Air Force Freedom of Information Act

**Report Date** : 01/08/2010

**Time** : 11:42:57 AM

John Greenewald
[redacted]

**Requester Invoice**

| | | |
|---|---|---|
| Request No | : | 2009-03935-F |
| Invoice No | : | 00000023774 |
| Invoice Date | : | 01/08/2010 |
| Requester Name | : | Greenewald, John |
| Requester Organization | : | |

| **Fee Items** | **Amount ($)** |
|---|---|

**Total Amount : ($) 0.00**

**Request Description**

Review DTIC Document AD140034

**Sub Requests**

Default

Make checks payable to:

UNCLASSIFIED

| |
|---|
| AD NUMBER |
| AD140034 |
| CLASSIFICATION CHANGES |
| TO<br><br>unclassified |
| FROM<br><br>confidential |
| AUTHORITY |
| 30 Jun 1969, DoDD 5200.10 |



UNCLASSIFIED

UNCLASSIFIED

| |
|---|
| AD NUMBER |
| AD140034 |
| CLASSIFICATION CHANGES |
| TO<br>confidential |
| FROM<br>secret |
| AUTHORITY |
| 30 Jun 1960, DoDD 5200.10 |

THIS PAGE IS UNCLASSIFIED

[redacted]

UNCLASSIFIED

SYSTEM

# 112A

# QUARTERLY PROGRESS REPORT


**REPORT NO. 56-981-021-49**

**30 JUNE 1957**

UNCLASSIFIED

NOTICE: This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission of this document or the revelation of its contents in any manner to any unauthorized person is prohibited.

This document comprises a title page, frontispiece, pages i through iv, and pages 1 through 56.

[redacted] [redacted] 5711 42205




# QUARTERLY PROGRESS REPORT

REPORT NO. 56-981-021-49

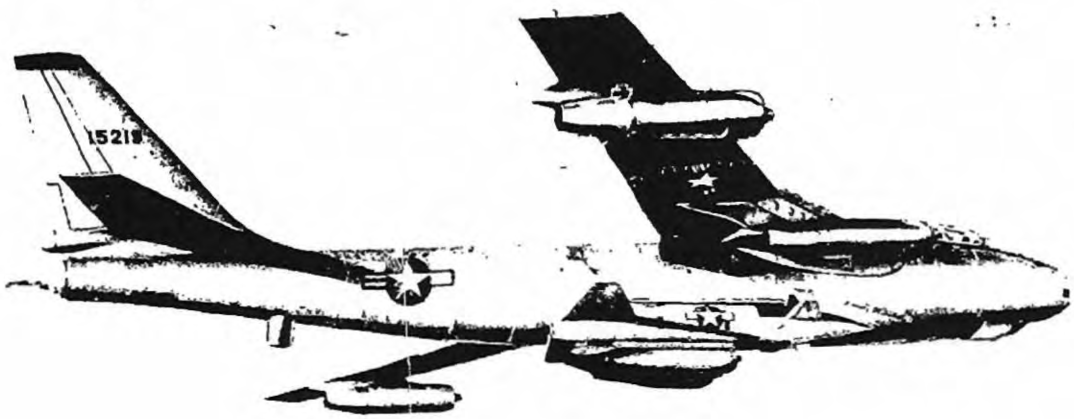


BELL Aircraft CORPORATION

30 JUNE 1957

UNCLASSIFIED

[redacted]




UNCLASSIFIED

UNCLASSIFIED

Report No. 56-981-021-49

BELL

THE ATTACHED DOCUMENT CONTAINS

# SECRET

# INFORMATION

## AND AS SUCH IT MUST BE

RECORDED

STORED

TRANSMITTED

RECEIPTED FOR

UNCLASSIFIED

# SUMMARY

The Bell Aircraft Corporation presents here a brief resume on the status and progress of major elements and efforts on the System 112A Program for the quarter ending 30 June 1957.

FLIGHT TEST PROGRAM . . . at Holloman Air Development Center, six missiles (Nos. 4985, 5087, 5180, and Gravity Bomb Test Vehicles Nos. 0102, 0201, and 0303) were expended during this quarter.

- Gravity Bomb Test Vehicle (GBTV) No. 0102 was released from a DB-47 director aircraft on 5 April 1957 . . . the missile entered a programmed roll and stable trajectory . . . the ailerons were fully deflected about one second after launch and performance was generally satisfactory throughout the drop.
- GAM-63A No. 4985 was released from a DB-47 on 10 April . . . the missile accelerated to a maximum speed of Mach 2.8 and a peak altitude of 63,550 feet, then impacted 1495 feet from the target at +267.5 seconds.
- GBTV No. 0201 was launched on 26 April . . . all systems operated satisfactorily and impact occurred 800 feet from the aimpoint.
- GAM-63A No. 5087 was automatically launched on 14 May . . . the flight progressed satisfactorily until +148 seconds when servo noise and alternator variations increased and the flight became erratic . . . impact occurred 11.8 miles short of the target at +286.2 seconds.
- GBTV No. 0303 was released on 13 June from 40,000 feet at Mach 0.76 . . . as with previous drop tests, both ailerons deflected fully and all systems operated satisfactorily . . . impact occurred within 100 feet of the predicted impact point.
- GAM-63A No. 5180 was automatically launched on 19 June . . . an intentional destruct signal was transmitted by range safety personnel at +17.3 seconds owing to loss of radar tracking at launch . . . flight test data indicated secondary tracking and other missile systems to be operating satisfactorily.

RELIABILITY . . . during the past 16 months, more than 20,000 reliability reports have been recorded on IBM punched cards . . . included are Equipment Discrepancy Reports and Ideas for Improvement . . . . A high level of corrective action is being taken on the 10 most critical Rascal components to produce the most beneficial reliability improvement in the shortest time . . . problems encountered have been of a repetitive nature . . . . Of 89 composite systems tests performed during the factory testing of Missiles Nos. 87, 88, 89, 93, and 94, 49 tests were 100% successful . . . this 55% success rate surpassed the 40% factory goal and improved greatly over the 27% success rate for Missiles 75 through 85 . . . . The 60 composite system tests scheduled as part of the life-testing program for GAM-63A No. 86 have been canceled because more significant data are being provided from a larger number of composite tests being conducted on production missiles . . . . Phase III of the Rascal reliability educational program, directed at all aspects of reliability on a departmental level, is now being prepared.

PROPULSION SYSTEM . . . standard, drilled-aluminum thrust chambers were flame-spray-coated with Michrome and Zirkonia (Rokide "Z") . . . each coating was evaluated by firing the coated chamber on a test stand . . . further evaluation was discontinued in favor of a tungsten-carbide coating previously found superior in performance . . . . Development testing included evaluation of a modified "doublet" injector . . . the modification, consisting of welding closed the "free" oxidizer orifices in the inner oxidizer row, resulted in a 3% increase in performance and a nearly constant combustion efficiency over the required temperature range . . . . A test program was conducted on gas generators for the LR-67-BA-9 rocket engine to determine firing capabilities at the most critical limits of drawing requirements when fired at -33°F with IRFNA containing 3% water . . . new distribution limits were established from test data and successful operation resulted from the fuel primary orificed for 21% distribution and IRFNA containing approximately 3.2% water at an over-all mixture ratio of 0.67.

GUIDANCE SYSTEM . . . addition of filters in the radar set has largely eliminated crystal burnouts . . . . Redesign of the search antenna feed has resulted in an improved pressure differential of 20 psi at 170°F for 100 pressure cycles . . . . Work on the low-power antijam radar set has been discontinued in accordance with USAF directives . . . . Several vendor-supplied d-c filament supplies were evaluated for reliability . . . all have failed to qualify; an approved Bell design will be used.

GROUND SUPPORT EQUIPMENT . . . engineering efforts were centered on liaison, evaluation, and testing of operational ground support equipment . . . . Liaison units have been set up to assist outside manufacturers of operational ground support items . . . . Project personnel are providing technical assistance at Eglin AFB in the E&ST Program and at HADC in the Evaluation Program for ground support equipment . . . . Design of the Tri-Liquid Flush Unit was completed during this quarter . . . . Fabrication of a test article Warhead Pan Stand is under way and the unit will be available for evaluation early in July . . . . Design of the R&D Rocket Engine Analyzer (Dwg. No. 112-809-822-1) was completed and the drawings were released to Manufacturing . . . fabrication of a prototype unit is well under way . . . . The first production article of the operational Flush and Disposal Trailer (Dwg. No. 112-789-541-1) was received from the Arnolt Corporation . . . final acceptance-testing will be conducted at AF Plant No. 38 during the next quarter . . . . Fabrication of the operational Transport and Handling Carriage (Dwg. No. 112-782-101-1), Serial No. 2, was completed at Bell Aircraft . . . the unit was delivered to the USAF for use in the CTCI Program scheduled for August 1957 at HADC . . . . Design of the operational Liquid Feed Regulator Tester (Dwg. No. 112-809-603-3) was completed and the drawings were released to Manufacturing.

TRAINING EQUIPMENT . . . fabrication of the 25 units comprising the missile and director aircraft portions of the Mobile Training Unit is well under way . . . . The Radar Simulator, a unit of the Rascal Guidance Operator Trainer (RGOT), is now equipped with a new light source and new optics to provide improved light transmission efficiency . . . . The Guidance Operator's Station and the Instructor's Console of the RGOT duplicate the production version of the DB-47 aircraft and include the latest weapon system changes . . . . Five weeks of intensive training on the RGOT was conducted during this quarter for five Bell Aircraft/HADC guidance operators . . . . The RGOT Target Acquisition Report was completed . . . also, a report entitled "Simulator Map-Making for the Rascal Guidance Operator Trainer" was completed.

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 112 A 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. 2849, was launched from a DB-36 R&D director airplane. This missile included inertial guidance and a sim-

*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.

ulated 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 was established to determine by test those components that require change to provide an overall 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.

During the second quarter of 1957, GAM-63A's Nos. 4985, 5087, and 5180, as well as Gravity Bomb Test Vehicles Nos. 0102, 0201, and 0303, were launched in the R&D flight test program at Holloman Air Development Center, New Mexico. Detailed flight test results are presented in Section II, B.

## B. Weapon System Description

The mission of the Rascal Weapon System is to carry out air-to-surface bombardment of strategic targets without exposing the director aircraft to local target defenses. This mission is accomplished by combining a high-performance DB-47 bomber with a supersonic Rascal guided aircraft missile.

Basically, the weapon system consists of four elements: a GAM-63A missile, a DB-47 director aircraft, ground support equipment, and training aids.

### 1. GAM-63A missile

The GAM-63A missile element of the Rascal Weapon System includes six major subsystems. These are the airframe, propulsion system, guidance system, control system, warhead and fuzing system, and instrumentation system.

#### A. AIRFRAME

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 of 18,500 pounds. Structurally, the airframe consists of five sections: the radome, forward body, warhead section, center tank section, and aft body.

The radome, a laminated ogive, encloses the search radar antenna and is attached to the forward body by a splice ring. The forward body section includes the rudders, 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 which is a removable structural door to facilitate installation of the warhead. An access door is located at the right side of the GAM-63A to permit arming the warhead when the missile is mated to the DB-47.

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, and 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 aircraft by means of shackel-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. PROPULSION SYSTEM

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 thrust chambers that develop 12,000 pounds thrust at an altitude of 40,000 feet. The liquid propellants, inhibited white fuming nitric acid and JP-4 fuel, are pumped to the thrust chambers by a gas-driven turbine pump which also furnishes auxiliary power to drive the hydraulic pump and alternator

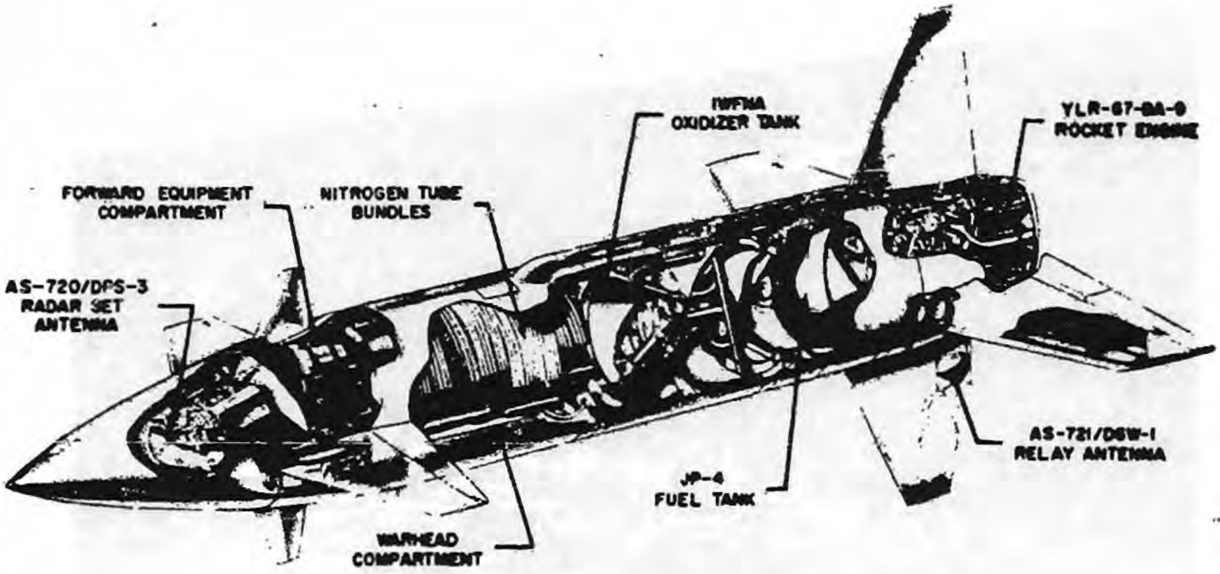



Figure 1. Cut-Away of Rascal Missile

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 pump propellants back to the tanks. Thus, the turbine pump continues to furnish the required electric and hydraulic power during period when thrust chamber operation is not required.

C. GUIDANCE SYSTFM

The Rascal guidance system combines an inertial range-computing system with a radar-relay command override. The inertial system directs the missile from the point of launch through initiation of the terminal dive. During terminal dive, a transmitter in the missile relays to the director aircraft a radar picture of the target area. This target video enables a trained guidance operator to send command signals to the missile with increasing precision as the target is approached, thus ensuring a high degree of accuracy.

In essence, the system operates as follows: The DB-47 carrying the GAM-63A is navigated to the launch area by means of its MA-8 bombing-navigation equipment. Immediately prior to launch, director aircraft velocity, range-to-target, and heading are supplied to the missile's inertial system. The GAM-63A is launched automatically after a functional checkout proves satisfactory. During the midcourse phase of flight, the missile is normally controlled by its inertial range-computing system, operating in conjunction with a directional gyro and an altimeter for control in azimuth and altitude, respectively.

Should the guidance operator desire to observe the progress of the missile prior to the terminal dive, a command can be transmitted to energize the search radar set in the GAM-63A. Then, the area ahead of the missile is scanned over a 150° sector by this search radar, and the video return information is transmitted by means of a microwave relay link to the DB-47. Here, the information is transmitted by means of a microwave relay link to the DB-47. Here, the information is displayed on a radar indicator. Should the guidance operator conclude from observing the indicator that the missile is not on the correct course to the target, commands can be initiated to override the directional gyro control of the GAM-63A. The operator can also remotely control the initiation of dive. Should the operator decide only to monitor the progress of the missile, the inertial guidance system retains control and, at a predetermined range from the target, initiates a nominal 35° terminal dive.

During the terminal dive phase of the flight, the operator in the director aircraft accomplishes

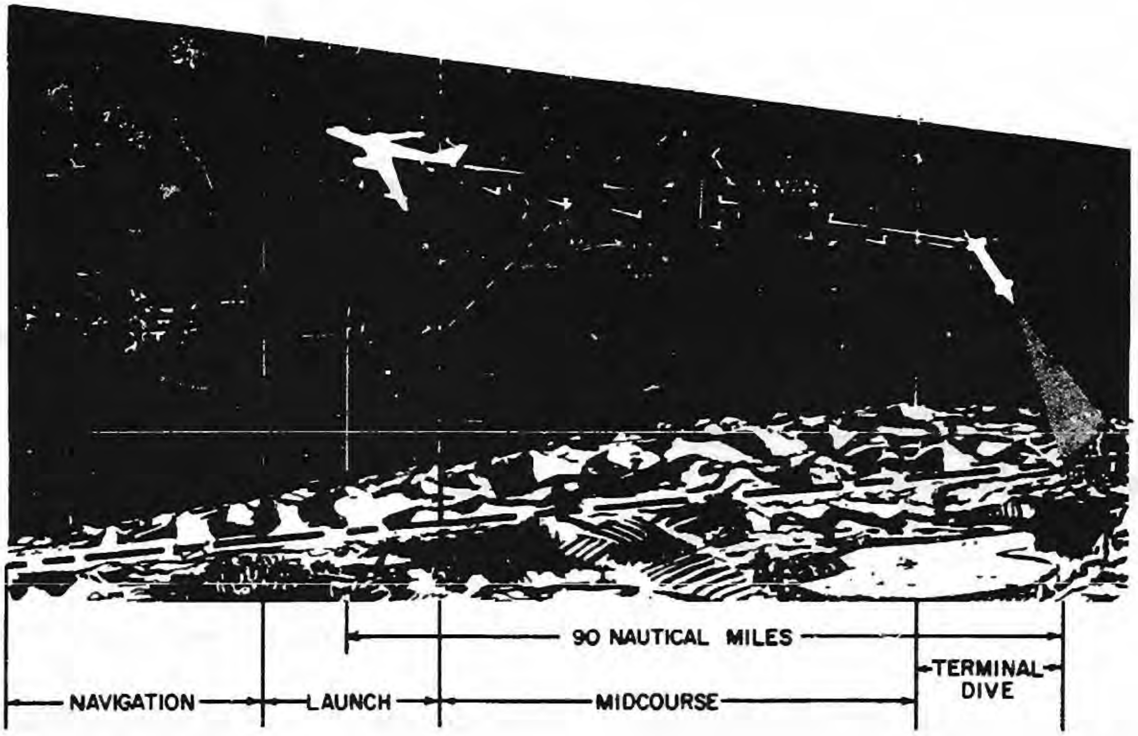



Figure 2. System 112A Guidance Scheme

guidance by means of tracking stick that positions range and azimuth cursors over the target radar return on the indicator. The displacement of the tracking stick determines the guidance command signals that are automatically computed, coded, and transmitted to the missile.

