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RASCAL WEAPON SYSTEM (Project MX-776)

BELL AEROSPACE CO BUFFALO NY

30 SEP 1954

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PROJECT MX-776

QUARTERLY PROGRESS REPORT

BMPR-38

30 SEPT. 1954

BELL Aircraft CORPORATION

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PROJECT MX-776
RASCAL WEAPON SYSTEM
quarterly progress report

BMPR-38

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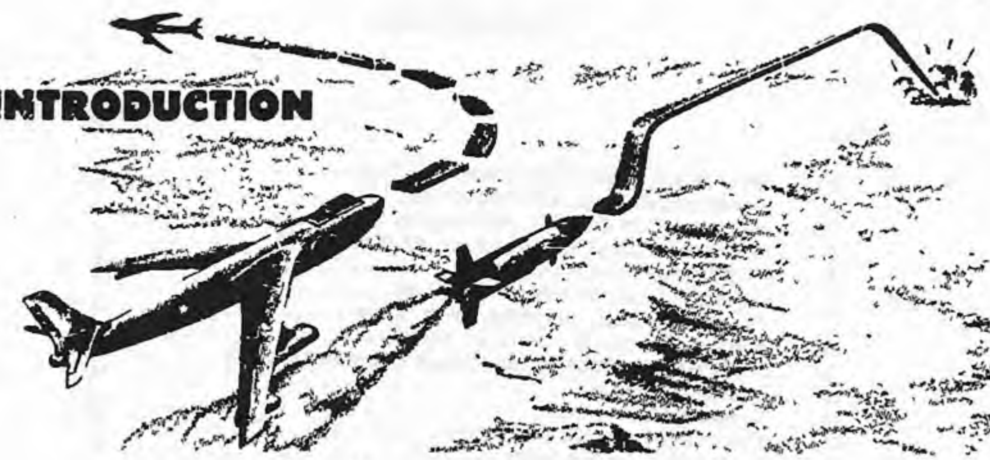

The Rascal Weapon System

The Rascal (B-63) Weapon System is an airborne instrument of combat designed "To provide strategic bomber aircraft with an increased capability for attacking and destroying heavily defended strategic targets".* Principal elements are: (1) the B-63 pilotless bomber, (2) the director aircraft, (3) support equipment, and (4) training aids.

The B-63 is a rocket-powered, supersonic, air-to-surface pilotless parasite bomber. Weighing 18,500 pounds, it carries a 3000-pound warhead at speeds in excess of Mach 1.0, with maximum in excess of Mach 2.0. It has a range of 90 nautical miles, and an accuracy, based on 75-nautical-mile range, so that 50 percent of the pilotless parasite bombers shall have a burst strike within 1500 feet of a vertical line through the target and within plus or minus 405 feet M.S.L. of a predetermined altitude. Principal dimensions of the B-63 are: length, 32 feet; diameter, 4 feet, and maximum horizontal span, 17 feet.

A rocket power plant using white fuming nitric acid and gasoline propellants supplies 12,000 pounds thrust for a short period to accelerate the pilotless parasite bomber to supersonic velocity during its climb to altitude. For the remainder of the flight, a smaller sustaining thrust of 4000 pounds is used to maintain supersonic speeds.

During the gyro-stabilized midcourse portion of the flight, a range-computing inertial guidance system computes the distance traveled and causes the PPB to enter the terminal dive automatically. During the terminal portion of the flight, a radar relay and command system enables the guidance operator in the director aircraft to send course correction signals to insure a strike within the required accuracy.

The B-36 strategic bomber has been designated the first priority director aircraft, followed by B-47 and B-52 bomber aircraft in this order. For the present, only B-36's and B-47's will be considered. For research and development testing, B-50's will be used as director aircraft.

In a typical mission, the director aircraft, using a standard navigation/bombing radar system, proceeds to a predetermined launch point. Immediately prior to launch, information regarding aircraft velocity and range to target is fed into the PPB and serves as initial condition data for its non-emanating inertial guidance system. The missile is under control of this gravity-referenced system during the midcourse phase of the flight. At a predetermined range from target, the missile's inertial system causes it to assume a 30° terminal dive. During the dive, an unattended search radar in the nose of the missile illuminates the target, and the radar return is relayed from the missile to the director aircraft where it is displayed on an indicator. An operator tracks the missile's flight to target, and, by sending guidance commands to the missile, makes slight corrections to the dive path to assure a strike within the required accuracy.

* "Military Characteristics for a Pilotless Parasite Bomber", SAB-51-B1, 14 December 1951, Directorate of Requirements Hq. USAF; and "Development Directive" No. 0027-A1, 4 February 1952, ARDC.

SECTION I
SUMMARY

A. Historical Summary

The Rascal project was initiated by the Air Materiel Command, USAF, on 29 April 1946, as a study program for the conception of a subsonic air-to-surface pilotless parasite bomber to be launched from bombardment aircraft. This program was later amended to include a supersonic pilotless parasite bomber; eventually the subsonic phase was dropped.

In January 1948, Project MX-776 was divided into two concurrent programs:

MX-776A (Shrike) - Design, development, and fabrication were started on the Shrike missile, a supersonic Rascal test vehicle with a 50-mile range and load-carrying provisions for warheads up to 2000 pounds.

