAC has requested Nos. 73 and 74 (after completion of E&ST) in an "as is" condition for SAC/OJT
(5) No 95 could be reworked (after completion of E&ST) for other disposition
(6) Serial Nos. 102 thru 115 are planned for launch in E&ST program
(7) Fiscal year 1957 procurement of 22 missiles will go to squadron; Bell Aircraft plans to deliver as Serial Nos. 201 thru 222
(8) Total missiles for R&D is 72 including Serial No. 08 (also see Note 4)
(9) Total missiles for E&ST is 3 for OJT and 14 for launch

(10) Recap totals:

48	missiles launched in R&D
10	missiles used in R&D other
3	missiles used in E&ST/OJT
1	missile used by ATC
12	missiles on hand for R&D launch
5	missiles delivered to be reworked
79	Subtotal
2	yet to be delivered for R&D
14	yet to be delivered for E&ST launch
41	yet to be delivered for squadron
136	Total

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AERONAUTICAL SYSTEMS CENTER (AFMC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

29 Dec 09

88 CS/SCOKIF (FOIA)
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Defense Technical Information Center
Attn: Ms. Kelly Akers (DTIC-R)
8725 John J. Kingman Rd, Suite 0944
Ft Belvoir VA 22060-6218

Dear Ms. Akers

This concerns the following Technical Report:

Technical Report number: AD131644
Technical Report Title: Quarterly Progress Report
Technical Report Date: 31 Mar 1957
Previous classification/distribution code: UNCLAS

Subsequent to WPAFB FOIA Control Number 2009-03934, the above record has been cleared for public release.

The review was performed by the following Air Force organization: AFRL/RB and 88 ABW/IPI.

Therefore, the above record is now fully releasable to the public. Please let my point of contact know when the record is available to the public. Email: darrin.booher@wpafb.af.mil If you have any questions, my point of contact is Darrin Booher, phone DSN 787-2719.

Sincerely,

KAREN COOK
Freedom of Information Act Manager
Base Information Management Section
Knowledge Operations

3 Attachments
1. FOIA Request # 2009-03934
2. Citation & Cover sheets of Technical Report #AD131644
3. Copy of AFMC Form 559