D. CONTROL SYSTEM

The primary function of the control system is to stabilize and control the missile with respect to gyroscopic references. The principal system is the autopilot which stabilizes the missile in roll, pitch, and yaw. Servos are also used (1) to pitch-stabilize the search radar antenna and to rotate it at a constant speed in space, (2) to orient the major lobe of the relay antenna toward the director aircraft, and (3) to stabilize the inertial platform about the pitch axis. Provisions are made for accepting pitch and yaw guidance signals which direct the missile to its target, and also for accepting command signals which change the position of the relay antenna in pitch.

The inertial range-computing system measures range in a horizontal plane in the direction of the longitudinal axis of the missile. It initiates the terminal dive at a preset range-to-go. This system can provide an "area" strike in the event of a malfunction of the emanating terminal guidance.

E. WARHEAD AND FUZING SYSTEMS

The GAM-63A is designed to accommodate a 2800-pound special warhead. The warhead is located within the airframe aft of the forward wing.

The fuzing system that arms and detonates the warhead consists of arming and firing baroswitches, an arming solenoid, and a network of impact crystals. Contrast circuitry to the director aircraft enables the guidance operator to select remotely the detonation altitude and burst mode during the prelaunch phase, as well as to perform the required arming functions. A warning light is also provided as a means of indicating warhead malfunctions.

F. INSTRUMENTATION SYSTEM

Two types of telemetering systems are used in the Rascal program. Type I transmits quantitative information for R&D tests. Type II transmits qualitative data for R&D and E&ST missiles. Missile No. 97 uses both the Types I and II telemetering systems.

1. Type I Telemetering System

The Type I telemetering system uses two r-f carriers in the 215 to 235-mc band. Each carrier is capable of modulation by a number of FM subcarriers. A maximum of 10 subcarriers may be used. Commutation of two or more subcarriers on each r-f carrier provides sampling of 27 functions. However, on Missile No. 97, only three subcarriers for each r-f carrier are used to transmit 18 functions of vibration data.

The subcarriers normally used are of the TOE or voltage-actuated type. This permits the use of standard potentiometer-type transducers for measurement of propellant pressures and hydraulic system pressures. Potentiometer-type acceleration transducers and rate gyros are used where required. Missile attitudes are telemetered by sampling the output of gyros with the necessary demodulation, amplification, and rectification.

Transducers are used for samplign a-c voltages and frequencies, crystal currents, valve currents, and guidance system outputs. Certain installations will incorporate strain-gage pickups for torque and stress measurements. Modulation of the subcarriers is through amplifier and rectifier assemblies.

Altitude values are transmitted through subcarrier channels consisting of vibration amplifier-gage combinations.

2. Type II Telemetering System

The Type II telemetering system is designed to transmit qualitative data on system functions in the R&D and E&ST missiles. This system will normally involve one r-f carrier in the 215 to 235-mc band, modulated by a maximum of four subcarriers. One subcarrier is used for the transmission of accurate altitude data. Two channels are continuous for use of functions requiring careful monitoring. The fourth channel is commutated to provide a maximum of 27 one-cps response channels. The transmitter of the Type II system is of an improved design capable of direct modulation by the impact-measuring and baro-switch transducers. Recognition of signals of 10 microseconds duration is possible.

The Type II system can use either of two power sources: a battery-type supply or a regulated power supply with input from the missile's 467-cps 115-volt source.

3. Beacon and Destruct Equipment

The L-band and S-band beacon equipment in the missile provides a ground-tracking capability to permit maintaining cognizance of the missile's location any time. A destruct capability built into the missile permits sending a destruct signal either from a ground station or from the DB-47.

## 2. director and ferrying aircraft

The director aircraft that form an integral part of the Rascal Weapon System are converted B-47 strategic bombardment aircraft, redesignated as DB-47. These director aircraft are modified to carry the GAM-63A to a predetermined launch point, to check out the GAM-63A prior to launch, to launch the missile, and to provide guidance control of the missile after launch.

The DB-47 carries the GAM-63A on a strut protruding from the right side of the DB-47 fuselage. The missile is mounted so that the angle of yaw is zero, the angle of pitch is 2-1/2° nose down from the DB-47 fuselage centerline, and the angle of roll is 13°.

The DB-47 airplane is equipped with an AN/APW-17 Radar Course-Directing Central which permits course corrections to be transmitted to the GAM-63A after launch. The AN/APW-17 system operates in conjunction with the MA-8 bombing-navigation system through the ME-6 adapter equipment. The MA-8 system provides the GAM-63A with initial conditions before launch. Components of the AN/APW-17 are installed in three locations in the DB-47 airplane. The control panels and indicators are located in the navigator's compartment in the nose of the airplane. The computers and amplifiers are located within a capsule in the bomb bay. The command transmitter and video receiver are located in the aft fuselage with the retractable relay antenna.

During the R&D flight test program at HADC, two YDB-47E's are being utilized as director aircraft. The "Y" signifies that these are the first two

B-47E's having AN/APW-17 guidance system installed.

Two ferry airplanes, JB-50D Nos. 48-069 and 48-126, are equipped with GAM-63A support fittings and bomb-bay cargo platforms. These aircraft will continue to be operated from the Wheatfield plant to deliver Rascal missiles and related equipment to the various test installations.

### 3. ground support equipment

The ground support equipment for System 112A encompasses all equipment which is not an integral part of the missile or director aircraft, but which is required to service, repair, test, and prepare the weapon for launching. Support equipment includes handling and transport devices, assembly stands and slings, special loading and fuel units, checkout units, special tools, and test equipment. A detailed list of equipment is presented in Bell Aircraft report, "GAM-63 Ground Support Equipment Subcommittee Listing," which is revised as necessary each 60 days, by mutual agreement of the WSPO and Bell Aircraft. Copies of this report with revisions have been forwarded to Air Force agencies.

### 4. training equipment

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.

The Mobile Training Unit (MTU), consisting of constituent systems of the GAM-63A and DB-47 director aircraft, and their checkout and test equipment, will be used for training Air Force maintenance personnel.

The Rascal Guidance Operator Trainer (RGOT), which includes the guidance operator's equipment in the director aircraft and an instructor's console, facilitates training Air Force personnel by introducing various tracking and flight problems during the ground training programs.

## C. Weapon System Requirements

An outline of the requirements for an air-to-surface weapon system comprising a supersonic missile, a director aircraft, and supporting equipment is contained in Air Force letter WCSGA/HDH/nrw, dated 4 March 1952, "Reorientation of Project MX-776, Contract W33-038ac-14169."

A WADC letter dated 19 November 1953 established a 90-nautical-mile range requirement for the Rascal missile. Bell Aircraft Corporation, as the prime Weapon System Contractor, is continuing to conduct a program for the development of the System 112A as defined by the following Military Characteristics:

(1) Airburst Accuracy

At a missile range of 75 nautical miles, a horizontal circular probable error (CEP) not greater than 1500 feet and, excluding errors in weather prediction and target intelligence, a vertical standard deviation not greater than 405 feet, under the following conditions:

- (a) Minimum launch altitude - 40,000 feet MSL
- (b) Minimum launch velocity - Mach 0.78
- (c) Zero wind and standard atmosphere as defined in NACA Report TN-3182
- (d) Flight termination - supersonic speed at 5000 feet MSL

(2) Maximum Range (Missile)

Not less than 90 nautical miles under the following conditions:

- (a) Launch altitude - 40,000 feet MSL
- (b) Launch velocity - Mach 0.78
- (c) Zero wind and standard atmosphere as defined in NACA Report TN-3182
- (d) Flight termination - supersonic speed at 5000 feet MSL
- (e) Maneuvers - no correction to the flight path
- (f) General - on all parameters affecting missile range, the average of the specification values, where applicable, are assumed

(3) Warhead Fuzing

The warhead and fuzing characteristics shall be as defined in Bell Aircraft Corporation Report 56-989-053, dated 14 October 1953, and Report 66-945-001, dated 17 February 1956.

(4) Guidance

The guidance system shall consist of an inertial range-computing system and an emanating system for control of the missile by a guidance operator during the terminal dive phase.

(a) Terminal dive phase is defined as that portion of the flight after dive initiation.
(b) Emanating guidance may be operative during that portion of the flight when the aimpoint is within radar range.

(5) Shipping

The missile and all associated equipment shall be capable of withstanding shipment completely assembled or in major components by conventional vehicles used for air, water, rail, and highway transportation with consideration being given to simplicity of packaging and economies of shipment. Consideration shall be given to any special problems associated with storage and/or shipment or weapon subcomponents or parts by air, water, rail, or highway.

(6) Readiness

Preflight preparation shall consist of ground checks of elements of the weapon system by means of mobile (air-transportable) test and checkout units, and ground handling and propellant servicing units. This will include GAM-63A deservicing and decontamination units. Inflight prelaunch adjustments shall be brief, simple, and positive.

(7) Training Aids

Training aids such as classroom demonstrators, a mobile training unit, and an operational procedure trainer required for individual and unit training will be developed and designed for training Air Force maintenance and operations personnel, and will be


Figure 3. The GAM-63A Missile

properly time-phased with other elements of the Rascal Weapon System.

(8) Support Equipment

The development and design of suitable ground handling, test and checkout, servicing, and other equipment required for storage, transport, checkout, maintenance and operational use will be properly time-phased with other elements of the Rascal Weapon System.

(9) Director Aircraft and Director Aircraft Guidance Systems

Guidance systems will be produced for the director aircraft used in launching the GAM-63A. Coordination efforts shall be established with airframe manufacturers producing the director aircraft.

# SECTION II

# RESEARCH AND DEVELOPMENT PROGRAM

## A. Ground Test Program

Presented here is the progress being made in systems testing of the various elements of the Rascal weapon at facilities in the Niagara Frontier area.

1. MISSILE TEST EQUIPMENT

Bell Aircraft maintains 18 stations for performing tests necessary to ensure continuing quality and proper functioning of GAM-63A's. These stations are capable of complete testing of missile emanating guidance, nonemanating guidance, fuzing, telemetering, and beacon systems, as well as portions of the propulsion system. Modifications to test equipment owing to changes in missile configuration and to improvements found through operating experience are being incorporated to ensure weapon system compatibility and test equipment reliability.

Design effort is continuing toward minimizing the complexity of test equipment necessary to perform a smoothly coordinated missile test countdown. Examples of such design work are the radio repeater test set and the radar test set. A mockup of the radio repeater test set, tested in Station M in conjunction with Missile No. 102, has proved satisfactory. This test unit, when completed, will replace the X-band signal generator and polycode driver employed in missile tests. A mockup of the radar test set, presently being fabricated, is designed to replace an X-band signal generator, a video simulator, and a pulse power amplifier.

A list of quality control test stations, their location, missile effectivity and test capabilities is presented in Table I.

Two test stations (Station M and the R&D Checkout Trailer) are maintained at the Wheatfield facility to evaluate engineering changes and development problems which effect GAM-63A system testing. Preliminary layout and equipment design necessary for the R&D Checkout Trailer to support altitude tests on GAM No. 78 are in progress. The altitude tests are scheduled to begin on 12 August 1957.

A listing of R&D test stations, their location, missile effectivity, and test capabilities is presented in Table II.

2. MISSILE TESTING

a. GAM's Nos. 78 and 86

Missiles 78 and 86 are being held in a standby status. Inspections were performed supporting the life test program on GAM No. 86 at

TABLE I

QUALITY CONTROL TEST STATIONS

| Station | Location | Missile Effectivity | Test Capabilities |
|---|---|---|---|
| A-1 | Wheatfield | 93 & subq | Subsystems and composite systems |
| A-2 | Wheatfield | 93 & subq | Subsystems and composite systems |
| B-1 | Wheatfield | 93 & subq | Emanating and nonemanating guidance systems |
| B-2 | Wheatfield | 93 & subq | Emanating and nonemanating guidance systems |
| C-1 | Wheatfield | 93 & subq | Nonemanating guidance, telemetering, and fuzing systems |
| C-2 | Wheatfield | 93 & subq | Nonemanating guidance, telemetering, and fuzing systems |
| D-1 | Wheatfield | 93 & subq | Nonemanating guidance system |
| D-2 | Wheatfield | 93 & subq | Nonemanating guidance system |
| P-1 | Wheatfield | 87 & subq | Pressure testing of GAM-63A |
| P-2 | Wheatfield | 87 & subq | Pressure testing of GAM-63A |
| E-8E | AF Plant 38 | 93 & subq | Static hot firings and composite systems |
| E-8W | AF Plant 38 | 93 & subq | Static hot firings and composite systems |
| E-9E | AF Plant 38 | 93 & subq | Static hot firings and composite systems |
| E-9W | AF Plant 38 | 93 & subq | Static hot firings and composite systems |
| F | HADC | 93 & subq | Composite systems |
| G | HADC | * | Composite systems |
| X | HADC | 93 & subq | Composite systems (portable) |
| Y | HADC | 73 & subq | Composite systems (portable) |

*Being modified to configuration of Missile No. 87 through 93.

TABLE II

R&D TEST STATIONS

| Station | Location | Missile Effectivity | Test Capabilities |
|---|---|---|---|
| M | Wheatfield | 93 & subq | Subsystems and composite systems |
| R&D Mobile Checkout Unit* | Wheatfield | 73 & subq | Subsystems and composite systems |

* Being modified for altitude tests on Missile No. 78.

Station M. Changes performed on the missile were logged and inspection records kept up to date. GAM No. 86 was placed in storage on 17 June 1957.

b. GAM No. 88

The final two consecutively successful composite tests were completed on 29 April 1957. Following surveillance tests, GAM No. 88 was returned to the Wheatfield plant on 7 May. After final preparations, the missile was ferried to HADC on 21 May.

c. GAM No. 89

Fifteen composite systems tests were completed on GAM No. 89 as of 29 March; the final two tests being successful. A surveillance test was also completed. Normal inspection operations were performed during testing in Stations A-1 and P. Hardware inspection was completed on 19 April and the missile was flown to HADC on 26 April.

d. GAM No. 90

Thirteen of the required 15 composite systems tests were completed as of 2 April 1957. Replacement of limited life items was then conducted, after which the final two composite systems tests were run. Following pressure checks at Station P, final clean-up was performed and GAM No. 90 was flown to HADC on 6 June.

e. GAM No. 93

The required 15 composite systems tests were completed as of 17 May 1957, and the missile was prepared for shipment to the Wheatfield plant. Hardware was accepted by the Air Force on 22 May, final inspection was performed, and the missile was flown to HADC on 27 May. A test magnetron was installed in missile at the time of flyaway; the flight magnetron was shipped on the ferry aircraft.

f. GAM No. 94

The 15 composite systems tests required for No. 94 by the Rascal Reliability Program were completed as of 1 May 1957. Following replacement of limited life items, a surveillance test was conducted successfully and the missile was returned to the Wheatfield plant. Hardware was accepted by the Air Force on 23 May, final inspection was performed, and the missile was flown to HADC on 28 May.

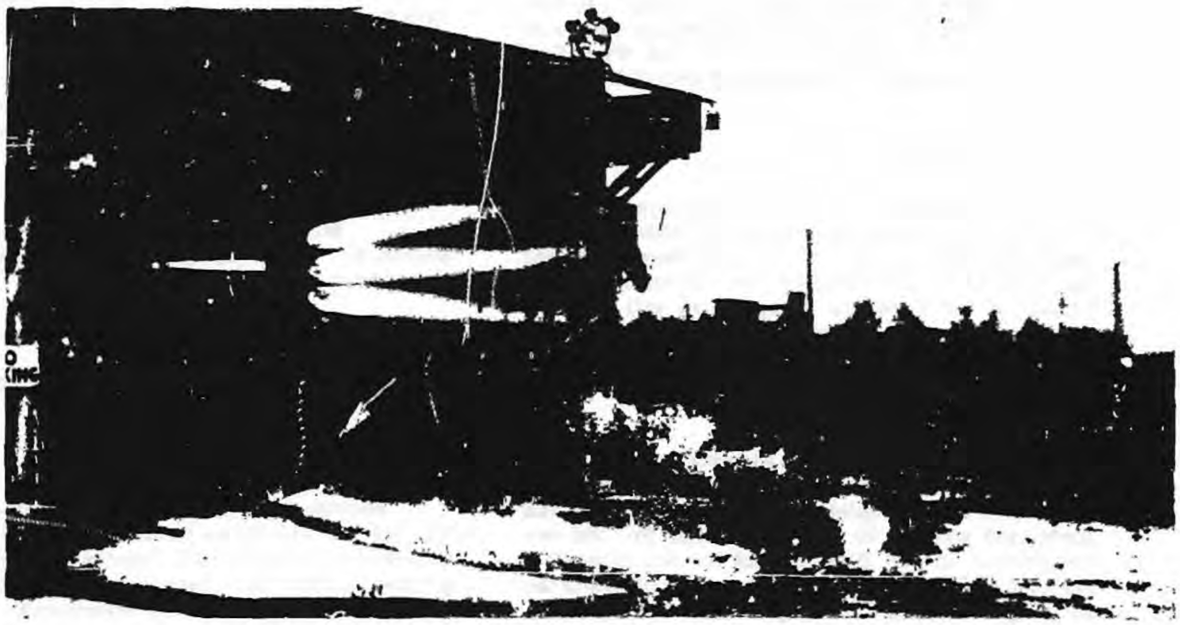


Figure 4. Firing the GAM-63A Rocket Engine at AF Plant No. 38

g. GAM No. 96

Subsystem testing of GAM No. 96 was completed after which 15 composite systems tests were performed. Included in the 15 tests were two composite tests with propulsion. The first firing was shut down owing to an engine malfunction. The second firing, conducted to completion, was unsuccessful owing to several problems that are under investigation. Following corrective action, a penalty firing will be conducted early in the next quarter.

h. GAM No. 97

The 15 composite systems tests on GAM No. 97 were completed; the final two consecutive successful tests were conducted on 10 May 1957. Final inspection was then performed and the missile was flown to HADC on 18 June.

i. GAM No. 98

Fifteen composite systems tests were conducted on GAM No. 98, with the final two tests completed on 10 May 1957. Upon completion of these tests, No. 98 was transferred to AF Plant No. 38 for a composite systems test with propulsion. This test was performed on 13 June, after which two successful composite tests without propulsion were run. The missile was then returned to the Wheatfield plant and is scheduled for flyaway to HADC early in July.

j. GAM No. 99

Telemetry tests were completed and GAM No. 99 was moved to Station A-1 to conduct 15 composite systems tests. The 15 tests were completed as of 25 June. The missile was then transferred to Station P for pressure tests; testing will be completed in the next quarter. It is planned to use this missile for a typical SAC profile mission.

k. GAM No. 100

Servo, telemetry, and guidance testing were completed and 13 of the required 15 composite systems tests have been completed. Clean-up inspection was performed and, on 20 June 1957, GAM No. 100 was transferred to AF Plant No. 38 for one composite systems test with propulsion and the completion of the 15 composite tests. Testing is scheduled for completion in the next quarter. It is planned to modify the rocket engine in this missile to use IRFNA (inhibited red fuming nitric acid) as the oxidizer instead of inhibited white fuming nitric acid.

l. GAM No. 101

All subsystem testing has been completed and 15 composite systems tests have been performed. Surveillance tests are being conducted, after which the missile will be moved to Station P. Plans are being made for modifying the rocket engine to use IRFNA as the oxidizer.

m. GAM No. 102

Station D hydraulic tests and a portion of Station C tests were completed on GAM No. 102. Missile No. 102 was then moved to Station M, all subsystem testing was completed, and 10 composite systems tests were performed. The missile was then connected to the GAM checkout trailer for compatibility checks. The compatibility checks were completed on 28 June, and the missile was returned to Station M for the completion of the 15 composite systems tests. This is the first missile of 20 allocated to the SAC/APGC Employment and Suitability Testing (E&ST) Program planned at Eglin AFB.

n. GAM No. 103

Missile No. 103 is positioned in Station B where 10% of the required composite systems tests have been completed.

o. GAM No. 104

GAM No. 104 is positioned in Station A were servo and telemetry tests are under way.

p. GAM's Nos. 105 and 106

Missiles 105 and 106 are positioned in Station D. No tests have been conducted owing to parts shortages.

q. GAM No. 107

Missile 107 is undergoing pressure checks at Station P.