MX-776B (Rascal) - Work initiated in 1946 on the development of a radar-relay guidance scheme for Rascal was continued. A simulated director and pilotless parasite bomber flying team, utilizing two B-17 aircraft, was equipped with an experimental Rascal guidance system. Reflecting the test results from this phase of the program, an improved system for installation in a B-17/F-80 (simulating a director and missile combination) aircraft was developed. This system, with certain refinements, is now being flight-tested in XB-63 pilotless parasite bombers.

In the Spring of 1950, Air Materiel Command authorized Bell Aircraft to proceed with the detail designing and fabrication of missiles.

The Rascal/Shrike program was subsequently accelerated in August 1950. In December 1951, the Air Force announced that the production Rascal PPB would be designated the B-63; early R & D missiles would be called XB-63's.

In February 1952, the Rascal program was again reoriented to attain a B-63 for use by the military in 1955. This B-63 will be as proposed in the Bell Aircraft feasibility proposal, dated 10 January 1952, and shall be capable of being launched from a DB-36 airplane.

The MX-776 program passed a major milestone in September 1952 when the first XB-63 pilotless parasite bomber was released from a DB-50 director aircraft to fly under its own power. In January 1953, the Shrike flight-test program, which included 31 missiles, was successfully completed. The experience gained from this program is now being applied to the XB-63. By the end of 1953, two glide and four powered XB-63's had been launched; the last had full guidance equipment.

B. Project Status Summary

THE FIRST OBJECTIVE OF PROJECT MX-776 IS A WEAPON SYSTEM CONSISTING OF A B-63 PILOTLESS PARASITE BOMBER (PPB) CARRIED AND DIRECTED BY A DB-36 DIRECTOR AIRCRAFT. THE PPB EMPLOYS AN INERTIAL RANGE COMPUTER, AN X-BAND TERMINAL GUIDANCE SYSTEM, AND ASSOCIATED EQUIPMENT. LATER IN THE PROGRAM A DB-47 AIRCRAFT WILL BE USED. EARLY IN 1952, A COMPLETELY NONEMANATING GUIDANCE SYSTEM WAS ESTABLISHED AS A BASIC ULTIMATE REQUIREMENT FOR THE PPB. THIS REQUIREMENT WILL BE SATISFIED UNDER LATER PROGRAM OBJECTIVES. A CHEMICAL WARHEAD CAPABILITY AND A K_u-BAND SEARCH RADAR WILL BE DOVETAILED INTO THE WEAPON SYSTEM.

* * * * * * * * * * * * * * *

Development studies are under way in an effort to simplify the XB-63 servopilot system by eliminating the roll-rate gyro from the roll system and the g-limiting accelerometers from the pitch and yaw systems.

Environmental testing of the PPB servo mock-up No. 2 has been completed with excellent results. The tests conducted in this quarter included five-degree-of-freedom computer runs at temperatures of +160°F and higher. The feasibility of converting this mock-up to conform with Model 56F missiles is being studied.

Initial temperature and vibration tests on prototype series "C" servo valves have indicated that it may be advantageous to replace the present servo valves with the series "C" valves. These valves feature a Bell-designed diaphragm which effectively isolates the magnetic circuit from the flow of fluid from the nozzles, thereby eliminating magnetic dirt particles that ordinarily cause failures in flapper-type valves.

A Staff Officer's Orientation course on Project MX-776 was started. Instruction covered the operation of the Weapon System and component parts. Classroom Demonstrators for the PPB and director aircraft have been completed and are being used in the Orientation Program. This program began at Bell Aircraft on 12 July 1954 and will continue until 22 October 1954. After this date, the demonstrators will be used by the Bell Aircraft Service and Training Section as training aids in the Training Program at Lowry and Chanute Air Force Bases. The breadboard model of the Bell-designed Optical Radar Simulator has been used to demonstrate the "blowup" of the target radar picture during the terminal dive of the XB-63. Procurement specifications for this unit, which contains computer-controlled map drives, movable cursors, and a superior optical system, have been completed and initial negotiations with a qualified optical subcontractor have taken place.

Phase II of a plastic materials study was started, comprising the investigation and design of the aft wing and other selected portions of the B-63 airframe from fibrous glass laminated plastic materials.

The climatic test program was successfully completed at Eglin Air Force Base. In this program XB-63 No. 18 was subjected to Rain, Temperature, Humidity, Salt Spray, Sand and Dust, and Solar Radiation to determine the environmental limits of internal components of the XB-63 when various external environments were imposed. The primary objective was to obtain information to be used in establishing climatic end limits for qualification testing missile components. The secondary purpose was to observe missile performance under extreme climatic condition.

Design of the prototype, Radar Guidance Operator Trainer RGOT, (DB-47 version) is complete except for the permanent-type shipping crates. Design of a DB-36 station for use with the RGOT has been started and will be completed in time to allow manufacture of this unit by August 1955 (initiation of guidance operator training).

Changes in telemetering instrumentation were made on all of the remaining Model 56B PPB's through No. 28. These changes consisted of adding continuous telemetering channels to the power plant instrumentation to obtain information on chamber pressures, fuel pressures, and oxidizer-pump discharge pressures. Provisions were also made to telemeter rocket firing, and turbine-arming and firing-switch actions. To provide for the continuous-channel telemetering of these items, some of the less critical data were removed from continuous channels and fed to a commutator. The entire four-channel telemetering system scheduled to be used in PPB's 46 through 64 has been reviewed to conform with changes in flight planning. Telemetering of the warhead fuzing system and a monitoring circuit for the crystal current of the USR were added. The matching network for instrumenting the PPB for impact data has been completed and the initial

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installations have been accomplished. This will provide for the monitoring of data from the MC-300 fuzes in all PPB's equipped with the 16-channel telemetering system.

Design revisions are nearly complete for the nose and aft body of the F-89C airplane which will be used to simulate the XB-63 in flight. An analysis report covering the major structural changes to this aircraft is being prepared for submittal to WADC during the next quarter.

More than one-thousand simulated B-63 flights have been made to determine the combined effects of midcourse errors, terminal guidance errors, and delayed target recognition on the dispersion of ground burst against ideal point-targets. The resulting data indicated that for each given condition of weight, velocity, and target recognition, it was possible to establish, in a horizontal plane at 60,000 feet, an area of terminal dive initiations wherein the miss-distance was less than 1500 feet.

The Boeing Airplane Company has completed the aerodynamic and compatibility tests utilizing DB-47, serial No. 51-5219, and a simulated pilotless parasite bomber. On 3 September 1954, the DB-47 and the simulated PPB were transferred to Edwards Air Force Base where extensive flight tests are to be conducted. Since this DB-47 is structurally equipped to launch PPB's it will be used to drop the simulated missile after the Air Force flight evaluation is complete. The DB-47 is scheduled for delivery to Boeing, Wichita, early in January 1955 for installation of Rascal guidance equipment.

The first set of Model 110 guidance system components fabricated by Bell Aircraft was installed by Convair in the DB-36 director airplane, serial No. 51-5710. The second set of Model 110 guidance components was installed by Boeing in the DB-47 airplane, serial No. 52-5220. A set of Model 110 components was delivered to Convair late in July 1954 for installation in the second DB-36, serial No. 51-5706.

Studies to improve the performance and reliability characteristics of the Rascal guidance system have met moderate success. These studies include an indirect bomb damage assessment (IBDA), a stabilized automatic tracking relay antenna system (SATRAS) and a high power unattended search radar (USR) system. A preliminary design of an IBDA marker unit has been completed and is ready for final packaging. This unit will provide range marks on a plan position indicator to determine the distance of the missile from the target. Fabrication of SATRAS prototypes is continuing concurrently with the flight evaluation of the laboratory model of the stabilized version of the relay antenna system. Spectrum difficulties during high-power operation of the USR system have been isolated. The pulse transformer is being redesigned to increase rise time of the modulating pulse and thereby eliminate this difficulty.

An approach for controlling the temperature of the inertial guidance compartment in the ultimate weapon system has been finalized. Also for the ultimate weapon system, initial-condition data for three targets can be set into memory circuits before take-off, thereby allowing an operator to choose a target during the prelaunch period by adjusting a selector switch. A three-axis hydraulic test table for evaluating the platform of the multiaxis inertial guidance system was put in operation in all three axes.

Owing to unexplainable power plant malfunctions subsequent to the launching of PPB's No. 1016 and 1117, these missiles became inoperative shortly after 1.6 seconds. None of the flight objectives were satisfied.

A series of captive flights was run on XB-63 Nos. 19, 21, 22, and 24. These tests progressed to a point where operation of all systems was considered satisfactory. Operation of PPB No. 22 was considered very good on its first captive flight and it was considered ready for a launching. PPB Nos. 19 and 21 were modified for a free-drop launch configuration and hot firings were scheduled for early October 1954.

At HADC, a program to establish compatibility between Model 56F missiles and DB-36/DB-47 director aircraft is being conducted. Both types of aircraft and PPB No. 48, to be used in this "mating" program, were delivered to HADC. Preliminary inspection work, incorporation of service kits, and functional checks have been made on director aircraft and missile equipment.

STATUS OF XB-63's, 30 SEPTEMBER 1954

AIR-FRAME	PURPOSE	PRODUCTION	FACTORY SYSTEMS TESTING	PRE-FLYAWAY MODIFICATION AND RETEST	HADC FLIGHT TESTING	DATE EXPENDED
01	MOCK-UP POWER PLANT	AT AF PLANT 38 FOR POWER PLANT DEVELOPMENT				—
02	MOCK-UP AUTOPILOT	A. WHEATFIELD FOR SERVO DEVELOPMENT				—
03	STATIC TEST / SIMULATED PPB	MODIFIED TO SIMULATED PPB – FOR DB-47				
04	GLIDE TEST					9–51
05	GLIDE TEST					12–51
07	HIGH-PRESSURE POWERED FLIGHT					9–52
08	INTERF. TESTS/PP ATTITUDE TESTS		AF PI[illegible]S FOR POWER PLANT TESTS			—
09	HIGH-PRESSURE POWERED FLIGHT					1–53
10	HIGH-PRESSURE POWERED FLIGHT					3–53
15	GUIDED FLIGHT – H.P ENGINE					10–53
13	GUIDED FLIGHT – H.P ENGINE					1–54
11	STAB. FLIGHT – AEROJET PUMP PP.					3–54
12	STAB. FLIGHT – AEROJET PUMP PP					5–54
14	STAB FLIGHT – AEROJET PUMP PP					6–54
16	GUIDED FLIGHT-AEROJET PUMP P.P.					7–54
17	GUIDED FLIGHT-AEROJET PUMP P.P.					8–54
18	ENVIRONMENTAL TEST ARTICLE					9–54
19	GUIDED FLIGHT-AEROJET PUMP PP					
20	GUIDED FLIGHT – BELL PUMP P.P.					
21	GUIDED FLIGHT – AEROJET PUMP P.P.					
22	GUIDED FLIGHT – AEROJET PUMP PP					
23	GUIDED FLIGHT – AEROJET PUMP PP					
24	GUIDED FLIGHT – AEROJET PUMP PP					
25	GUIDED FLIGHT – AEROJET PUMP PP					
26	GUIDED FLIGHT – AEROJET PUMP PP					
27	GUIDED FLIGHT – AEROJET PUMP PP.					
28	GUIDED FLIGHT – AEROJET PUMP PP.					
29	K_U-BAND GROUND TEST		IN MODIFICATION			
30	2 POINT FREE DROP					
31	2 POINT FREE DROP					
32	2 POINT FREE DROP					
33	2 POINT FREE DROP					
34	2 POINT FREE DROP					
35	2 POINT FREE DROP					
36	INTERFERENCE TESTS/FLIGHT TEST					
37	TECH COMP. TESTS/FLIGHT TEST					
38	DB-36 / DB-47 CHECKOUT AT HADC		AT HADC FOR DB-36/DB-47 CAPTIVE F/T			
39	FLIGHT TEST					