3. GROUND SUPPORT EQUIPMENT

Engineering work on the range calibrator (Dwg. No. 112-542-110-7) has been completed satisfactorily. In addition to the design changes previously incorporated, blowers have been added to permit operation at high temperatures with no objectionable code shift.

The following major items of ground support equipment were quality-tested satisfactorily during this quarter:

Hydraulic Test Stand, Dwg. No. 112-542-027-1 (Serial No. 7)

Filtering and Handling Stand, Dwg. No. 112-542-285-1 (1 unit)

Type D5A Hydraulic Test Stand (3 units)

Type B-8 Metallic Rectifiers (10 units)

The following major units of ground support equipment are in test:

GAM-63A Checkout Trailer, Dwg. No. 56-542-310-7 (Serial No. 4)

DB-47 Checkout Trailer, Dwg. No. 112-795-001-7 (Serial Nos. 5 and 6)

DB-47 Checkout Trailer, Dwg. No. 112-795-001-9 (Serial Nos. 7 and 10)

4. DIRECTOR AIRCRAFT EQUIPMENT

Preproduction systems testing of the AN/APW-17 Radar Course—Directing Central has been completed. Approximately 95% of the test reports have been submitted to the WSPO.

## B. Flight Test Program

1. SYNOPSIS

Fifty-one Rascal missiles have been launched in the R&D 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 24 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, three GAM-63A's (Nos. 4985, 5087, and 5180) and three gravity bomb test vehicles (Nos. 0102, 0201, and 0303) 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. 88, 89, 90, 93, 94, and 97.

3. FLIGHT TEST REPORTS

Data reduction reports were issued during this quarter for the final flights of the following missiles and gravity bomb test vehicles:

| Missile No. | Date of Flight | Director Aircraft No. | Report No. |
|---|---|---|---|
| 4891 | 3/13/57 | 51-5220 | 56-980-245 |
| 4985 | 4/10/57 | 51-5220 | 56-980-247 |
| 5087 | 5/14/57 | 51-5220 | 56-980-249 |
| 5180 | 6/19/57 | 51-5220 | 56-980-251 |
| Gravity Bomb No. | | | |
| 0102 | 4/5/57 | 51-5220 | 56-980-246 |
| 0201 | 4/26/57 | 51-5219 | 56-980-248 |
| 0303 | 6/13/57 | 51-5219 | 56-980-250 |

4. CAPTIVE FLIGHT TESTING

Missile No. 61 and DB-36 No. 51-5710 were employed for tests of the low-power antijam radar set to check the operation of this system and to determine if there was interaction between this system and other portions of the guidance system. Three successful flights were made and much useful data were obtained; however, on 19 April tests with this combination were terminated at Air Force request.

5. PRELAUNCH TESTS

a. GAM-63A No. 89

Missile No. 89 was received at HADC on 26 April 1957. After electronic preflights were completed, this GAM was used for demonstrating the -6 handbooks. This demonstration continued through 20 June, after which preflights of the guidance system were begun in preparation for launching the missile.

b. GAM-63A No. 88

GAM No. 88 was received at HADC on 21 May 1957. Electronic preflights in preparation for a captive flight with the E&ST DB-47 No. 53-2345, were completed. A captive flight was made on 7 June and operation of the weapon system was satisfactory with two exceptions: The 4-channel telemetering would not come on; this was traced to a breaker wire in the autocheck system. Hydraulic pressure dropped from 2700 psi to approximately 2200 psi. This caused the emergency hydraulic pump in the DB-47 to cycle almost continuously. A second captive flight was flown on 13 June to check the operation of the hydraulic system. This was necessary because ground checks proved the system was operating in a normal manner and no cause for the malfunction could be found. During the second flight, the hydraulic system operated satisfactorily, as did the other DB-47 and GAM systems.

Preflight tests were completed in preparation for a launch attempt scheduled for 27 June. During the hot run of this attempt, Sandia instrumentation became intermittent. Occurrence of this condition during flight of the missile could cause a loss of 75% of the data desired. In addition, command contact between the DB-47 and the missile was intermittent and ultimately could not be established with the waveguide switch in the test position. Both these malfunctions caused the launch to be concelled. Trouble-shooting of the malfunctions is under way and the launch of GAM No. 88 has been scheduled for the first week of July 1957.

c. GAM-63A No. 90

Missile No. 90 was received at HADC on 6 June 1957. Electronic and power plant preflight inspections were completed in preparation for a schedulated launching early in July 1957.

d. GAM-63A No. 93

Missile No. 93 was received at HADC on 27 May 1957. Electronic preflights and power plant preflights were completed in preparation for the scheduled launch on 20 June, from DB-47 No. 53-2345. This launch attempt was cancelled in flight because the S-band and L-band beacon tracking was marginal, the video and code pulse amplitude decreased to a minimum value toward the end of checks, and decode


Figure 5. GAM-63A Mounted on the DB-47 Director Aircraft

and lock-in were marginal. In trouble-shooting these problems, the following changes were made: the S-band and L-band beacons were replaced; the relay magnetron was replaced, thus normal video and code pulse amplitudes were restored; and, as a precautionary measure against marginal decode and lock-in, the synchronizer was replaced. On 26 June, weapon system became airborne and checks revealed acceptable operation of the various systems with one exception. The operator reported a shift in the terminal guidance indicator phasing. This necessitated cancellation of the flight as the operator would have been unable to determine accurately the flight path of the missile. Ground checks revealed the spin drive amplifier was unbalanced and this caused the shift in the indicator. Adjustments were made and the GAM was scheduled for firing early in July.

e. GAM-63A No. 94

GAM No. 94 was received at HADC on 28 May 1957. Electronic preflights and power plant preflights were completed in preparation for the scheduled launch. On 28 June, the weapon system became airborne on schedule; however, during the command checks, in the climb to altitude, the operator reported that the heading marker was unstable. The mission was cancelled and subsequent trouble-shooting indicated that the radar set antenna was faulty. This unit has been replaced and the weapon system is being readied for a scheduled launch early in August.

6. MISSILE LAUNCHINGS

a. GAM-63A No. 4985

The launch attempt of 8 April 1957 was cancelled in flight at X-5 minutes because the turn angle mechanism at the operator's position in the DB-47 was rotating. Checks of the missile release computer and associated equipment after the flight failed to reveal the cause of the problem; therefore, DB-47 No. 51-5220 was substituted for DB-47 No 51-5219. (Note: Subsequent trouble-shooting of the missile release system indicated the harness assembly in the capsule required replacing; it is suspected that an intermittent condition occurred within this assembly causing the problem with the turn angle mechanism.)

GAM No. 4985 was launched from DB-47 No. 51-5220 on 10 April 1957. All systems operated satisfactorily. The guidance operator was able to guide the GAM successfully to the target. Impact occurred 1495 feet from the target. The sequence of events for the final flight of GAM-63A No. 4985 is shown in Table III.

TABLE III

SEQUENCE OF EVENTS – GAM-63A No. 4985

| | Time in Seconds |
|---|---|
| Take-off (0546 hours MST) | |
| Range Coincidence (Turbine Arm) | -53.9 |
| Test to Normal (Inertial Range-Computing System) | -51.3 |
| Turbine Fire | -27.9 |
| Transfer from External to Internal Power | -14.2 |
| Enable (Angular Coincidence Circuit Armed) | - 0.38 |
| Angular Coincidence | - 0.36 |
| Gyro Uncage | - 0.27 |
| Release (Automatic Checkout System) | - 0.24 |
| Release (Unbilical) | - 0.1 |
| Release (Lanyard) (0713 hours MST) | 0 |
| Rocket Fire | 1.7 |
| Full Thrust Attained | 3.0 |
| Altitude Controller Connected to Pitch Servopilot | 33.4 |
| DB-47 Completes Postlaunch Turn | 119.9 |
| ATRAS Lock-on; Relay Link Established | 128.0 |
| Missile Radar Set On | 136.5 |
| Thrust Chambers Off | 154.0 |
| Azimuth Command (7.3° right) | 191.7 |
| Azimuth Command (Changed to 0.8° left) | 192.3 |
| Azimuth Command (Changed to 3.2° right) | 193.5 |
| Programmed Dive (Inertial Range - Computing System) | 195.3 |
| Dive Command (-25.0°) | 197.6 |
| Pitch Command (Increased to 29.5°) | 199.2 |
| Pitch Command (Increased to 30.5°) | 200.3 |

TABLE III (cont)

| | Time in Seconds |
|---|---|
| Azimuth Command (Changed to 7.3° right) | 203.8 |
| Pitch Command (Increased to 32.0°) | 206.4 |
| Pitch Command Increased to 33.5°) | 212.6 |
| Azimuth Command (Changed to 4.25° right) | 223.3 |
| Pitch Command (Increased to 34.0°) | 226.0 |
| Azimuth Command (Changed to 1.6° left) | 229.9 |
| Pitch Command (Decreased to 33.3°) | 230.0 |
| Azimuth Command (Changed to 0°) | 230.5 |
| Pitch Command (Increased to 33.7°) | 232.0 |
| MC-273 Arming Baroswitch Actuation | 244.0 |
| Loss of Telemetering Signal | 251.5 |
| Pitch Command (Increased to 34.0 ) | 253.5 |
| Azimuth Command (Changed to 1.8° right) | 259.5 |
| Impact | 267.5 |

b. GAM-63A No. 5087

The scheduled launch attempt on 10 May 1957 of GAM No. 5087 was cancelled in flight because of a high voltage battery arming problem within the Sandia equipment. This problem was resolved in a postflight investigation.

GAM No. 87 was launched on 14 May 1957. The flight was normal until +147.7 seconds. At this time, the GAM surfaces became noisy, creating an excessive demand on the hydraulic system. As a result, the flight became erratic and remained so until impact at+286.3 seconds.

Subsequent investigation and analysis of telemetered records indicated that fluctuations of the 400-cycle 115-volt power supply caused the servo noise.

The sequence of events for the final flight of GAM-63A No. 5087 is presented in Table IV.

TABLE IV

SEQUENCE OF EVENTS — GAM-63 No. 5087

| | Time in Seconds |
|---|---|
| Take-off (0530 MST) | |
| Range Coincidence (Turbine Arm) | -53.6 |
| Test to Normal (Inertial Range Computing System) | -51.2 |
| Turbine Fire | -28.1 |
| Transfer from External to Internal Power | -14.3 |
| Enable (Angular Coincidence Circuit Armed) | - 0.37 |
| Angular Coincidence | - 0.32 |
| Gyro Uncage; Release (Automatic Checkout System) | - 0.25 |
| Release (Umbilical) | - 0.10 |
| Release (Lanyard) (0700 hours MST) | 0 |
| Rocket Fire | 1.7 |
| Full Thrust Attained | 3.0 |
| Altitude Controller Connected to the Pitch Servopilot | 32.0 |
| DB-47 Completes Postlaunch Turn | 92.8 |
| ATRAS Lock-On; Relay Link Established | 102.0 |
| Missile Radar Set On | 108.9 |
| GAM Becomes Completely Uncontrolled; Intermittent Relay Contact | 147.7 |
| GAM Climbs Slightly | 171.5 |
| GAM Dives | 175.2 |
| Programmed Dive (Inertial Range-Computing System) | 191.3 |
| Relay Antenna Command (1.5° up) | 215.7 |
| Antenna Command (Changed to 4.18° up) | 218.4 |
| Antenna Command (Changed to 0.19° up) | 219.0 |

TABLE IV (cont)

| | Time in Seconds |
|---|---|
| Antenna Command (Changed to 4.5° down) | 220.9 |
| Antenna Command (Changed to 0°) | 221.5 |
| Dive Command (29.7°) | 224.2 |
| Arming Baroswitches Actuate | 256.8 |
| Dive Command (Increased to 36.4°) | 257.1 |
| Fuzing Baroswitch Actuates | 281.7 |
| Impact | 286.3 |

c. GAM-63A No. 5180

On 23 May 1957, an attempt was made to launch GAM No. 80 from DB-47 No. 51-5219. During the final countdown the PDI began to rotate continuously and the launching was cancelled in flight; GAM operation was satisfactory. A firm cause for the rotating PDI could not be established; however, as a precautionary measure, the amplifier on the missile release computer was replaced and the true heading error signal was instrumented for the next flight.

An attempt to launch GAM No. 80 on 28 May was unsuccessful. Following initial guidance checks immediately after take-off, the ATRAS antenna was retracted and the climb to altitude was completed. Efforts to lower the antenna at altitude both by the normal and the emergency methods were unsuccessful. Therefore, the mission was cancelled.

The launch attempt of 4 June was cancelled at X-4 minutes because the pilot's data indicator made several revolutions, then settled at approximately 30° to the right of the correct heading. Since considerable trouble-shooting will be required to isolate this problem in DB-47 No. 51-5219, it was decided to substitute DB-47 No. 51-5220 as the director aircraft for Missile No. 80. (Note: Subsequent trouble-shooting of the problem with the PDI in DB-47 No. 51-5219 proved the malfunction was caused by an intermittent floating connector in the aircraft wiring.)

A scheduled launch of 11 June 1957 was cancelled because the sky was completely overcast, thus preventing phototheodolite coverage.

The scheduled launch of 12 June was cancelled in flight, midway in the prelaunch checks, because a power failure was experienced in the west area of the base and at the prime range stations.

On the attempt of 17 June 1957, operation of the various systems was satisfactory until initial application of the high voltage, at which point the relay magnetron failed to start. During subsequent application of high voltage, the magnetron started and operated normally. However, it had been decided that, should a magnetron fail to start on a 100% basis, the mission would be cancelled if no proof existed that the cause was external to the magnetron.

Figure 6. DB-47 Taking Off with Rascal Missile

GAM No. 80 was satisfactorily launched on 19 June 1957. The servo, guidance, and power plant systems operated satisfactorily until approximately X+18.0 seconds when the range safety officer actuated the destruct system. Upon noting the loss of S-band tracking, the range safety officer initiated the S-band and L-band destruct signals.

7. GRAVITY BOMB LAUNCHINGS

a. Gravity Bomb Test Vehicle (GBTV) No. 0102

Scheduled launch of GBTV No. 0102 on 1 April 1957 was cancelled prior to take-off because of foul weather. The attempted launch on 3 April was cancelled in flight because of cloud coverage reported by the Askania stations. No. 0102 was launched successfully on 5 April and performance was satisfactorily. The impact point was approximately 0.16 nautical miles to the east of the predicted impact point.

A sequence of events for the drop test of Gravity Bomb Test Vehicle No. 0102 is presented in Table V.

TABLE V

SEQUENCE OF EVENTS — GBTV No. 0102

| | Time in Seconds |
|---|---|
| Take-Off (0724 hours MST) | |
| Launch (0902 hours MST) | 0 |
| Switch from Belly Antenna to Nose Antenna | 0.8 |
| Left Aileron Hard Over (to cause CW roll) | 1.1 |
| Right Aileron Hard Over (to cause CW roll) | 1.6 |
| Left Aileron Starts Drifting Toward Neutral | 15.6 |
| Maximum Roll Rate Attained | 16.0 |
| Right Aileron Starts Drifting Toward Neutral | 37.0 |
| Impact | 50.0 |

b. Gravity Bomb Test Vehicle No. 0201

Gravity Bomb Test Vehicle No. 0201 was launched on 26 April 1957 and performance was as predicted. Impact was estimated to be 0.14 nautical miles west from the predicted impact point.

The sequence of events for the flight of GBTV No. 0201 is presented in Table VI.

TABLE VI

SEQUENCE OF EVENTS — GBTV No. 0201

| | Time in Seconds |
|---|---|
| Take-Off (0935 hours MST) | |
| Launch (1121 hours MST) | 0 |
| Switch from Belly Antenna to Nose Antenna | 0.06 |
| Elevators moved to 17.2° down | 0.2 |
| Both Ailerons Hard Over | 1.2 |
| Elevators moved to 15.2° down | 2.1 |
| Elevators moved to 20.5° down | 3.1 |
| Elevators moved to 12.2° down | 15.3 |
| Maximum Roll Rate (3.15 rps) | 30.0 |
| Maximum Speed (Mach 1.033) | 41.3 |
| Elevators moved to 10.0° down | 49.0 |
| Impact | 50.6 |

c. Gravity Bomb Test Vehicle No. 0303

Gravity Bomb No. 0303 was launched on 13 June 1957 and performance was as predicted. This vehicle was launched via the ground track method because the MA-8 system in the DB-47 was not functioning properly. Impact was estimated to be 0.24 miles southwest of the predicted impact point.