C. Facilities

1. GENERAL

Various facilities are operated by Bell Aircraft Corporation in developing, manufacturing, and testing the Rascal Weapon System. Principal activities and locations are: research, development, and research flight-testing at Bell Aircraft's Wheatfield Plant near Niagara Falls, New York; rocket engine and B-63 systems testing at nearby AF Plant No. 38; and final flight testing of the Rascal weapon 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:

(1) Design and manufacture of Rascal missiles.

(2) Design and fabrication of equipment for, and the modification of R&D and trainer aircraft.

(3) Design and fabrication of guidance equipment for operational director aircraft.

(4) Design and manufacture of ground support equipment.

Figure 1. Bell Aircraft Plant at Wheatfield, New York

(5) Design and fabrication of training aids.

(6) Training of Air Force personnel and an XB-63 Training Program.

a. Wheatfield Plant

The Bell Aircraft facility at Wheatfield, New York, Figure 1, is the nerve-center of the MX-776 Program. This plant with its engineering and manufacturing auxiliaries fulfills the requirements for both developing and producing units of the Rascal Weapon System. The Wheatfield Plant is located adjacent to the Niagara Falls Municipal Airport where extensive development flight-testing is conducted.

Rocket research and development is centered at the Wheatfield rocket test facility where 13 test cells and associated control rooms are in use. Data from these test cells are recorded in a centrally located instrumentation room.

b. Air Force Plant No. 38

Air Force Plant No. 38, a major testing facility operated by Bell Aircraft, is located approximately 12 miles from Bell Aircraft's Wheatfield Plant. This test area, formerly used for the manufacture and storage of TNT during World War II, is used for testing pilotless parasite bombers, rocket power plants, and component parts. The plant consists of 58 earth-covered concrete igloos, test cells, offices, railroad sidings, surfaced roads, power lines, and various supporting installations. It exists chiefly for the production acceptance testing of XB-63 power plants, and for checking the various systems of XB-63's before they are shipped to Holloman Air Development Center. Air Force Plant No. 38 is also used as a proving ground for Rascal ground handling equipment.

During this quarter, several construction activities were undertaken or completed at AF Plant No. 38 in support of Project MX-776.

Construction of the new 500,000-gallon reservoir tank, Figure 2, is continuing and should be completed in the next quarter. This tank will be filled continuously to ensure a two-day supply of water, and to permit peak loads to be drawn by the 500-gpm pumps already installed. The revised water distribution system provides loops in the water lines so that pressure losses are decreased. In emergencies, the loops will allow sections of the line to be shut off without affecting supply to other test cells.

An addition to test cell E-3, Figure 3, is under construction. A new observation and control room with an additional cell for thrust chamber firing will double the testing capacity of this area.

A new quonset cell is being erected at the E-7 test area as shown in Figure 4. This cell will be used for development testing and evaluating the Bell-designed turbine pump for XB-63 missiles.

Contracts have been awarded and work will soon be started on a 34.5-kv electrical substation. This substation will provide a more complete distribution and balance of electrical power in the test area.

Contracts have also been awarded for constructing additional tankage and pumping facilities for the acid storage area. This will double the present acid storage facilities.

Drawings are 80 percent complete for the 100-bottle central nitrogen storage system, including piping necessary to carry nitrogen from the main cascade to each of the test cells. This system will ensure an adequate supply of nitrogen at each test unit. The nitrogen bottles have already been delivered for this new storage system.

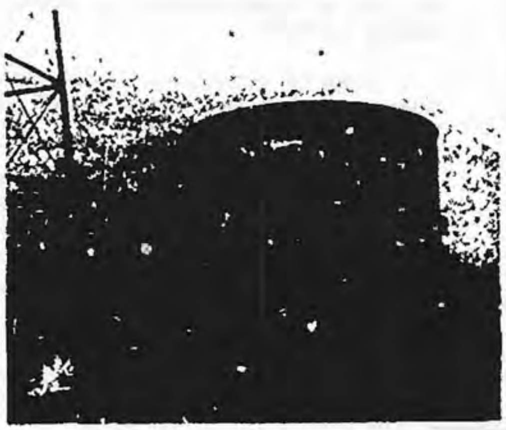


Figure 2. New Reservoir Tank, AF Plant No. 38

3. HOLLOMAN AIR DEVELOPMENT CENTER

Final flight testing of the Rascal XB-63 is being conducted at Holloman Air Development Center (HADC), New Mexico. Captive flights of pilotless parasite bombers, guidance testing and evaluation with DB-50 and EF-80 aircraft, and flights to familiarize Air Force personnel with various aspects of the weapon system are also conducted here.

Figure 3. Addition at Test Cell E-3, AF Plant No. 38

Figure 4. New Quonset Hut at E-7 Test Area, AF Plant No. 38

Laboratory, shop, warehouse, and missile assembling and servicing facilities are available at HADC. Askania cinetheodolites and a mobile relay telemetering station are installed for in-flight instrumentation coverage. Instrumentation data from scheduled test flights are reduced and forwarded to development groups at the Wheatfield Plant so that pertinent data which may affect design, performance, reliability, and safety of the weapon system are integrated into the development program.

To permit the testing of four XB-63's per month, 18 test positions (stations) are required. Of the six fixed test positions planned for HADC, five are installed and in use. Installation of the sixth station is under way. The R&D mobile checkout unit, located opposite Station "J" in the main laboratory, is being used to check out XB-63 No. 48 during Phase II of the Interference Test Program.

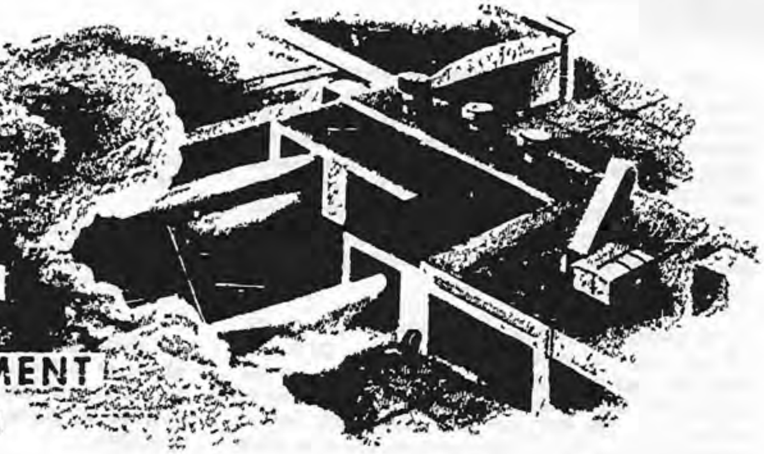
Facilities for the K-system bench test set in the main laboratory area have been completed and are in use.

The facilities required at HADC by Convair and Boeing for their portion of Project MX-776 have been completed.

To augment the storage facilities in Building 823, an additional 4800 square feet of area has been allocated to Bell Aircraft by the Air Force. With the installation of bins and cribs to facilitate systematic storage of parts, work at this new area is now complete.

SECTION II

RESEARCH and DEVELOPMENT PROGRAM



A. Servo

1. GENERAL

Following early design studies that included the experience gained from the Shrike program, laboratory development of the autopilot system for the B-63 PPB was put on a full-scale basis in January of 1951. In September of that same year, the first XB-63 PPB was delivered to HADC for flight testing.

The first autopilot systems for XB-63's 0307, 0409, and 0510 were very similar to that used in the Model 59 Shrike missiles. The design of the autopilot for subsequent XB-63's, however, showed a significant increase in complexity, when such capabilities as acceleration limiting, guidance loop tie-in, antenna stabilization, and altitude control were added. These features are included in the basic model "B" and "D" configurations that include PPB's Nos. 7 through 35. The model "F" configuration, 46 through 78, is further modified to accommodate the single-axis inertial guidance system that was designed to meet the requirements of the Objectives I and II Weapon Systems.*

* B-63 Objective I Weapon System consists of B-63 pilotless parasite bombers incorporating non-emanating midcourse and emanating X-band terminal guidance, atomic warhead, and DB-47 director aircraft; Objective II utilizes DB-36 director aircraft.

With the development of this basic autopilot system, major emphasis has been shifted to means of simplifying the product, improving reliability, and eliminating undesirable design characteristics. This program is well under way and proceeding satisfactorily. Concurrent with autopilot development, a series of terminal guidance control studies were undertaken, and these contributed significantly to the over-all design of the autopilot system. These studies are now concerned with design changes to increase the target acquisition capabilities of the PPB under extremely adverse conditions.

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

The servopilot stabilizes the B-63 about its three axes: longitudinal (roll), lateral (pitch), and vertical (yaw). The roll system maintains the lateral axis of the PPB horizontal throughout its flight. During portions of the flight, the pitch and yaw systems are programmed and receive radar-relay commands (see Section C, Guidance) which direct the PPB to the target.

[redacted]

The antenna stabilization system performs three functions: (1) maintains the search antenna horizontal about the roll axis only with respect to the earth's horizon (since the search antenna is fixed to the airframe, the roll servo maintains it in a horizontal position); (2) maintains the rotating search antenna at a constant angular velocity in space; (3) orients the relay antenna in pitch so that its major lobe is directed toward the director aircraft.

The program to evaluate materials for protective coating of electronic circuitry is nearing completion. The results of this work to date indicate that a silicone phenolic resin (Dow Corning XR875) is a suitable coating material. An amplifier coated with this material passed a 50-hour salt fog test per specification QQM-151. It was also found that a silicone rubber (Dow Corning RTU Silastic X-5302-e) and an Epoxy resin (Shell EPON 826) are suitable materials for potting purposes.

Evaluation tests have been completed on a power supply which was modified for high-altitude operation. The unit w.- tested successfully up to a simulated altitude of 80,000 feet. Test results indicate that the changes will prevent voltage breakdown at the altitudes in which the component must operate.

Progress on the Inertial Guidance System, formerly presented here, is reported in Section C, Guidance.