## 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 this quarter appear in other appropriate sections of the report. Outlined here are some general programs of the reliability effort, together with discussions of reliability activities and accomplishments that are not integral to specific areas of the weapon system covered separately in this publication.

Detailed reliability information may be found in the System 112A Quarterly Reliability Report, Bell Aircraft No. 56-989-114, for the period ending 30 May 1957.

### 1. RELIABILITY ORGANIZATION

The basic reliability organization is shown in Figure 7. This organization was established in October 1955 and modified as a result of the new divisional reorganization within Bell Aircraft. The Director of Reliability directs and coordinates reliability efforts within the four operating Divisions. The Rascal Reliability Board under the Chairmanship of the Director of Reliability, is composed of representatives from Engineering, Manufacturing, Quality, and Marketing of the Guided Missiles Division, as well as representatives from the Avionics, Research, and Rocket Divisions. The Board plans, coordinates, and directs a high level of effort on System 112A reliability.

An operational group, the Reliability Control Section, supports the Director of Reliability and the Rascal Reliability Board. The functions performed by the Reliability Control Section include:

(1) Collection and processing of basic reliability data on successes and failures.

(2) Transmittal of information on reliability problem areas to the organizations responsible for taking corrective action.

(3) Transmittal of information to management concerning corrective action to ensure "closing the loop."

(4) Transmittal of information to management to permit an evaluation of the success of entire reliability program.

### 2. DATA COLLECTING AND PROCESSING SYSTEM

The reliability data collection system used on the Rascal program has been fully described in Bell Aircraft Report 56-989-071, Revision A, dated 1 April 1957. This system collects success information (operating time) and failure information (discrepancies) to provide the raw data which are processed and analyzed to determine the degree of accomplishment in improving product reliability. Each reported discrepancy is summarized by recording on punched cards 19 pieces of information pertinent to the individual discrepancy. During the past 16 months, over 20,000 reliability reports have been recorded in this form, including reports submitted as information only. Continued analysis of these data has attained the objective of directing corrective action on reliability problems which, when solved, will produce the maximum increase in over-all System 112A reliability.

### 3. CORRECTIVE ACTION CONTROLS

#### a. Idea-for-Improvement System

In addition to reporting discrepancies, the Equipment Discrepancy Report is used to convey suggestions or ideas for improvement from the testing agencies to the design agencies. Control is maintained by the Reliability Control Section to ensure that each idea submitted receives adequate consideration and that the originator is told of what final action is taken on the suggestion.

Monthly reports to management indicate the status of this "suggestion system" with respect to action taken to effect improvement. During the past 17 months, 755 suggestions were written and disposition was effected as follows:

| | |
|---|---|
| Suggestions Incorporated in Equipment | 59% |
| Considered for Future Incorporation | 5% |
| Suggestions Not Incorporated | 21% |
| Disposition Not Yet Effected | 15% |

Fifty-six percent of the suggestions were concerned with ground support and test equipment. The Idea-for-Improvement system, through extensive

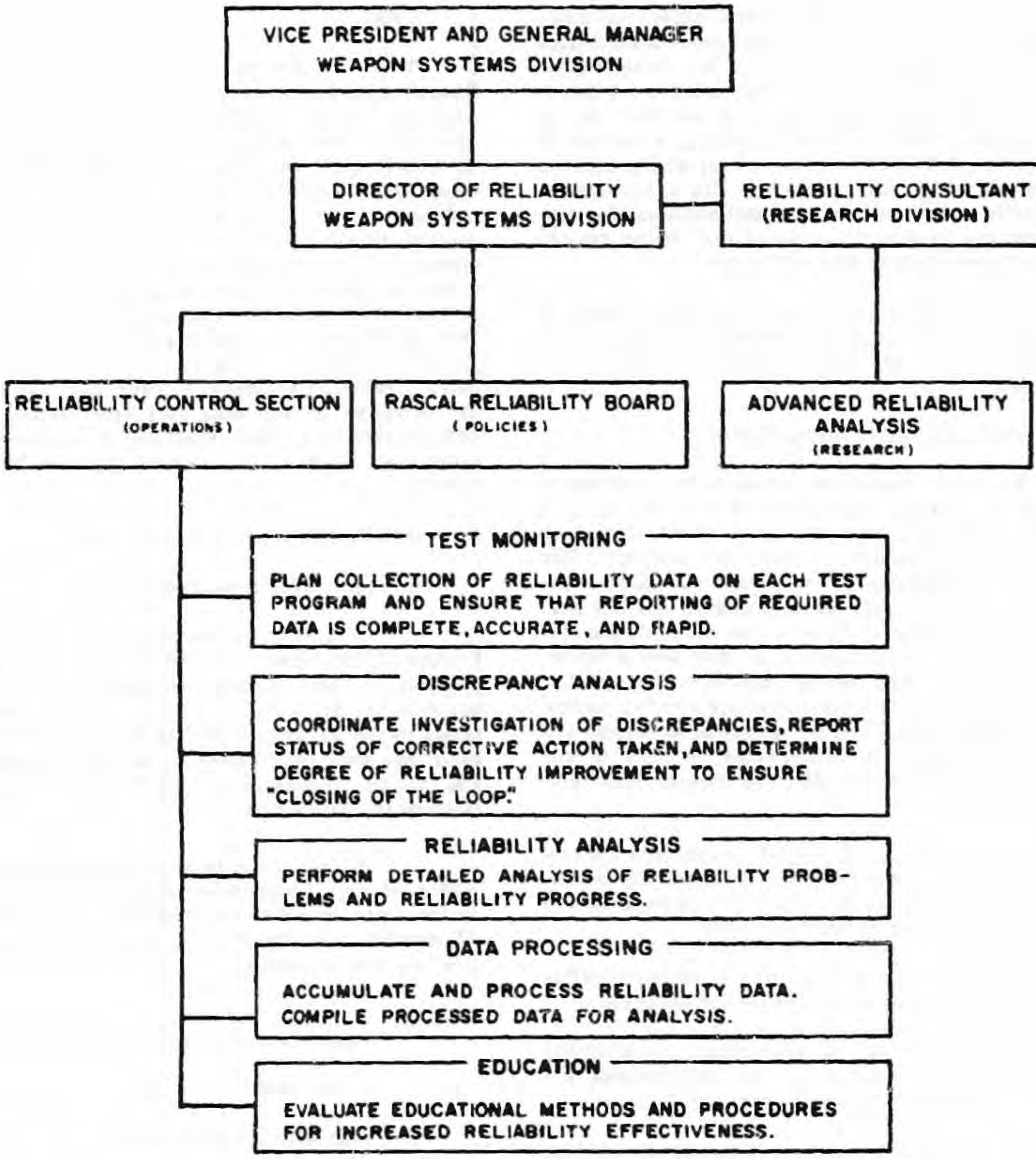



Figure 7. Reliability Functional Control Chart

practical use, has been fully proven as an efficient method of collecting and controlling ideas for improvement of the Rascal weapon system.

The functions formerly performed by the Component Parts Committee, the Component Parts Evaluation Team, and the Replacement Hardware Committee are being performed by the individual divisions within the Weapon System Division.

b. DATR System

Discrepancy Analysis Team Reports (DATR's) are published on discrepancies that require corrective action to effect reliability improvement. The Reliability Control Section maintains control on those DATR's on which corrective action has not been effected.

Reports to management indicate the status of corrective action taken by responsible agencies and also provide surveillance on closed action to ensure that the required improvement has been obtained and is maintained. During the past 17 months, 858 DATR's were originated; 14% came from HADC and the remainder from other test areas.

As of 31 May 1957, 45 problems, investigated by Discrepancy Analysis Teams, require completion of corrective action.

c. Evaulation of Failed Parts

During this quarter, the Electronic Standards Group received 296 failed parts for evaluation from the test areas of Bell Aircraft. Vacuum tubes accounted for 139 of the 296 parts evaluated.

In addition to the 296 failed parts evaluated, 22 component-part types were qualification-tested. Ten of these types did not meet the specifications satisfactorily.

d. Inspection Procedures

To provide increased emphasis on the detection of quality-type discrepancies during the factory testing phase of a missile, the inspection procedure has been modified to permit the initiation of a single document (Form I1-135) for each discrepancy found at HADC. Copies of this form are then placed in the inspection records, where required, for each missile being tested. This revised system is expected to result in more efficient inspection and a corresponding reduction in the frequency of repetitive quality-type discrepancies in the field.

e. Ten Most Critical Missile Components

A high level of corrective-action effort has been directed on the 10 most critical missile components to produce the most beneficial reliability results in the shortest possible time. One important result of accomplishing significant corrective action on these 10 components will be to reduce the actual test time required for each missile. The critical components in order of priority are:

(1) Command Unit

(2) Receiver-Transmitter Unit (Radar Set)

(3) Synchronizer (Radar Set)

(4) Relay Transmitter

(5) Servo Power Supply

(6) Modulator (Radar Set)

(7) Search Antenna (Radar Set)

(8) Servo Valves

(9) Voltage Regulator

(10) Beacons (S-Band and L-Band)

Reliability problems have been designated through direct use of all IBM-processed reliability data on each of the components. This method of discrepancy history compilation has proved the most rapid and effective yet tried. Following identification of the nature and extent of each problem, additional technical details on the cause of failure and status of corrective action are provided from reliability records. The resulting document on each problem is used by persons directing the corrective-action effort on each of the 10 components.

Of the 2675 discrepancies recorded on the aforementioned 10 components at all levels of test and during a 15-month period, approximately 730 represent 63 individual problems. This illustrates the repetitive nature of the problems encountered with these components.

f. Limited-Life Components and Parts

Revised preventive maintenance requirements for Missiles Nos. 88 through 90, 93, 94, 96, and subsequent in the factory testing phase have been published in Bell Aircraft Report 56-989-161. In general, the revisions to the inspection requirements replacement schedule for limited-life components represent a decrease in the frequency of required maintenance for certain components and the elimination of other components from the report where these components are no longer used. All revisions are predicated on the results of testing observed on GAM's Nos. 75 through 85.

## 4. FACTORY MISSILE TESTING

Data have been summarized on five missiles (GAM's Nos. 87, 88, 89, 93, and 94) which recently completed factory testing. A total of 89 composite system tests were conducted or attempted on these missiles; 49 of these tests were 100% successful and 40 were unsuccessful with respect to reliability-type failures on tactical, beacon, and telemetering equipment in the missiles.

The 55% success of these composite tests is well over the factory goal of 40% and represents a significant improvement over the 27% success observed for Missiles Nos. 75 through 85. Composite tests that were incomplete or invalid because of failure of test equipment or tester errors are not included in this summary.

## 5. LIFE TESTS, TESTS TO FAILURE, AND REABILITY EVALUATION TESTS

### a. Servo/GAM Auxiliary/IRCS Component Life Test Program

As of 31 May 1957, the components being life-tested in the airframe fo GAM-63A No. 72 have acquired 1084 hours on master power and servo B-plus and have been subjected to 100 system tests. Of the 125 Equipment Discrepancy Reports (EDR's) written on this missile, 26 list discrepancies before test cycling began. Of the remaining 99 EDR's, 43 discrepancies were classified as reliability-type failure as follows: 32 part failures, 10 adjustments, and 1 problem whose cause has not yet been determined. Fourteen of the part failures were the result of faulty valves and actuators of which five occurred on the relay antenna actuator.

The observed reliability of all components tested is comparable to the present goals as evidenced by the following tabulation:

| Component | Observed Reliability | Present Goal |
|---|---|---|
| Servo | 96.0% | 95.8% |
| GAM Auxiliary | 98.9% | 96.8% |
| GAM Nonemanating Guidance (IRCS) | 99.7% | 99.3% |

### b. Missile Life Test Program

The Rascal Reliability Board has determined that the larger numbers of composite system tests being conducted on production missiles are sufficient cause for cancelation of the first 60 tests previously scheduled for GAM-63A No. 86. The production testing results, accumulated from a larger number of missiles, are providing far more significant data on the capabilities of the GAM-63A weapon system than could be provided by 60 tests on a single missile.

The need for conducting 10 ground firings (composite system tests with propulsion system operating) on GAM No. 86 is under study by the Rascal Reliability Board.

Additional analysis of the life testing results of GAM-63A No. 78 shows that while the equipment failure rate per hour was not significantly degraded under the imposed vibration conditions, with the power plant operating, and under cold-temperature conditions, the ability to run successful composite system tests was degraded. This trend is demonstrated by the following table:

| | Successful Tests | Unsuccessful Tests | Invalid Tests |
|---|---|---|---|
| 51 Composite System Test Phase (Including one reference composite, less vibration, less power plant) | 34 | 12 | 5 |
| Vibration Test Phase (Including one reference composite without vibration) | 5 | 6 | 0 |
| Propulsion Test Phase (Including five reference composites at cold temperatures without the rocket engine operating) | 1 | 14 | 4 |

A successful test is defined as one during which no reliability-type failures occur on tactical, beacon, or telemetering equipment on a missile.

### c. Blower Motors

Twenty Western Gear (F2-3 type) blower motors have been subjected to a test-to-failure program. This test consisted of operating the motors at 125°C until each had failed twice. At the conclusion of testing, 775 hours had been accumulated.

In addition to determining motor bearing life characteristics, an evaluation of the effect of dust-capping one of the two bearings on each motor was conducted. Four of the 20 motors tested used these caps which contain a lubricant. Two of the four capped motors failed during the test. Only one of the failures was due to bearing burnout and this failure was of the uncapped bearing at approximately 750 hours. The capped bearing was found to be in perfect condition. Seven of the uncapped motors failed once because of bearing contamination and wear and were reworked. Four of these seven failed again when the rotor began to bind on the stator. Chemical and metallurgical analyses are being conducted on the failed bearings to determine the extent of contamination, the characteristics of lubricant residue, and the effect of wear at high temperature on the bearing material.

Five Eastern Air Device and five Air Marine blower motors have been obtained for evaluation as possible replacements for the F2-3 blower motor.

d. Flight Control and IRCS Environmental Re-Evaluation Program

One hundred and ninety additional environmental tests were performed on electronic components of the flight control and inertial range-computing systems during this quarter. Each component has completed three cycles of environment testing at conditions as outlined in the System 112A Quarterly Reliability Report, No. 56-989-109, dated 28 February 1956, plus an additional cycle of tests at intensified environmental stress. Twenty-one hydraulic units have completed testing.

e. Environmental Data-Collecting Program

Bell Aircraft Reports 56-984-036 and 56-984-037 were issued this quarter to present the temperature and vibration data recorded during the ground test, captive flight, and free flight of GAM-63A No. 4176. Recording and analysis of additional data will continue.

Temperature and vibration data analyzed during this quarter have been within the previously observed environmental values.

Analysis of the vibration data obtained from the final flight of Missile No. 4581 revealed that vibrations of higher order of magnitude than those previously experienced occurred throughout the missile from approximately the time of loss of hydraulic pressure until impact. Certain major systems (for example, the propulsion system and emanating guidance) continued to operate for some time in the presence of these vibrations.

f. Servo Amplifier Tests by Federal Telecommunications Laboratory

One sample of each of the following types of amplifiers was evaluation-tested at the Federal Telecommunications Laboratories:

| Type of Amplifier Tested | No. of Tests Conducted |
|---|---|
| (1) Roll (1 failure) | 860 |
| (2) Relay Antenna Pitch Stabilization | 1301 |
| (3) Yaw | 271 |
| (4) Pitch | 289 |
| (5) Vertical Gyro Erection | 394 |
| (6) Stable Platform | 394 |

The duration of each test was approximately 15 minutes. One failure was reported in approximately 875 hours of amplifier operation. From a reliability standpoint, the operating time and the number of samples tested are not sufficient to verify the degree of improvement resulting from the improved packaging and the use of improved parts. Although tested under less severe environments, the amplifiers of these types in Nos. 75 and subsequent missiles have experienced approximately one failure per 600 hours of amplifier operation during missile ground testing.

6. RELIABILITY EDUCATIONAL PROGRAM

Phase III of the Reliability Education Program is being prepared. This phase is directed at all aspects of the reliability problem on a departmental level. Departments within Bell Aircraft engaged in Rascal work have selected a qualified person to develop a presentation pointing out the major problems within the department. Photographic slides are being made to illustrate and to emphasize the nature of the problems encountered. Items being particularly emphasized during Phase III include transportation, packaging, handling, and storage of materials and finished products.

The Quality Department of the Avionics Division has instituted a program to make functional test personnel constantly aware of what increased quality control can mean to Rascal. This program also allows personnel to contribute suggestions through supervision to improve quality, reduce costs, and improve the effectiveness of the program.

Figure 8 shows a typical reliability poster placed in strategic locations within the Bell Aircraft facilities as a constant reminder of the importance of reliability.


Figure 8. Typical Reliability Poster

# D. GAM-63A Missile

## 1. airframe

### A. STUDY PROGRAMS

1. Low-Viscosity Hydraulic Fluid Investigation.

Evaluation tests of Dow Corning XF 4270 low-viscosity hydraulic fluid were completed during this quarter and reports are being written.

2. Simplification of the Electrical System

Evaluation of the new alternator designed by the Electric Corporation is awaiting delivery of the first prototype from the vendor.

### B. WEIGHT CONTROL

Weight and balance data have been obtained on GAM-63A's 88, 89, 90, 93, 94, and 97. The actual data were in good agreement with the predicted weight and balance estimates. No difficulties were encountered.

### C. FLUTTER ANALYSIS

Report No. 56-984-033, "Summary of Flutter Studies of the GAM-63A Rudder," has been issued. The report summarizing the flutter studies performed for the aft horizontal surface is being reviewed and will soon be issued.

Tests conducted to determine experimentally the dynamic characteristics of the Rascal airframe in the pitch, roll, and yaw planes are complete. These dynamic characteristics were obtained by feeding a sinusoidal input to the controls and recording the response from several points on the airframe. Based upon the results of these tests, the servo-coupling effects on the flutter stability of the missile are being examined and re-evaluated.