2. SERVOPILOT SYSTEM

Development studies, bench and computer evaluations, and fabrication of breadboard models of R&D equipment are continuing in an effort to simplify the control systems. As a time and materials savings device, existing components are being modified, where practical, to conform with circuitry changes. This step eliminates the necessity for fabricating completely new breadboard models. The major objectives of this simplification program are the elimination of the roll-rate gyro from the roll system and the g-limiting accelerometers from the pitch and yaw systems. Packaging problems of standardizing and simplifying circuitry are also being considered. Progress on the individual control systems is as follows:

Roll System - A system has been developed which does not include a roll-rate gyro and is satisfactory from a stability and performance point of view. This system is currently being evaluated in an XB-63 airframe to determine the effects of mechanical and electrical intercoupling.

Pitch and Yaw Systems - Redesign work on the pitch and yaw systems has temporarily been postponed. It is planned to resume these studies after redesign on the roll system has been completed.

The circuit design of a transistorized preamplifier, for multiaxis platform application (see BMPR No. 38, p. 24), has been completed. Present plans call for the building of three prototype units; one for use in the multiaxis platform and the other units for evaluation purposes. Silicon transistors have been received and evaluation of these units, in the preamplifier design, is planned. The use of transistors in other parts of the Rascal program is also being considered.

Starting with PPB No. 75, the pitch and yaw command modulators were to be replaced with command servos. The primary reason for choosing command servos was to provide a drift-free memory function in the command loop. However, recent developments have significantly improved components available for the memory circuit in the command package (see BMPR No. 37, p. 22). The use of these components has produced a system which is satisfactory. Plans for using the more expensive command servo design have, therefore, been cancelled and an improved version of the present command modulators will be incorporated in No. 75 and subsequent PPB's.

During this quarter, two high-temperature tests on pilotless parasite bomber mock-up No. 02 gave excellent results. These tests included five-degree-of-freedom computer runs at temperatures of +160°F or higher. This completes the environmental tests planned for No. 02. A study is now being made to determine the feasibility of converting this mock-up to conform with the configuration of Model 56F missiles.

Additional temperature tests on the hydraulic mock-up for Model 56F missiles have indicated that a greatly simplified system for circulating warm oil prior to launch is possible. The simplified system eliminates the use of the circulation sequencer. Evaluations are now being made.

An altitude control system for No. 46 and subsequent PPB's has been completed and evaluated. Principal difficulties that were overcome included the effect of vibration on the output of the altitude controller, from a noise standpoint, and the control of maneuvering g's during the transition from climb to level flight.

[redacted]

3. ANTENNA STABILIZATION SYSTEMS (XB-63)

a. Unattended Search Radar (USR) Antenna

Development of the hydraulic spin-drive system for the antenna of the USR for No. 75 and subsequent PPB's is proceeding satisfactorily. The major emphasis, at the present time, is to improve the stability margin of this system.

Although redesign of the K_u-band system has temporarily been postponed, work to date indicates that redesigning of some electronic components may be necessary; no mechanical or hydraulic modifications are needed. Development of the K_u-band system will be resumed after X-band development has been completed.

b. Antenna Pitch Stabilization Systems

A study on the error analysis of the relay antenna positioning system has been completed and the results have been published. A similar report on the pitch stabilization of the B-63 search antenna will be completed during the next quarter.

4. SERVO VALVES

Prototypes of the series "C" servo valves have been subjected to limited temperature and vibration tests and then used in several "laboratory" systems. The results of both tests and operations indicate that it would be advantageous to replace the present servo valves with the series "C" valves. Although these valves are intended for use starting with airframe No. 125, it now appears that earlier flight testing will be possible. At the present time, the SV-6C, SV-7C, SV-9C, and SV-11C valves are in limited production and will be used for R&D purposes.

Shown in Figure 5 is an SV-6C valve which is the same in size and appearance as the SV-9C. Figure 6 is a schematic cross-section of a "C" valve showing the method of construction. Note the application of the diaphragm in the first stage. This diaphragm initially developed by Bell Aircraft for the commercial application of servo valves, effectively isolates the magnetic circuit from the flow of fluid from the nozzles. In this manner, magnetic dirt particles, a cause of failure in flapper-type valves, are eliminated. Other features are the all-steel spool, the insert, the spring and spacing adjuster assembly, and the floating fit of the insert in the aluminum alloy body, all of which are designed to minimize changes in valve characteristics brought about by changes in operating temperatures. Typical flow characteristics and frequency response curves for the SV-9C valve are shown in Figures 7 and 8.

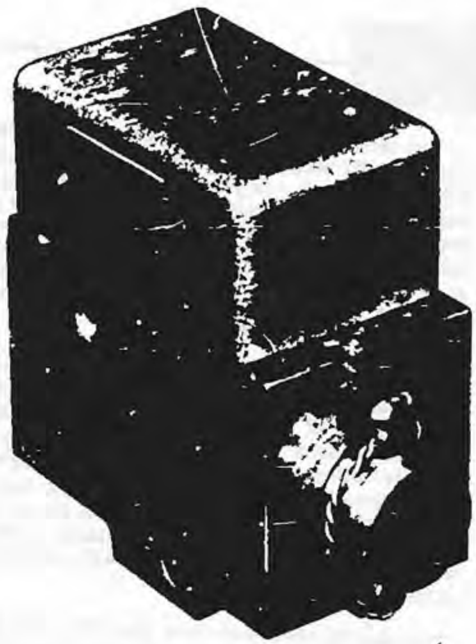


Figure 5. SV-6C Servo Valve

5. TERMINAL GUIDANCE CONTROL

A second report on terminal guidance studies has been completed. This report outlines the use of navigation techniques in the terminal guidance phase of the B-63 weapon system. Present terminal guidance studies include the evaluation of design changes which can further increase the target acquisition capabilities of the B-63.

6. AUTOPILOT FOR OBJECTIVE V*

Preliminary planning of the autopilot for the Objective V B-63 Weapon System has been completed

* Objective V is a complete B-63 Weapon System incorporating a completely nonemanating guidance system.

and analogue computer studies on the integration of the multiaxis inertial guidance and servopilot systems are continuing. Computer studies are currently aimed at a more complete evaluation of the capabilities of the proposed system and its tie-in with certain navigational aids. Autopilot component development work and detailed system design will be started in the next quarter.

7. ANTENNA SERVOS

Testing has been completed on the mock-up of the antenna stabilization system for the F-89C/simulated PPB. Installation of servo components in the airplane is expected to take place early in the next quarter. Some minor design changes were made based on preliminary test results.

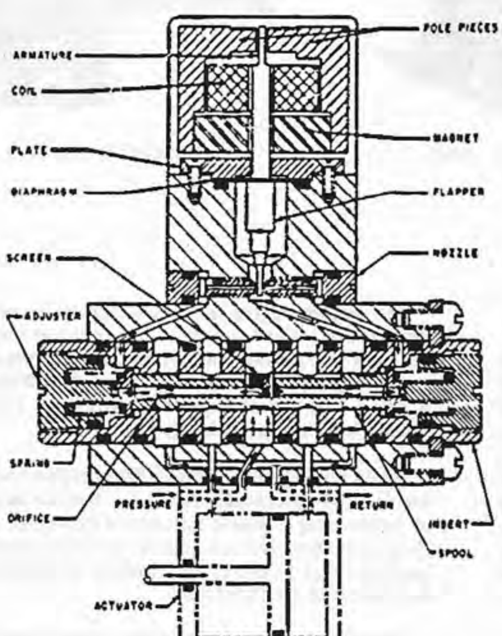


Figure 6. Schematic Cross-Section of "C" Valve

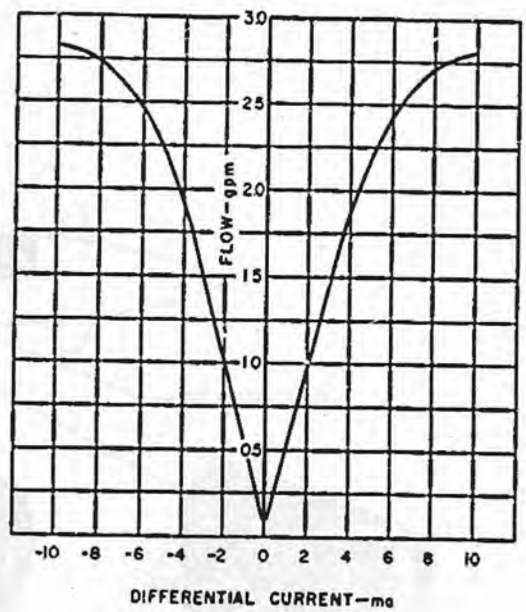


Figure 7. Typical Flow Characteristics, SV-9C Valve

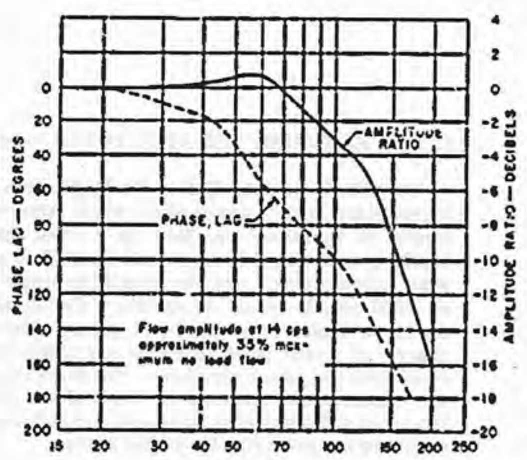
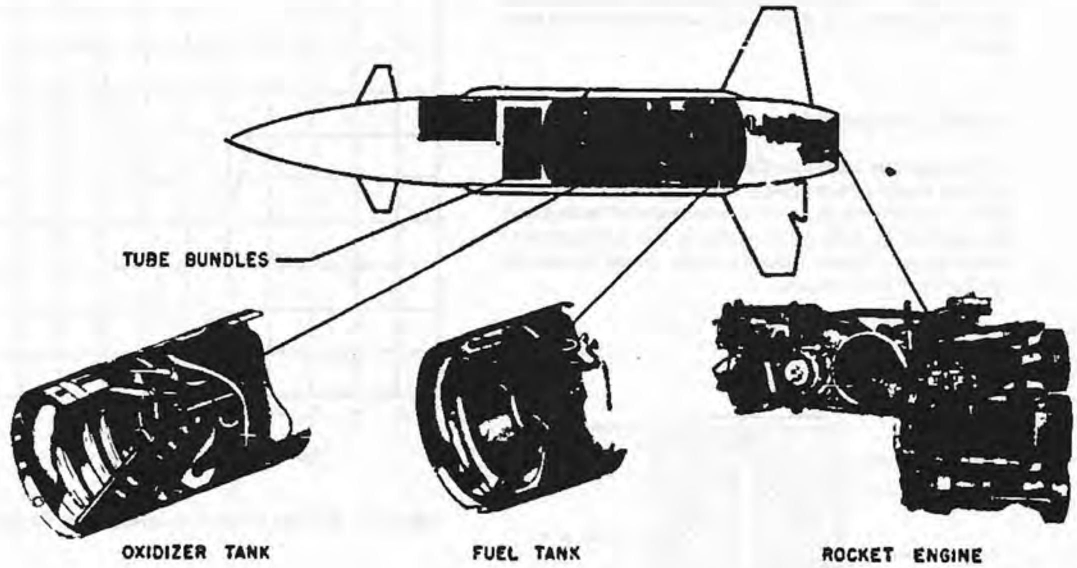