The program of measuring the free play of the control surfaces is continuing. Nine missiles with known amounts of free play have been flown. Although in some cases the free play exceeded that allowed in Paragraph A-17 of Specification 66-947-011, no detrimental effects to the flutter stability have been indicated in any case. A series of ten missiles are being measured using a revised procedure that increases the reliability of the measurements.

## 2. propulsion system

### A. 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 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.

Qualification testing of the YLR-67-BA-11 rocket engine was terminated during this quarter by USAF directive. A Preliminary Flight Rating Test Program was approved for the LR-67-BA-9 engine utilizing inhibited red fuming nitric acid.

Eight YLR-67-BA-9 rocket engines were accepted after thirteen runs. One engine, serial No. 29, was re-acceptance-tested because of damage after delivery. 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. No fires occurred between the exhaust duct to manifold seal since the new, higher temperature, sealing compound has been in use.

2. Thrust Chamber Assemblies

a. Tubular Thrust Chambers

During this quarter, 11 thrust chambers were acceptance-tested for use on YLR-67-BA-9 rocket engines. One chamber was rejected because of low performance.

The durability investigation of the cast aluminum tubular thrust chamber has been terminated. At this point, no definite cause of the burnout of tubes at the throat has been uncovered. One chamber was fired in which the coolant passages were flushed with Versene reagent after each run. A total of 1166 seconds of operating time was attained before the performance dropped below specification. No significant improvement was noted. An improved reagent believed to be more suitable for stainless steel has been ordered for further testing.

A thrust chamber cast by the permanent mold method was evaluated and found to be satisfactory. Henceforth, all production thrust chambers will be cast by this method which yields a sounder casting and considerably reduces the machining required. This process is also preferable to the sand-casting method in that no throat shrinkage occurs, making throat areas of 5.0 square inches more easily attainable.

An exploratory program to determine the -65°F capability of the tubular, cast aluminum thrust chamber was conducted. The test results indicated that the present production configuration would operate satisfactorily at this temperature when using IRFNA. Slight instability was noted on several of the runs; however, this was traced to a particular propellant valve. This valve is being examined to determine the cause of the discrepancy.

b. Drilled Aluminum Thrust Chambers

Development work on the drilled aluminum thrust chamber was concluded and a final report was submitted. This program objective was considered satisfied and a prototype thrust chamber configuration was recommended for possible replacement of the cast aluminum tubular thrust chamber. The configuration consists of a standard production stainless steel injector bolted into drilled aluminum thrust chamber in which the chamber section is coated with 0.004-inch chrome-nickel-bound tungsten carbide and the nozzle is coated with 0.003-inch thick alumilite hardkote. The use of a 60-hole drill pattern nozzle instead of the 38-hole drill pattern nozzle with helical inserts is optional. For production quantities sufficient to warrant the drilling tooling required for the 60-hole configuration, a reduction in cost would result. The principal advantages of this assembly over the current production configuration are:

| | | |
|---|---|---|
| (1) | Increase in service life | 100% |
| (2) | Reduction in field maintenance | 100% |
| (3) | Reduction in use of strategic material | 50% |
| (4) | Reduction in weight | 39% |
| (5) | Increase in performance | 1% |
| (6) | Reduction in cost on a moderate production scale. | 10% |

Two additional thrust chambers with tungsten-carbide-coated chamber sections were fire-tested to compare the durability of the coating using cobalt as a binder with that employing chrome nickel as a binder. To reinforce the area of greatest wear, the thrust chamber with the cobalt binder was coated with a thickness of 0.008 inch in the center third of the chamber and 0.004 inch on the remaining area. The oxidizer regenerative coolant passages were penetrated after 1220 seconds of firing time. Postrun examination of this chamber indicated slight spalling in the area of greatest coating thickness. This was probably due to the poorer resistance of a heavy coating to thermal shock. The chamber employing the chrome nickel binder completed twelve 160-pound runs including one with propellants at 95°F. In the testing completed to date, the chrome-nickel-bound tungsten carbide with a uniform thickness of 0.004 inch has shown superior durability.

c. Injectors

Durability tests were made on a tungsten-carbide-coated thrust chamber and evaluation tests were made on a modified configuration of the "doublet" injector.

The durability tests on the tungsten carbide chamber were conducted with a standard production, stainless steel, 72-impinging-pair injector. Satisfactory duration was achieved with this thrust chamber/injector combination. Owing to the availability and the production status of this injector, further development work on injectors for use with the drilled aluminum chamber was terminated. Further details on the thrust chamber may be found in the drilled aluminum thrust chamber section of this report.

Development tests prior to the program termination included the evaluation of a modified "doublet" injector. The "free" oxidizer orifices in the inner oxidizer row were welded closed to reduce the mixture ratio in the central injection pattern. The modification resulted in a 3% increase in performance (5100 ft/sec characteristic exhaust velocity) and a nearly constant combustion efficiency over the required temperature range. No increase in chamber or injector erosion was noted after full-duration operation; however, one instance of buckling of the thrust chamber occurred which was attributed to a high chamber heat flux in the central and nozzle portions of the chamber. The tests indicated that with a minimum of development an injector could be made to operate with the "hardkote" chamber. However, the satisfactory operation of the tungsten carbide coated thrust chamber did not justify further expenditure to obtain a completely satisfactory unit.

3. Turbine Pump Assemblies

a. Turbine Pumps

During this quarter, 27 runs were made in acceptance testing nine turbine pumps for YLR-67-BA-9 rocket engines.

A total of 25 runs were made with turbine pump assembly (66-474-200-1) Nos. G-1 (Qualification Test Pump No. 1), G-3 (Qualification Test Pump No. 3), and GP-8T (R&S Pump No. 8). These pumps incorporated the dual-flow (fuel and oxidizer metering) flyball governor speed-control system. Also, 26 runs were made with turbine pump assembly (62-474-004-9) Nos. 45, 48 (production), and P-14A (R&D). These pumps incorporated the regulator and power control valve speed-control system. Four units, G-1, G-3, No. 45, and No. 48 were subjected to standard acceptance testing using IRFNA as the oxidizer propellant.

Nine R&D runs were made with turbine pump No. GP-8T to evaluate various types of manifold support bolt seals. During the series of tests, no gas leakage was evident, but postrun pressure tests of the manifold indicated leakage was present. Attempting to obtain a better manifold joint, turbine pump No. P-14A was built with the turbine manifold welded to its support. A total run time of 65 minutes was accumulated on this unit. There was no evidence of gas leakage and manifold prallelism remained the same throughout the series of tests.

b. Gas Generators

During this quarter, 42 runs were made in acceptance testing seven gas generators. Three gas generator packages were accepted for use.

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

As a result of the explosion of a gas generator package, serial No. 27 (-9 engine), during the last quarter, tests were conducted to determine a safe malfunction condition for the -11 engine. The malfunction condition in which the propellant valve remains open on a command shutdown and the drain valve opened can cause the -11 generator to run at a lean mixture ratio since there is no regulator downstream of the propellant valve. Tests were made with the drain valve opened and closed before and after regulation to determine the effects on the package. As a modification to the package to eliminate any detrimental effects, a check valve and vent port were incorporated into the drain valve actuation line. This arrangement allows the drain valve to stay closed when the propellant valve closes. The drain valve may then be opened by loosening the cap of the vent part to remove the actuation pressure of the valve. This modification provides a "fail-safe" condition if the propellant valve hangs open on a command shutdown.

The investigation to determine the cause of the flameouts experienced with gas generator package No. GH-112 during acceptance testing at -33°F was continued. As a portion of this testing, calibration of flowmeters with actual propellants at -33°F was accomplished to compare with ambient calibrations. This was accomplished to determine if mixture ratio and distribution may have been out of specification values. These tests indicated that errors up to approximately 6% could be obtained by using flowmeters calibrated at ambient conditions and used at -33°F.

Gas generator package GH-104 with gas generator HGP-114 was fire-tested at -33°F to evaluate the test cell and typical hardware. This package performed satisfactorily at critical conditions of low mixture ratio, low power, and high water content in IRFNA. A second generator, No. HGP-134, was installed on the package for evaluation. Initial tests of this generator flamed out with run parameters exceeding the critical low limits. A flow check of the generator indicated that it did not meet drawing requirements. These tests were discontinued when work on the -11 engine was terminated.

Gas generator package No. GH-111 with gas generator No. GHP-132 was received for acceptance testing, but experienced flameout difficulties at critical conditions of low temperature, low mixture ratio, low power, and high water content. The reasons for the flameouts were not determined owing to the work stoppage on the -11 engine.

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

The testing of the fourth trial flushing and purging procedure with the special fitting at the propellant valve oxidizer outlet was continued. Eight successful bench tests were made, but further testing was discontinued owing to more urgent work.

Three gas generator packages, Nos. 22, 29, and 30, were reacceptance-tested satisfactorily with IRFNA.

A test program was conducted to determine the firing capabilities of existing hardware at the most critical limits of drawing requirements when fired at -33°F with IRFNA containing 3% water. It was found that flameouts occur at total ratios above 0.66 during the bypass power level start transient.

To overcome this difficulty, a program was initiated to determine a range of fuel percentage distribution, by utilizing hydrazine cartridge orifices, so as to prevent flameouts and also not cause ignition delays. These tests were conducted with IRFNA containing 2.9% ±1% water at critical conditions of low mixture ratio and low power with gas generators Nos. HGP-120, HGP-125, and HGP-147.

It was determined from the test data that the hydrazine cartridge orifice should be such as to give fuel primary distribution of 19% to 21% and that the over-all mixture ratio limits should be set at 0.68 to 0.77.

With the new distribution limits, additional runs were made satisfactorily with the fuel primary orificed for 21% distribution and IRFNA containing approximately 3.2% water at an over-all mixture ratio of 0.67 to ensure reliable operation at the new specification values.

4. Valves and Controls

a. Fuel-Operated Sequence Valve

A prototype R&D unit of the redesigned sequence valve which incorporated a teflon piston ring with an expander, as well as a drain port of 1/4- inch tubing has successfully completed 11 runs. Of these, seven were full-duration runs. The leakage measured during the full-duration runs was found to be 4 to 11 cc. Analysis of test data indicated no significant change in the starting transient or steady state fuel flow to the gas generator secondary with this sequence valve.

Additional tests are planned to determine the maximum possible leakage when the teflon piston ring is removed. This is to evaluate its effect on a turbine run in an effort to determine the maximum possible leakage condition that can be tolerated without detriment to the allowable starting transient and temperature.

During acceptance testing the regulator pack, which incorporated the second-stage regulator of the shortened stroke configuration, humming due to high frequency oscillations was experienced during normal operation of the regulator. Studies have been initiated to alleviate this condition.

b. Regulator Pack Assembly

Because of the critical sensitivity of the regulator to demand requirements, extreme tests have been imposed on the regulator for evaluation. Of the various approaches attempted, the solution to the problem was found to be a shorter stroke regulator.

Accordingly several runs were made with the gas pressurizing pack which incorporated a second-stage regulator with a shortened poppet stroke. These runs demonstrated that the oxidizer and fuel tank pressures remained stable.

The peak oulet pressure of the second-stage regulator was significantly reduced while pressurizing the tanks with a maximum allowable ullage (see Figure 9).

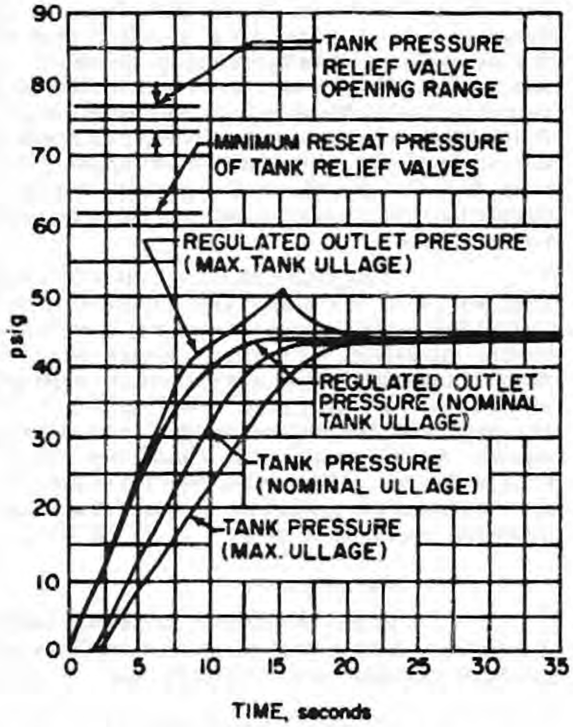



Figure 9. Operational Transient of Regulators

c. Fuel and Oxidizer Relief Valve

The spring buckling problem was solved by the redesigned spring. The relief valves have been subjected to tests to establish the cracking and reseat pressures. These were found to be of a 75 psig magnitude, respectively. The flow capacity was measured and proved to be 150 SCFM at 75 psig.

Testing at malfunction conditions of the second-stage regulator established the capacity as adequate since the maximum tank pressure obtained under these conditions was 80 psig.

## B. STUDY PROGRAMS

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

Detonation limits and detonation velocities of FNA/n-heptane/$N_2$ gas mixtures have been determined at an initial pressure of 2.0 atmospheres, with 50 mole percentage of nitrogen dilution. Stable detonations were obtained over the composition range from r = 3.5 to r = 10.0. These results are plotted in relation to the theoretical curves in Figure 10. Ignition of these mixtures was achieved with shocks from the detonation of equimolar oxygen/acetylene mixtures.

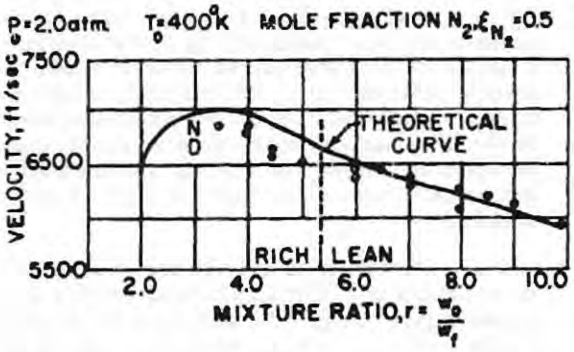



Figure 10. Detonation Velocity vs Mixture Ratio for FNA/n-Heptane/$N_2$ Gas Mixtures

Detonation velocities and detonable limits of FNA/n-haptane/nitrogen gas mixtures at $p_0$ = 2.0 atmospheres have been determined for FNA/n/heptane mixture ratios of 5.0 and 6.0. Detonations were sustained in FNA/n-heptane/$N_2$ gas mixtures with up to 65 mole percentage of $N_2$ at r = 5.0 and up to 70 mole percentage of $N_2$ at r = 6.0. In Figure 11, the experimental results are plotted in relation to the theoretical curves. In Figure 12, the limiting mole fraction of nitrogen experimentally found to prevent detonation in FNA/n-heptane/$N_2$ gas mixtures at initial pressure of 0.5, 1.0, and 2.0 atmospheres are shown. It is evident from the figure that even at 2.0 atmospheres the limiting nitrogen dilution appears to have levelled off at 0.70 mole fraction nitrogen. 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 Rascal rocket chamber pressure.

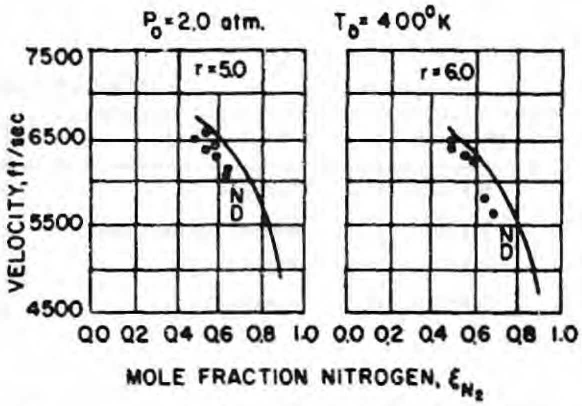



Figure 11. Detonation Velocity vs Mole Fraction Nitrogen for FNA/n-Heptane/$N_2$ Gas Mixtures

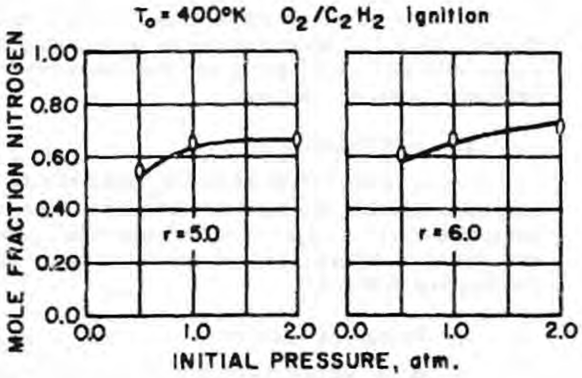



Figure 12. Detonability Limits of FNA/n-Heptane/$N_2$ Gas Mixtures as a Function of Initial Pressure and Nitrogen Dilution

### 2. Burner Studies

Burning velocity measurements on gaseous nitric acid and four hydrocarbon fuels have been completed at atmospheric pressures and 260°F nominal temperature. The maximum burning velocities are given in Table VII.

In general appearance, the flames supported by all the hydrocarbons showed the typical step-type burning as reported in the last quarterly report. In fuel-rich mixtures of toluene, however, there is a distinct difference from the others in that the flame steps shrink together and the flame becomes brilliant

TABLE VII

BURNING VELOCITY MEASUREMENTS

| Oxidizer | Fuel | $S_u$ (cm/sec) | r = O/F | Mole % Fuel |
|---|---|---|---|---|
| WFNA | Propane | 104 | 7.85 | 15 |
| WFNA | Methyl Cyclopentane | 92 | 5.85 | 11 |
| WFNA | Toluene | 91 | 5.25 | 11.2 |
| WFNA | n-Heptane | 87 | 6.20 | 9.2 |

and apparently while hot. It is impossible to resolve the inner cone by Schlieren techniques even with a concentrated arc light because of the intense light emitted. It is believed that the radiation is from fine soot formed in the flame, and that the flame is much hotter than the flames with other hydrocarbons.

This brilliant flame is due to atmospheric oxygen, as it can be eliminated by surrounding the flame with nitrogen, leaving the inner cone which is reddish-orange still burning.

3. Acid Storage

A drum of Type III RFNA, modified with the corrosion inhibitor ammonium hexafluophosphate, has completed seven months of field storage. The original and latest analyses are presented in Table VIII. Testing will continue.

4. Propellant Analyses

In the Quality Control Program for Rascal propellants, 677 samples of IFNA were completely analyzed. In addition, 18 JP-4 samples were analyzed and 40 hydrometer calibrations were made.

A Beckman DU spectrophotometer, modified for use in the near infrared by the Southern Research Institute, was evaluated as a means of determining the $NO_2$ content of IRFNA. A special sample holder was found necessary, and a satisfactory one was designed and built. The holder features a stainless steel body, sapphire windows, and a 2.5-mm light path. A calibration curve was constructed by taking readings for a series of acid samples vs titration values. The acids varied in $NO_2$, $H_2O$, HF, and $HNO_3$ content so as to give a representative curve. Subsequent check of 36 incoming samples by titration vs the instrument indicated agreement within ±0.4%. On this basis, the instrument is considered ready for use for field tests of IRFNA.

Two samples of IWFNA were adjusted to a water content of 2.3% to 2.6% and submitted for special rocket engine firings. An additional 12 samples of WFNA were analyzed in support of combustion research flame studies. Also, in support of this latter program, 2900 cc of 99.9% HNO3 were prepared. Finally, because a steady demand for such acid arose, a vacuum still of suitable capacity was built and checked out.

Three drums of IWFNA of varying water content were prepared in support of a performance vs acid composition program. The final percentages of water content were 1.0, 2.4 and 3.8.

Quality control of Rascal propellants at the squadron level was discussed during a conference at

TABLE VIII

STORAGEABILITY OF TYPE III RFNA

| Date | % $FNO_3$ | % $NO_2$ | % $NF_4PF_6 \cdot NF_4F$ | % $H_2O$ | % Fe | % Al |
|---|---|---|---|---|---|---|
| 11-15-56 | 84.22 | 12.99 | 0.34 | 2.43 | 0.001 | 0.001 |
| 6-18-57 | 85.12 | 12.71 | 0.34 | 1.83 | 0.003 | 0.001 |

WADC on 17 May 1957. Plans formulated by Bell Aircraft and modified during this conference await final approval by the WSPO. In support of plans advanced, it was brought out that storage tests conducted at Bell Aircraft prove IRFNA stable for periods up to 20 months. Analyses of IWFNA held in missiles in HADC for periods up to 30 days showed maximum rises of 0.1% in $NO_2$ and $H_2O$ content. Tests performed in the propellants laboratory set the density of UDMH containing 1.0% water at 0.787 at 77°F; UDMH with this amount of water is acceptable for use. Prints of the cartridges for holding UDMH were supplied. To expedite matters, procedures for carrying out the quality control program proposed have been written and will be available if required. Finally, an attempt is being made to arrange with WADC for a propellants laboratory evaluation of the instruments proposed by WADC for quality control analyses at the squadron.

5. Rocket Engine Flushing Procedures

In support of the rocket engine flushing procedures program, three experiments were performed with chromic acid. Two experiments 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 and 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.

C. MISCELLANEOUS

The rate at which hydrometers are etched by exposure to IFNA was determined. After 226 minutes of exposure, the average change for four hydrometers was 0.0175 units. Since a change of 0.0160 units is considered significant, a 3-hour service life is anticipated. Periodic checks are made to guard against use of unacceptable hydrometers.

The nitrogen tube bundles in 10 missiles were checked for water. An excessive amount of moisture was found in two missiles and this was corrected.

Failures of Giannini gages owing to salt formation were investigated. It was found that the gages and associated lines that pick up acid during a rocket engine firing will become contaminated with salt if the acid is allowed to act on the metal for several days. To remedy the situation, gage removal and clean-up by standard procedures and a methqlene chloride flush of the lines all within 24 hours following a firing, were recommended.

Viscosity determinations as a function of temperature were made for three turbine lubricants. The results obtained are as follows:

| Temperature °F | 1005 Oil Centistokes | 1010 Oil Centistokes | 6808C Centistokes |
|---|---|---|---|
| 176 | 2.1 | 3.5 | 6.0 |
| 140 | 2.8 | 5.3 | 8.9 |
| 100 | 4.6 | 10.9 | 16.5 |
| 68 | 7.8 | 20.9 | 30.2 |
| 32 | 13.2 | 50.7 | 57.4 |
| 14 | 23.0 | 100.8 | 111.0 |
| - 4 | 51.8 | 284.4 | 271.0 |
| - 22 | 110.8 | 808.0 | 656.0 |
| - 40 | 315.0 | 2740.0 | 1835.0 |
| - 67 | 2390.0 | 45800.0 | 10500.0 |

Viscosity and specific gravity determinations as a function of temperature were made for Arseco Solvent. The results obtained are as follows:

| Temperature F° | Specific Gravity TT°F/39° | Viscosity Centistokes |
|---|---|---|
| 74 | 0.7823 | 1.16 |
| 32 | 0.7968 | 1.81 |
| 14 | 0.8039 | 2.36 |
| - 4 | 0.8108 | 3.13 |
| -22 | 0.8173 | 4.32 |
| -40 | 0.8253 | 6.36 |

Small amounts of Nordcoseal/Molycote and Molycote were added to IRFNA. No reaction took place at room temperature, but at 160°F the materials were incompatible. Heat and nitrogen gas were evolved through a vigorous reaction.

A batch of IRFNA was modified by addition of water for low temperature fire tests. The analysis and freezing point of the final product is given in the following:

| $\%HNO_3$ | $\%NO_2$ | %HF | %TN | $\%H_2O$ | F. P. |
|---|---|---|---|---|---|
| 82.89 | 13.76 | 0.5 | 0.04 | 2.81 | -77.5°F |

# 3. guidance system

A. 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

Using a missile configuration, an investigation was conducted into the reason for mixer crystal burnout in the radar and radio sets. Large missile power switching transients appearing on the crystal current monitoring leads were either eliminated or greatly reduced by addition of filters in the radar set and the shortening of the monitoring leads to the test racks for both systems. Crystal burnout has since been practically eliminated.

2. Radar Set

An extensive program was conducted to improve the electrical and mechanical performance and relaibility of the search antenna. Redesign and evaluation of the antenna feed resulted in an improved pressure cover which will maintain the required pressure differential of 20 psi at 170°F for 100 pressure cycles. The voltage standing-wave ratio of the feed was reduced by removal of the glass window and rematching the irises for open-ended waveguide. Requirements on side lobes and gain were modified to be compatible with the mechanical tolerances. The excessive friction and resulting hydraulic pressure drop was reduced by incorporation of a felt wick washer soaked in lubricant; backlash of the gears was reduced; and preloading the main bearing assured meeting synchronization requirements. The cap heater was eliminated and the revised method of mounting the remaining heaters eliminated failures.

The pressurized cover for the feed, a 3-inch bubble as it is now designed, limits the peak power owing to the presence of corona above 70,000 feet. To eliminate this limitation, a 4-inch bubble is being developed which will be capable of handling 100-kw power at 73,000 feet. Evaluation to date on this design indicates that the requirements can be met and will be incorporated into the design as soon as evaluation is completed.

The electrical synchronizer reliability has been improved by incorporation of lumped constant delay lines. Minor circuit changes to the automatic gain control circuit, plus assuring the use of a standard adjustment procedure, have resulted in elimination of what was considered to be a drift problem.

3. Low-Power Antijam Radar Set

Work on the low-power antijam radar set has been discontinued in accordance with USAF directives. A termination report has been prepared covering drawings, models, specifications, and parts inventories.

4. Radio Set

Subcontract 2705 was negotiated with RCA to continue development of the A-1016 relay magnetron to improve life and reliability. Work is primarily directed at improving the cathode design for greater stability and reduced susceptibility to moding, and at redesigning the modulating gun to eliminate current leakage. To alleviate the shortage of this tube, provisions were made for source inspection, and modification of test procedures to permit use of dummy loads and test tubes. Through additional facilities provided at RCA, the number of tubes shipped has been doubled. To increase reliability of the radio set, temperature-conducting tube shields were provided for all miniature tubes and an improved type of blower was evaluated and incorporated into the design.

B. NONEMANATING GUIDANCE

Inertial Range—Computing System (IRCS)

Directional control of the missile is maintained by the autopilot keeping the missile aligned to a gyroscopic reference heading which is set in at launch. Altitude control is determined by means of a pressure-sensing altimeter which directs the missile to climb until a preset altitude is attained. This preset altitude is maintained thereafter until dive initiation is commanded by the IRCS.

The IRCS measures range in a plane tangent to the earth's surface at the instant of launch. An accelerometer mounted on the stable platform senses accelerations in the same plane and along the heading of the missile in this plane. The output is double-integrated and compared with the initial range-to go value, 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 stable platform is leveled and the necessary initial conditions are inserted into the inertial system of the missile. A signal is sent to ungage the yaw gyro when the director aircraft attains the desired launch heading.

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.

The repackaged computer work was discontinued owing to contract termination. The prototype unit was operated successfully prior to termination.

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. Since all samples evaluated except the Bell unit have failed to qualify, Bell Aircraft will supply units for all future missiles.

## 4. control system

### A. FLIGHT CONTROL SYSTEM

During recent months, several projects have been discontinued. Following is the status of the projects at termination.

Under the environmental re-evaluation program of the Rascal flight control system and the inertial range computing system, 30 units had been given four complete cycles, 11 units have attained between three and four cycles, and 13 units have completed less than three cycles.

No formal report on the mechanical coupling test or platform leveling system will be completed.

Two mechanical improvements on the spin drive system for the search antenna were adopted to improve system operation. One is an improved lubricant to relieve excessive rotational friction and the other is an improved assembly procedure that controls bearing preload.

The Phase I repackaged amplifiers built by Federal Telecommunications Laboratories have passed qualification testing with good results. This work effort has since been terminated.

### B. SERVO

Development work on the double-nozzle, dry-first-stage servo valves has been terminated.

### C. HYDRAULICS

The search for an accumulator capable of cycling at -65°F without resulting in excessive internal leakage has failed to uncover a satisfactory unit. It is anticipated that Missile No. 95 and subsequent will incorporate heaters (on the accumulators) designed to keep the O-ring at a temperature where it does not lose its resilience. Tests have shown that such an installation will prevent internal leakage and over-pressurization of the hydraulic reservoir.

An investigation is being made of a simple, reliable method of determining the degree of oil contamination in the field. If proven satisfactory, it would eliminate the need for laboratory facilities and trained personnel.

## 5. warhead and fuzing system

### A. SYNOPSIS

Sufficient test planning is included in the overall 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.

The warhead is located in the Rascal missile in a cylindrical compartment between the forward wing and the oxidizer tank. The warhead is installed by first loading and attaching it to a structural door, which in turn is raised into place and bolted to the warhead compartment.

### B. WARHEAD

The GAM-63A is designed to accommodate a 2800-pound special warhead. An access door approximately 14 inches square is located at the top centerline of the airframe and provides access for fuzing battery installation. The elimination of the DB-36 as an operational director aircraft instigated the relocation of this door to the right-hand side of the airframe to provide accessibility when the missile is loaded on a DB-47 director aircraft. This change is effective on No. 112 and subsequent missiles.

Early in 1957, an engineering evaluation test was held at Eglin AFB by personnel from the Air Force Special Weapons Center. The test involved a complete loading and unloading of the warhead with an E&ST configuration missile utilizing operational support equipment and related technical publications. As a result of this evaluation, several change recommendations were made by AFSWC personnel. To date, most of these changes have been incorporated in the missile.

A flight test program for evaluation of the warhead, with special instrumentation provided by Sandia Corporation, is in progress at HADC. Twelve warhead evaluation flights are planned to obtain environmental and operational data for the GAM-63A warhead and fuzing system. Electrical noise and interference tests were run on the first of these warheads installed in Missile 4891 and it was determined that no interference existed between the new warhead and the missile systems. This missile was subsequently fired and operation of the warhead was considered successful by Sandia Corporation. To date, ten more missiles remain to 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. Both the burst mode selection and the director aircraft. The system uses the missile lanyard switch, MC-5 and MC-273 baroswitches, and MC-384 safing switch, MC-271 batteries, and MC-616 impact crystals. Monitoring and arming functions are accomplished by means of a T-249 control panel in the DB-47.

As a result of the decision to relocate the warhead arming door, the equipment installation of the fuzing system will change with Missile No. 112.

Components such as the MC-271 batteries will be relocated to be accessible at the new door location. Fuzing wiring harnesses will also be changed in No. 112 to eliminate spare cabling originally provided for the dual capability requirement.

During May of 1957, the Air Force Special Weapons Center requested a change to the fuzing system to prevent accidental premature arming of the warhead. This change was made effective for all warhead test vehicles at HADC, as well as for all E&ST and operational missiles.

Another change in process resulted from a change to the warhead. The tenth warhead for the E&ST program will have different impact crystal connectors and a similar change is required for the mating fuzing cables to make the systems compatible. The E&ST missiles will be provided with alternate impact connecting cables so that warheads of either configration may be accommodated.

Evaluation tests on the MC-394 baroswitches were completed with results similar to those displayed by the MC-5. The only differences between the two baroswitches are a change in adjustable range and an improved pressure seal at the electrical connector for the MC-394.

Work is continuing on the preparation of drawings and specifications for all components of the fuzing system so that they may be purchased directly from their respective manufacturers. This effort was initiated at the request of the Air Materiel Command which had been supplying these components as GFP. Work is being finalized for all components except the MC-384 safing switch which is not available commercially and will continue, for the present, as GFP.

Additional studies, evaluations, and tests are in progress on newly developed fuzing components so that higher quality components may be installed in 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 telemetering 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.

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, propulsion system, 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

Three GAM-63A missiles (Nos. 4985, 5087, and 5180) and three Rascal gravity bombs (Nos. 0102, 0201, and 0303) were launched during this quarter. Missile No. 5180 contained both Groups III and IV telemetering systems. GAM Nos. 4985 and 5087 contained a Group III system, and the three gravity bombs contained a modified Group IV system.

In general, the records obtained from the six flights were of good quality. The following instrumentation discrepancies were noted during the flights:

(1) GAM-63A No. 4985 — All telemetering signals were lost 16 seconds before impact and the noise level of the 22-kc/217-mc channel was 4.5% (maximum specification level is 2.0%).

(2) GAM-63A No. 5087 — The gas generator pilot valve switch function which is superimposed on the IRCS dive command channel was either missing or of insufficient amplitude. The alternator voltage channel noise level was 6.2% (maximum specification level is 2.0%) and calibration for this channel was missing.

(3) GAM-63A No. 5180 — The lanyard pulse which is superimposed on the 3.0 kc/217-mc trace was either missing or of insufficient amplitude.

C. TELEMETERING DESIGN AND DEVELOPMENT

1. Groups I and II Telemetering Systems

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

2. Group III Telemetering Systems

a. Telemetry Transmitter Evaluation

An r-f telemetry transmitter evaluation program was conducted during this quarter to comply with a WADC request for frequency stability and spurious radiation to conform with specifications MIL-T-26985 and MIL-I-6181B.

The following crystal-controlled transmitters were evaluated: Tele-Dynamics Inc. Type

1001A, Radiation Inc. unit, and Tele-Chrome unit. The Radiation Inc. and Tele-Dynamics units were satisfactory except for a minor deviation in the spurious radiation. To comply with the 1 November 1957 completion date, the Tele-Dynamics unit was selected because of delivery schedules.

The Tele-Dynamics unit has a frequency stability exceeding MIL-T-26985 requirements and the spurious radiation approaches the requirements of MIL-I-6181B when used with a noise-free B+ supply.

Mock-up and prototype design drawings are complete and fabrication of the prototype transmitter installation assembly has been started. Production drawings for the assembly are 50% complete.

b. Pressure Transducers

The major source of repetitive trouble with the Giannini pressure gages (Dwg. No. 56-535-480) has been due to improper filling and sealing techniques and inadequate expansion cavity for the damping fluid. Corrective action was initiated at Bell Aircraft and the units are now satisfactory.

3. Group IV Telemetering Systems

Modified Group IV telemetering systems were installed in GBTV Nos. 0102, 0201, and 0303. Five continuous channels were provided and the functions monitored were as follows:

No. 0102 — Forward, aft, and cg accelerometers - 3 channels

Left-hand aileron — 1 channel

Right-hand aileron — 1 channel

No. 0201 — Forward, aft, and cg accelerometers - 3 channels

Left-and right hand-aileron — 1 channel

Elevator — 1 channel

No. 0303 — Forward, aft, cg, and yaw accelerometers - 4 channels

Left-and right-hand aileron and elevator- 1 channel

The instrumentation system of Missile No. 5180 was changed to incorporate continuous monitoring of alternator phase "B" voltage and current on the 16-channel system. This change was made as a result of possible alternator difficulties experienced during the flight of Missile No. 5087. Phase "C" alternator voltage was added to a continuous channel of the Group III system.

D. BEACON AND DESTRUCT SYSTEM

A further study was made into the causes for random noise triggering of the S-band and L-band beacons. On the L-band beacon, grounding of the power filter was improved and the antenna cable was changed to a double-shielded type. Noise was found to be entering the beacon through unfiltered telemetering leads; a filter design to eliminate this is in progress. On the S-band beacon, an r-f gasket was incorporated at the power plug to improve shielding. Also investigated were noise sources from gasoline engine ignition system, and several methods of filtering were employed without achieving satisfactory noise suppression.

Because of the proposed change in White Sands Proving Ground range-tracking requirements, a survey is being made of the availability of coded beacons.

## E. Support Aircraft

1. SYNOPSIS

The director aircraft that form an integral part of the Rascal Weapon System are converted B-47 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.

The JB-50D, JF-80B, and JF-89C, which were being used for Rascal guidance system R&D flight testing, have been removed from that program.

2. DIRECTOR AIRCRAFT

a. DB-47E (USAF No. 51-5219)

During this quarter, five flights of the DB-47 were flown in support of the missile firing program. In addition, the DB-47 has launched two Gravity Bombs, Nos. 0201 and 0303.

b. DB-47E (USAF No. 51-5220)

Eight flights of the DB-47 were flown in support of the missile firing program, including the launch flights of Missiles Nos. 4985, 5087, and 5180. In addition, the DB-47 launched Gravity Bomb No. 0102.

c. DB-47 (USAF No. 53-2345)

This aircraft was mated with GAM-63A No. 4985 and will be used to launch R&D missiles.

d. DB-36H (USAF No. 51-5710)

This airplane was removed from the Rascal program and returned to the USAF on 16 May 1957.

e. JDB-36H (USAF No. 51-5706)

A second JDB-36H airplane has been participating in the Electronics Vulnerability Testing (EVT) Program with the JF-89C simulated missile.

3. DIRECTOR AIRCRAFT EQUIPMENT

a. Radio Set

(1) Automatic Tracking Relay Antenna System (ATRAS)

Evaluation of the new spin drive motor was successfully completed and an Engineering Change Request to incorporate the new motor in the system is being processed.

(2) Polycode Driver

System compatibility checks are continuing with design changes scheduled for this unit to provide positive compatibility between the director aircraft and missile equipment.

(3) Command Transmitter

The first model of the new microwave discriminator has been tested with satisfactory results. Two models of the AFC assembly were built and are undergoing laboratory tests; command compatibility changes are also required in this unit.

(4) NU5857 Tube

The redesign program on the NU5857 tube is under way by the vendor, National Union.

b. Terminal Guidance Control System (TGCS)

(1) 3-D Computer

Work has been discontinued on the 3-D offset computer. A status report is being prepared.

(2) Range Computer

A complete investigation was made to determine the reason for the miss distance encountered with GAM's 4985 and 4891. It was found that the components in the range computing circuitry drifted from nominal value as a result of temperature changes. Zero temperature coefficient components were incorporated in all prototype and all production systems.

(3) Azimuth and Elevation Indicators

All prototype azimuth and elevation indicators have been modified to incorporate the new unblanking change. This change eliminates extraneous video signals from being displayed during the retrace time of the sweep signal. A change request has been processed recommending incorporation in all production systems.

(4) Indirect Bomb Damage Assessment (IBDA)

Tests are continuing on the experimental models of the detector head and the servo amplifier, and developmental models of the two units are being fabricated.

Contractual obligations for the IBDA marker unit, to fabricate and functionally ground test the developmental model, have been completed. System bench tests with the unit installed in the AN/APW-17 were completed.

c. Automatic Checkout System (ACS)

In accordance with the DEI held on 16 through 18 April 1957, the following investigations are in progress:

(1) The incorporation of a marker malfunction panel in the operator's station containing all indications pertaining to safety items or functions critical to weapon system operation.

(2) Change color of all indicators in the operator's station to be compatible with the latest human engineering practices.

All Group Simulators, Dwg. No. 112-542-500-5, have been delivered to Boeing Airplane Company for use in checking out installed AN/APW-17 equipment. One additional unit is being built for evaluation purposes for the ground support trailer.

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

The DB-50D was modified as a test bed airplane for development testing and trouble-shooting the missile guidance systems.

The airplane was flown on one engineering check flight and one electronic development flight. Owing to cancellation of the Item 3 development work, this airplane has been removed from the program. Upon receipt of delivery instructions, it will be returned to the USAF.

b. JF-80B (USAF No. 45-8485)

During this quarter, use of the JF-80B aircraft for Electronic Vulnerability Tests was terminated. Arrangements to return the airplane to the USAF are in process and flyaway is expected early in the next quarter.

c. JF-89C (USAF No. 51-5814)

The JF-89C was delivered to HADC in March 1957 for use in flight testing the narrow-band relay system. Flight tests for the system have been cancelled and the aircraft will be used for Electronic Vulnerability Tests in place of the JF-80B.

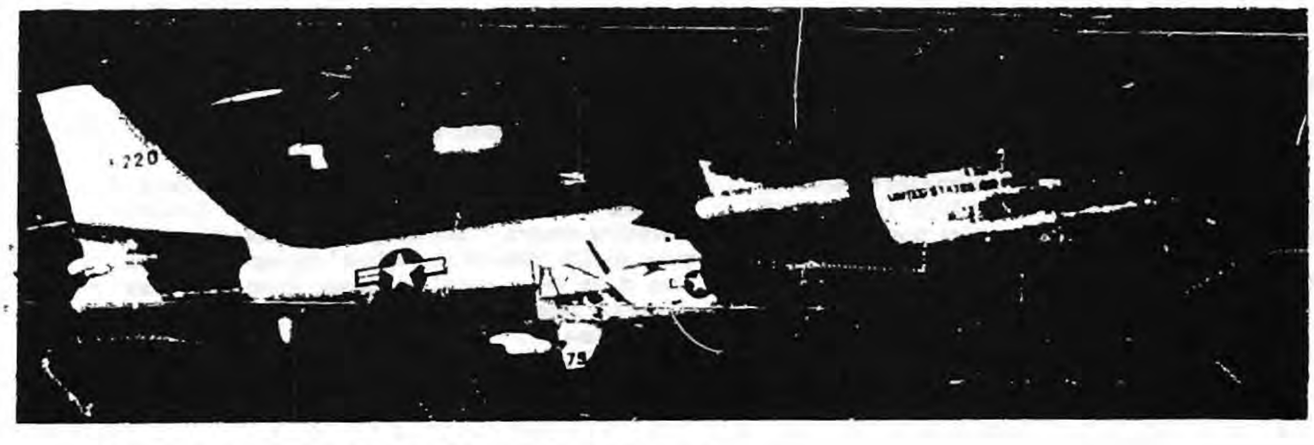


Figure 13. GAM-63A Missile and DB-47 Director Aircraft

## F. Ground Support Equipment

### 1. SYNOPSIS

The ground support equipment for System 112A 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

Fabrication of a test article of the operational Warhead Door Pan Stand (Dwg. No. 112-809-775-1) was nearing completion at the end of this quarter. The stand will facilitate transportation of a warhead pan, complete with warhead door and warhead by fork-lift truck.

#### b. Service Equipment

Design of the Tri-Liquid Flush Unit is complete and the production drawings were in final check at the close of the quarter. The unit will be utilized for cleaning the propellant pressure regulator (liquid feed valve) in the propellant 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 and Test Equipment

Engineering design of the Rocket Engine Analyzer (Dwg. No. 112-809-822-1) was completed during this quarter and the drawings were released to Manufacturing.

### 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 Manufacturing. 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 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.

Delivery of the first production article of the operational Flush and Disposal Trailer (Dwg. No. 112-789-541-1) is expected at Bell Aircraft from the Arnolt Corporation, Indianapolis, Indiana, during July 1957. The unit will undergo final acceptance-testing at AF Plant No. 38 before delivery to the USAF in the next quarter.

Engineering design of the operational Liquid Feed Regulator Tester (Dwg. No. 112-809-603-3) was completed and the drawings were released to manufacturing.

Fabrication of the operational Transport and Handling Carriage, Serial No. 2, (Dwg. No. 112-789-101-1) was completed at Bell Aircraft and then delivered to the USAF. The unit was shipped to HADC to be used in the -6/CTCI Program scheduled for August 1957.

Engineering design of a gear drive assembly (speed reducer), to be incorporated in the operational carriage, was initiated and completed during this quarter. The speed reducer will couple the hydraulic pump to the engine power take-off and its function is to permit engine speed to be increased to a more efficient range without changing the speed of the hydraulic pump.

Design effort continues in the development of shipping stands for the four major sections of the missile.

4. SPECIAL PROGRAMS

a. Development Engineering Inspection

A Development Engineering Inspection (DEI) on operational ground support equipment was conducted at Bell Aircraft's Wheatfield facility in May 1956. A total of 88 discrepancies were submitted on Form 68's. Only two items remain to be completed; both are study items.

b. Engineering Evaluation Test

An evaluation test program on warhead operational ground support equipment was conducted at Eglin AFB, Florida, during February 1957 and attended by an AFSWC team. As a result of this program, 45 recommended changes, all of a minor nature, were submitted at a later conference at AFSWC Headquarters, Albuquerque, New Mexico. The review and final disposition of all recommended changes have been accomplished and efforts are under way to make all required changes to the operational hardware, either by retrofit or in-line incorporation.

c. Human Engineering

Human engineering efforts during this quarter have been directed toward an analysis of the ground support tasks required at the squadron level to prepare the weapon for a tactical mission.

A preliminary study was undertaken at HADC, utilizing the Handbook and Hardware Compatibility Program as a data-gathering source. Observations from the human factors point of view were completed, noting testing techniques, operational hazards, and human factors problem areas. The results of a preliminary data analysis is being prepared in report form, including associated recommendations suggested for incorporation in the weapon system.

d. Ground Support Evaluation Program

The Ground Support Equipment Evaluation Program being conducted at Holloman Air Development Center is nearly completed. All but a few items have been evaluated; exceptions are the Flush and Disposal Trailer and a few pieces of equipment (tools) which have recently been added to the Subcommittee List. For the most part, the problems encountered were of a minor nature and, as such, required no major redesign.

## 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.

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.

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 currently in agreement with the operational missile and the operational DB-47 director aircraft. The instructor's console has all new panels of a nonglare type incorporating the latest nomenclature. Junction boxes and cables have been expanded to provide spares for future changes. A new optical system has been installed and is operating satisfactorily. A temporary light source which is compatible with the new optics has been installed and design work on a finalized version is in progress. The trainer is ready in this configuration to be transferred to the Air Force during August.

In addition to preparing the RGOT for transfer to the Air Force, five weeks of this quarter were used in training five Bell Aircraft/HADC guidance operators.

The all-optical target briefing device has been completed, but has not been tested or debugged due to lack of time and funds. This device was designed to produce a simulated radar picture on a screen by optical means for target briefing purposes. Its chief advantages lay in simplicity, low cost, and transportability.

## 4. TARGET ACQUISITION AND RGOT MAP EVALUATION PROGRAM

The target acquisition investigation conducted at Bell Aircraft Corporation, using the RGOT and SAC AOB's, was completed in 1956. The report on the investigation was completed during this quarter.

A new report, No. 56-949-061 entitled "Simulator Map Making for the Rascal Guidance Operator Trainer," was published in April 1957. This report includes background information and detailed step procedures for the making of simulator maps for use with the RGOT.

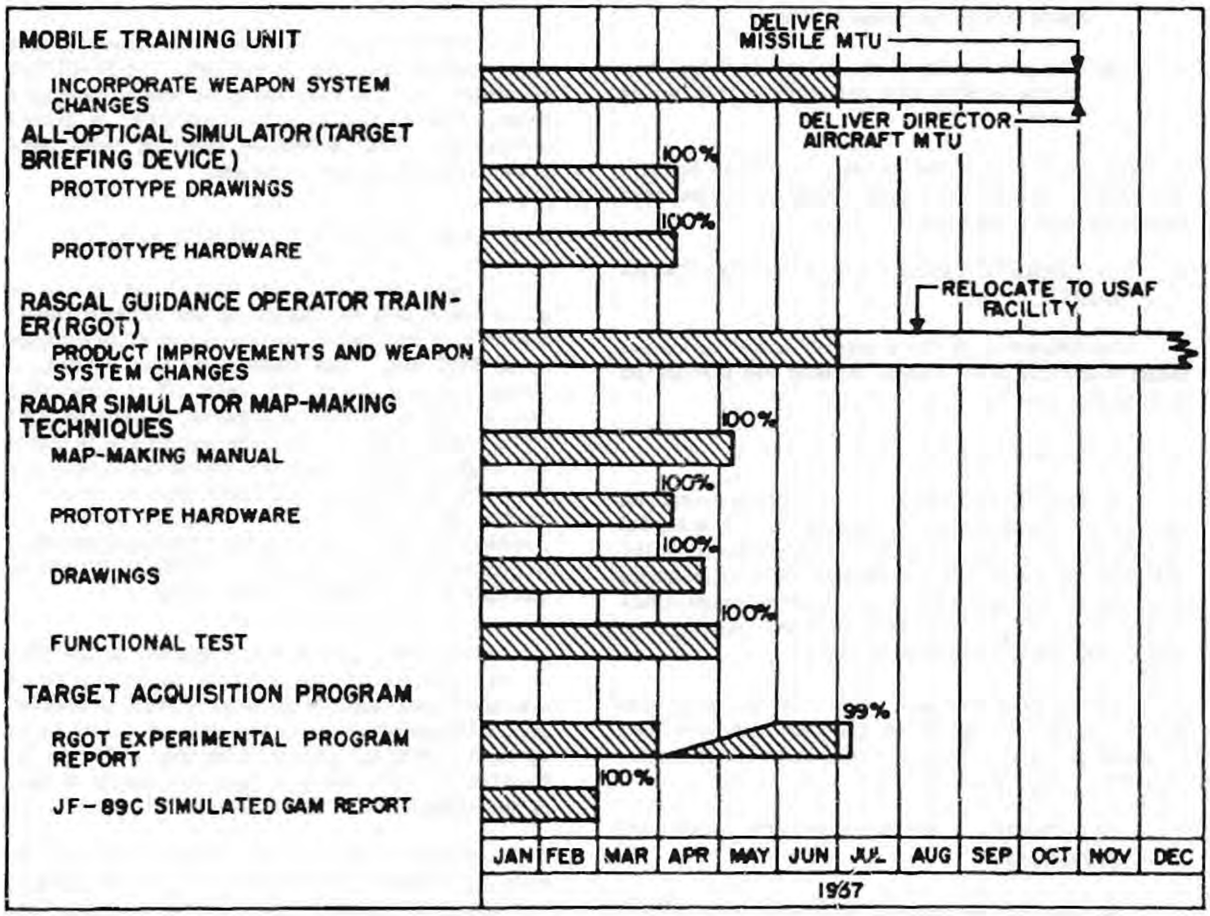



Figure 14. Status of Training Equipment Programs

## H. Weapon System Investigations

1. GRAVITY BOMBING CAPABILITY

In the gravity bombing capability program, three full-scale Rascal missiles have been released from a DB-47 under typical launch conditions. Summary reports are being prepared. Results of the tests were satisfactory and the design for missile incorporation is being accomplished.

Studies had been made to determine holding forces necessary when surfaces were to be held in place during the missile drop. It was predicted that a clean launch would occur when the missile was launched with the rudders locked in the worst possible way. This prediction was based on the following facts:

(1) The rudders are small and are at a low force stalled condition at launch.

(2) The yaw inertia of the missile is large, thus giving a slow yaw response to the rudder force.

A subsequent launch did result in a "clean break." Trajectory predictions were made and compared favorably with actual drops.

2. ALTERNATE TARGET AND AIMPOINT CAPABILITY

Investigation of the alternate target and aimpoint capability of the Rascal missile was terminated during this quarter.

3. CAPABILITY STUDIES

Recent curtailment of USAF requirements has prevented continuation of studies on (1) autopilot structural coupling, (2) requirements imposed on the autopilot by the radar set antenna, (3) requirements imposed on the autopilot by the inertial range-computing system, (4) terminal guidance capabilities, and (5) analysis of platform leveling.

Drafts of a summary report on the pitch loop and a summary report on the yaw loop have been completed. It is planned to have these reports published by 1 September 1957.

4. ELECTRONIC VULNERABILITY TESTING PROGRAM

As part of the System 112A R&D work effort, an Electronic Vulnerability Test (EVT) Program is under way at HADC utilizing the JF-89C (USAF No. 51-5814) and the JDB-36H (USAF No. 51-5706) aircraft. 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.

In this quarter, six successful flights were made for data requested by the Missile Countermeasures Laboratory. Four flights were completed satisfactorily using the JF-80B (USAF No. 45-8465) and two were satisfactorily made using the JF-89C (USAF No. 51-5814). The JF-80B was replaced in the EVT program by the JF-89C on 12 June.

Flights for the detection and analysis phase requirements have been completed. The JF-89 flights scheduled in June were directed toward testing the relay receiver and command receiver in jamming techniques. Four scheduled jamming tests remain to be completed in this program.

5. LOW-ALTITUDE LAUNCH CAPABILITY

Flight plans have been formulated for this program which call for launching the missile while the director is in a 2g pull-up maneuver at an altitude of about 2400 feet. The missile will then continue at a climb angle of about 30°, level off at about 50,000 feet, and dive shortly afterwards, as initiated by the IRCS. The missile will dive toward the target at a 35° angle. The performance evaluation revealed that the missile is aerodynamically capable of attaining ranges up to 58.5 nautical miles and impact Mach numbers as high as 1.09, after climbing from the low launch altitude to altitudes of 50,000 or 60,000 feet, and then diving normally to the target.

Utilization of the MA-8 system of the DB-47 at low altitude, to insert initial conditions into the missile's nonemanating guidance system, proved feasible, although marginal, based upon experiences gained by SAC. With the advent of Doppler radar, in combination with the MA-8 system, the marginal nature of this operation will be eliminated.

Further studies on the autopilot disclosed that, with the exception of the roll loop, no modifications are required. Again, change in the roll loop (lower gain) is required at altitudes below about 10,000 feet.

Thus, a pressure-sensitive gain-switching mechanism will be required in the roll loop.

The pitch programmer is in error by about 3°; however, this is still within the tolerance requirements of the relay link.

Minor modifications will be required on the auto-check system to adapt it to operation in conjunction with the LABS computer, which, as presently planned, will cause the missile release.

Modifications are required in the warhead fuzing system to prevent arming of the warhead at low altitude. The modification consists of inserting a timer in the fuzing circuit to disable this circuit until the missile has attained altitude.

6. OPERATIONAL UTILIZATION SUMMARY REPORT

The "Operational Utilization Summary," Report No. 66-989-001, dated June 1957, was published and is being prepared for distribution.

7. MISSION PLANNING DATA REPORT

The flight planning information required for the E&ST program has been completed and transmitted to Eglin AFB. A flight planning computer, including the ground set, specific mission adjustments, and necessary inflight corrections, has been completed and transmitted to appropriate agencies.

Revision "A" to the Flight Planning Data Report is in work and includes the planning effort commensurate with the operational utilization of the weapon system.

8. ANALYSIS OF PACKAGING REQUIREMENTS

The System 112A packaging analysis, Report No. 66-989-028, has been published. Publication of Report No. 02-945-155, packaging proposal, is expected during the next quarter.

# 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 AFB 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.

During this quarter, a formal technical training program was conducted by contractor technical representatives at the request of APGC. The training program involved nine training courses, enrolling 83 trainees. The objectives of the program were to provide adequate numbers of technical personnel to support a two-shift operation during E&ST and to qualify all USAF maintenance personnel, in conjunction with the new Airmen Guided Missile Career Field.

As of this date, 90% of all classroom instruction was completed. Plans were formulated for practical training that should qualify all trainees prior to 1 October 1957. On 26 June 1957, all additional contractor technical representatives assigned to Eglin AFB to conduct training returned to Buffalo owing to a lack of funds for Fiscal Year 1958. Training will be completed by USAF personnel and contractor technical representatives presently assigned to Eglin AFB.

Some performance computations have been made for the compilation of the E&ST program handbook. In addition, detrimental range losses due to degraded launch conditions were computed and forwarded to the WSPO.

## B. Logistics Depot

Accountability records have been established and the system reflects the growing number of items received and shipped by the Depot to support the GAM-63A Weapon System. To date, 14,000 Common AF Tools and Equipment items of an ultimate 18,000 such items are in stock. There are 9,600 line items of the GAM-63A Weapon System in stock, provisioned to the Depot under Contract AF 33(038)-15069.

## C. Technical Training And Support

1. AIR FORCE TRAINING

Plans have been formulated and contract negotiation has been initiated with Technical Training Air Force (TTAF) and Mobile Training Wing (MTW) Commands for a Mobile Training Unit (MTU) Training Program for the GAM-63A Mobile Training Detachment. This program will involve seven training courses and approximately fourteen MTW personnel. The training program is planned to start upon delivery of the MTU's, approximately 1 November 1957.

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.

In addition to the technical representatives at Eglin AFB, Bell Aircraft has assigned three technical representatives to Lowry AFB to assist Air Training Command (ATC) instructors in their Phase II Factory Training Program.

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.

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 Requirement Handbook and the List of Applicable Pulbications, have been delivered to the USAF. The remaining two technical orders will be delivered when requested by the Air Force. All Illustrated Parts Breakdowns for the missile have been completed. Completion of the eight remaining vendor IPB's is expected by 1 October 1957.

3. GROUND SUPPORT EQUIPMENT

Delivery of handbooks for ground support equipment is required 30 days prior to delivery of related equipment. A continuous review is in process to ensure issuance of additional handbooks in support of added operational requirements.

The balance of 11 IPB's for ground support equipment will be completed by 1 September 1957. Fifteen vendor IPB's will be completed by 1 October 1957.

4. AN/APW-17 DIRECTOR AIRCRAFT GUIDANCE

System maintenance handbooks on the AN/APW-17 Radar Course-Directing Central have been delivered on schedule. Constant reviews are in process to keep the handbooks current with system configuration.

Illustrated Parts Breakdowns for the AN/APW-17 guidance system have been completed and delivered. IPB revisions to present system configurations are in work.

5. OVERHAUL HANDBOOKS

Overhaul handbooks on the Rascal Weapon System have been partly prepared pending resolution of equipment requirements at the GAM-63A Logistics Depot (see Appendix I, Facilities). Completion date of the handbooks will be determined by AMC with respect to Depot equipment requirements.

6. HANDBOOK REVISIONS

A program is in effect in which handbooks already delivered are revised to reflect (1) additional component configurations (dash numbers added to Bell drawings) and (2) changes resulting from handbook equipment demonstration programs under way at Bell Aircraft facilities.

To achieve maximum reliability, the handbooks are continually reviewed and revised to incorporate the maximum level of adjustments and repairs which can safely be accomplished at a Wing/Base level.

# 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 15 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

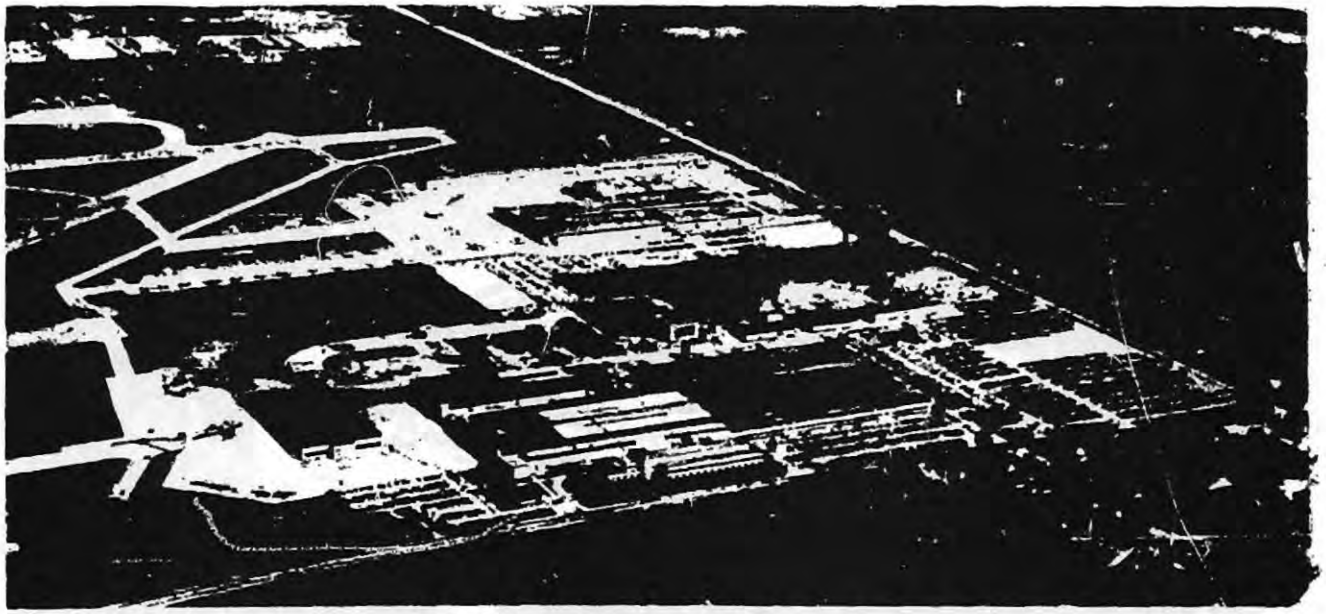


Figure 15. Bell Aircraft Plant at Wheatfield, New York

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. The general administrative offices are also situated here.

An Electronic Data Center is being erected west of the Administration Building at the Wheatfield Plant. The one-story structure, 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 58 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 propulsion system and for checking

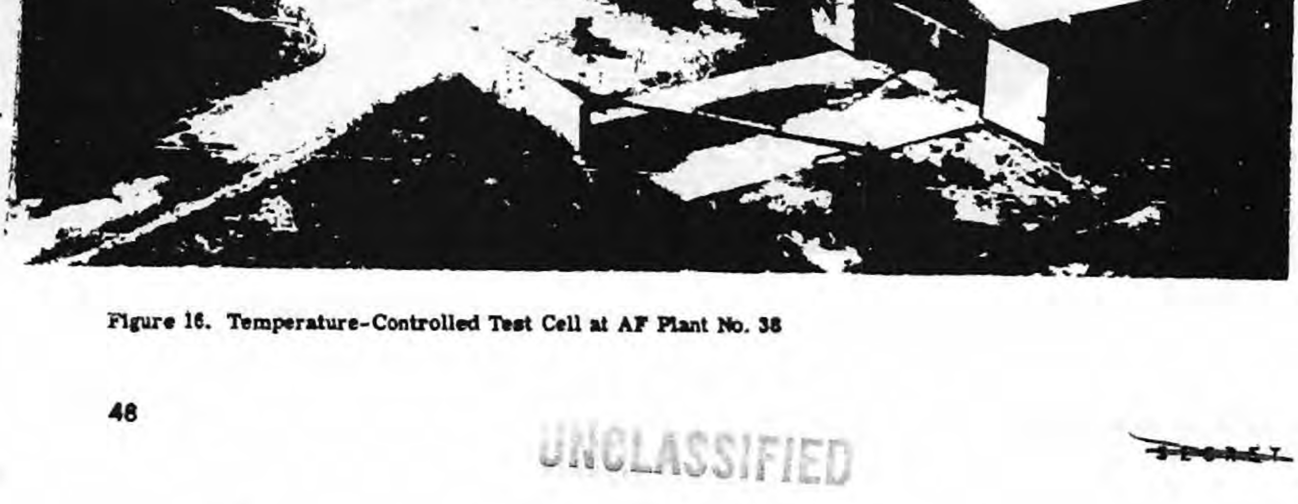


Figure 16. Temperature-Controlled Test Cell at AF Plant No. 38

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.

A temperature-controlled test cell is shown in Figure 16.

Additional laboratory space has been provided in the area formerly occupied by the cafeteria which was moved to the Manufacturing Building. Testing 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.

During this quarter, two new test areas, designated E-10 and E-11, were placed in operation for testing Rascal thrust chambers, pumps, and engines. All of the test information was recorded, using the new high-speed digital data-handling system. The mixture ratio computer chassis for this system is scheduled for delivery early in July. The contract for the additional laboratory space has been awarded, and construction should be completed during the next quarter. As soon as this area is completed, it will increase the rate of calibration of pressure transducers and, at the same time, diminish the inaccuracies.

The new equipment will include an analogue-to-digital conversion unit for processing the calibration data. Additional space and facilities will be made available for the Standards and Calibrations operation at this facility.

The permanent installation of the MB Type C100 vibrator test assembly has been completed and the vibrator placed into production testing. Transferring of this vibration testing from the Wheatfield facility to AF Plant No. 38 has diminished the time between final assembly and final acceptance-testing.

d. Air Force Plant No. 40

Following negotiations with Headquarters, Air Materiel Command, Bell Aircraft Corporation was granted right of-entry to Air Force Plant 40 to establish a Logistics Depot for the Rascal Weapon System. Located in the Town of Tonawanda, New York, this contractor-operated facility comprises approximately 56,000 square feet of floor space. A proposal has been submitted through Air Force channels to obtain an additional 42,000 square feet of floor space required for bulk storage. 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. Deliverable Depot items are being stocked and procurement of facility equipment to operate the Depot is approximately 90% complete.

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-89C 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. The flight test program is supported by the HADC range instrumentation which includes Askania cinetheodolite stations, radar tracking stations, a radar network, telemetering ground stations, 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 that the pertinent information affecting design 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 position, Stations F, G, X, and Y, are located at HADC (see Table I).

# APPENDIX II

# LIAISON

## 1. CHRONOLOGICAL LISTING OF TRIPS

| Organization Visited | Date | Topics Discussed |
|---|---|---|
| Eglin Air Force Base Valparaiso, Florida | 4/10/57 | Flight Planning for EAST Program |
| Eglin Air Force Base Valparaiso, Florida | 4/17/57 | Ground Support Equipment Evaluation |
| Naval Air Development Center, Johnsville, Pa. | 4/24/57 | Symposium on "The Acceptance of Risk in Weapon Delivery" |
| Holloman Air Development Center, New Mexico | 4/24/57 | Gravity Bomb Test Vehicle |
| Oklahoma A&M College Stillwater, Oklahoma | 4/25/57 | Electromagnetic Relays — National Conference |
| Holloman Air Development Center, New Mexico | 4/26/57 | DB-47 Checkout Trailer |
| Eglin Air Force Base Valparaiso, Florida | 5/2/57 | Handbook Evaluation – Ground Support Equipment |
| Pinecastle Air Force Orlando, Florida | 5/8/57 | Squadron Facility Conference |
| Wright Air Development Dayton, Ohio | 5/9/57 | Power Plant Specification |
| Wright Air Development Center, Ohio | 5/13/57 | Oxidizer Fill and Vent Adapter |
| Holloman Air Development Center, New Mexico | 5/15/57 | Handbook Demonstration Program |
| Wright Air Development Center, Ohio | 5/16/57 | Propellant Quality Control for Rascal Squadron |
| ACF Industries Berwick, Pa. | 5/23/57 | Ground Support Equipment Transport Carriage |
| ARDC Dayton, Ohio | 5/28/57 | ECP Technical Approval |
| Lytle Engineering and AFSWC, Albuquerque, New Mexico | 6/7/57 | Handbook Coordination Conference |

## 2. SUMMARY OF TRIP REPORTS

### a. Wright Air Development Center

#### (1) Specifications

Bell Aircraft Specification 66-947-406 was reviewed with WADC Power Plant Laboratory personnel on 9 May 1957. It was agreed that the specification would include separate Preliminary Flight Rating Test (PFRT) and Qualification Tests sections.

#### (2) Quality Control

A Bell Aircraft memo entitled "Propellant Quality Control for Rascal Squadron" was reviewed with WSPO and WADC Power Plant Laboratory personnel on 16 May 1957.

A decision was made by WADC to use a B-1 Nitric Acid Trailer for the Rascal Weapon System since a B-2 trailer would not be available.

#### (3) ECP Technical Approval

During a visit to ARDC on 28 May 1957, ECP Technical approvals were granted by ARDC and AMC personnel, following a review of ECC's, covering several systems contained in the Rascal missile. Bell Aircraft was asked to define contractual requirements for the technical data portions of a telemetering change.

#### (4) Oxidizer Fill and Vent Adapter

A conference was held at WADC to discuss the technical background and cost structure of ECP BEL-GAM-63-256A, which incorporates a stainless steel oxidizer fill and vent adapter into Missiles 95 and 102 and subsequent. An Air Force standard part manufactured from aluminum alloy was considered but, although the unit costs agreed for both aluminum and stainless steel, technically it appeared desirable to use stainless steel for the adapters.

### b. Holloman Air Development Center

#### (1) Director Aircraft Checkout Trailer

At HADC on 26 April 1957, checkout of DB-47 No. 53-2345 with the checkout trailer was completed to the minimum performance requirements specified in T.O. 11G2-3-3-14.

#### (2) Gravity Bomb Test Vehicles (GBTV)

Binding of aileron locking pins was encountered at HADC on GBTV Nos. 0201 and 0303. Wheatfield personnel familiar with the aileron mechanism successfully reworked and reinstalled the working parts at HADC on 24 May 1957.

#### (3) Handbook Demonstration Program

A Handbook Demonstration Program was prepared by HADC and Wheatfield personnel during May 1957, using GAM No. 89 and suitable ground support equipment.

c. Eglin Air Force Base

(1) E&ST Program

During a trip to Eglin Air Force Base on 10 April 1957, final detailed flight planning data for E&ST missiles was presented to Air Force personnel.

(2) Ground Support Equipment Evaluation

During the week of 24 April 1957, Bell personnel invesigated ground support problems arising at Eglin AFB. Of primary concern was the flush and disposal trailer. No major problems were encountered; all problems were quickly resolved.

(3) Handbook Evaluation

The purpose of the trip to Eglin AFB was to check the DB-47 checkout trailer for compatibility with Technical Order 11G-3-3-14 and propose corrective action.

d. Pinecastle Air Force Base – Squadron Facility Conference

SAC requested Bell Aircraft representation at the GAM-63A Operational Squadron Facility Conference at Pinecastle AFB on 8 May 1957. Customer Service personnel attended the Conference during which an existing working estimate for construction of the subject facility was reviewed. Reduction of construction cost and the effects of such reductions on the operational sequence were the major issues discussed.

e. Miscellaneous

(1) Risks in Weapon Delivery

On 24 and 25 April 1957 a meeting was held at the Naval Air Development Center, Johnsville, Pa., on the subject of "The Acceptance of Risk in Weapon Delivery." All types of weapons were discussed including nuclear weapons and the risk involved due to radiation, gusts, and flying debris.

(2) Electromagnetic Relays

The Fifth National Conference on Electromagnetic Relays was held at Oklahoma A&M College, Stillwater, Oklahoma, on 2[illegible] through 25 April 1957.

The Navy Inter-Bureau Technical Committee reported on the results of a survey of relay application requirements taken among a general cross-section of U.S. guided missile manufacturers, with the objective to guide relay manufacturers to design relays suitable for missile use. Another report dealt with evaluation test procedures for guided missile relay application and related problems, such as environments, which confront relays in application.

(3) GAM Transport Carriage

A trip was made to ACF Industries, Berwick, Pa., on 21 May 1957 to investigate and aid in eliminating a galling problem on the pitch and translate structure of the GAM transport and handling carriage.

(4) Handbook Coordination Conference

A Handbook Coordination Conference was held at Lytle Engineering on 4 and 5 June 1957 dealing with warhead T.O.'s.

On 6 June, a conference was held in the AFSWC Development Directorate Conference room to discuss the requirements of a new T.O. dealing with information required by an aircrew to perform a mission.

# APPENDIX III

## DELIVERY AND DISPOSITION OF GAM-63A's

| Bell Serial No. | AMC Delivery Date | R&D | | | | USAF Serial No. | Other Disposition | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Launch | | Other | | | | | | |
| | | No. | Date | Used For | Date | | EAST | ATC | 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 | 18 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. | Other Disposition E&ST | Other Disposition ATC | Other Disposition Rework | Other Disposition 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 Launch No. | R&D Launch Date | R&D Other Used For | R&D Other Date | USAF Serial No. | Other Disposition EAST | ATC | Rework | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 5180 | 19 Jun 57 | | | AF53-8215 | | | | Destruct system triggered few seconds after launch. Missile functioning ok. |
| 81 | 17 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 | 4985 | 10 Apr 57 | | | AF53-8220 | | | | |
| 86 | 31 Oct 56 | - | - | Test to failure | 31 Oct 56 | AF53-8221 | | | | |
| 87 | 16 Nov 56 | 5087 | 14 May 57 | | | AF53-8222 | | | | |
| 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 | 19 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 | 26 Mar 57 | - | - | | | AF53-8233 | | | | On hand for R&D |
| 99 | 27 Mar 57 | - | - | | | AF53-8234 | | | | (DEI missile 16-18 Apr 57) |
| 100 | 17 Apr 57 | - | - | | | AF53-8235 | | | | On hand for R&D |
| 101 | 19 Apr 57 | - | - | | | AF53-8236 | | | | On hand for R&D |

| 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 | 33 | 33 | | | | | | | Not yet delivered Nos. 59, 62, 65 thru 72, 100 thru 124 (see Note 3) |
| | | | | 14 | 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 |
| | | | | | | | | 11 | | On hand for R&D Nos. 88, 89, 90, 93, 94, 96 thru 101. |
| 1956 | 22 | 22 | 0 | | | | | | | |
| Total | 136 | 55 | 81 | 51 | 10 | 3 | 1 | 11 | 5 | Planning for 55 missiles not yet delivered: 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:

51 missiles launched in R&D
10 missiles used in R&D other
3 missiles used in E&ST/OJT
1 missile used by ATC
11 missiles on hand for R&D launch
5 missiles delivered to be reworked

81 Subtotal

14 yet to be delivered for E&ST launch
41 yet to be delivered for squadron

136 Total