Figure 8. Frequency Response Curves, SV-9C Valve

B. Propulsion



1. DESCRIPTION OF THE XB-63 POWER PLANT

The XB-63 is propelled to its target by a liquid bipropellant rocket power plant which features two levels of operation: the first is a boost phase of 12,000 pounds thrust to accelerate the PPB to supersonic speeds quickly, and the second is a cruise phase of 4000 pounds thrust to maintain the supersonic speed reached during the boost phase. These two phases of power plant operation are obtained from three identical thrust chambers. The three chambers fire simultaneously during the boost phase, then the two outer chambers shut down and the middle chamber continues to fire during the cruise phase.

In its present configuration, each chamber is rated at 4000 pounds of thrust at an altitude of 40,000 feet. The nozzle of each chamber is designed for complete gas expansion at 12,000 feet. Specific impulse is approximately 24[illegible] seconds at design altitude.

The rocket engine is the principal subassembly of the power plant and consists of three thrust chambers, a turbine pump, lines and fittings, control valves, and a mounting bracket. The engine, weighing 600 pounds, is fitted atop the aft wing carry-through, and is enveloped by a boattail fairing.

White fuming nitric acid (WFNA oxidizer) and aviation fuel (JP-4) are the propellants. Ignition is effected by introducing a small quantity of hydrazine into the thrust chamber with the oxidizer to form a hypergolic (self-igniting) mixture. Combustion is maintained by fuel following the hydrazine.

Propellants are supplied to the thrust chambers by a turbine pump driven by a gas generator. The gas generator is a small combustion chamber operating on the same propellants as those used by the missile's thrust chambers. In addition to satisfying propellant flow demands, the turbine drives the alternator which

[redacted]

supplies electrical power for the various subsystems of the missile, and a pump which provides hydraulic pressure to the servo system.

The propellants are contained in tanks that are integral parts of the airframe. Center-of-gravity control is maintained by sectioning the individual tanks into compartments, and propellant expulsion is accomplished through flexible outlets. Because of the mixture ratio of oxidizer to fuel, the oxidizer and fuel tanks hold 615 and 295 gallons, respectively. For tank pressurization and valve actuation, nitrogen gas under high pressure is used. The gas is stored in tube bundles which conform to the inner circumference of the missile, thus occupying minimum space.

2. THRUST CHAMBER AND TURBINE PUMP INSTALLATION

a. At Bell Aircraft Corporation

Before rocket engines are flight-tested, flight approval tests are conducted. A formal flight approval program has been completed on the XLR-67-BA-1 (65 L* thrust chambers and Aerojet turbine pump) rocket engine. This included vibration and environmental tests. One phase, the flight approval test of the turbine-pump start tank, was successfully completed at Aerojet-General Corporation. A preliminary test report has been submitted to WADC.

An engine of the XLR-67-BA-5 configuration was used to test the autocheck system (see Section C, Guidance) which has been designed for the Model 56F missiles. (The -5 engine incorporates 75 L* thrust chambers and an Aerojet turbine pump.) The results indicate that the phase of the autocheck system that automatically sequences the power plant from "turbine arm" to "turbine fire" is satisfactory. The -5 engine was also subjected to informal environmental flight approval tests. The results of these firings were satisfactory.

Testing of the XLR-67-BA-7 rocket engine (65 L* thrust chambers and Bell Aircraft turbine pump) has been terminated. The reason is that this engine, which was designated for use in only one missile, would have required a complete acceptance and flight approval program prior to the final flight test. Although the cost of such a program for just one missile appears prohibitive, the testing completed on the -7 engine is applicable almost in its entirety to the XLR-67-BA-9 rocket engine (75 L* thrust chambers and Bell Aircraft turbine pump), and has also contributed materially to the development of a hypergolic (self-igniting) starting system on the gas generator package.

The first -9 test engine has been assembled and testing will be started early in the next quarter. A metal mock-up of this engine was reviewed by Air Force personnel during a development engineering inspection.

Various thermocouple units and a combustible gas detector manufactured by Mine Safety Appliance were tested to determine the applicability of these heat- and fire-detecting units. As a result of these tests, an Edison continuous cable was selected because of its satisfactory operation and ability to cover a larger area per unit.

Missile No. 0914 was flight-tested on 22 June 1954. Satisfactory operation of the power plant was attained for 158 seconds. Although the flight became unstable during the last 26 seconds of power plant operation, instability had no noticeable detrimental effects on engine performance.

Missile No. 1016 was launched on 27 July 1954 and No. 1117 on 9 August 1954. In both missiles a malfunction of the rocket engine occurred approximately 1.6 seconds after the fire signal. The cause of the malfunction is unknown; however, it is believed that a spurious electrical signal actuated the "malfunction" safety system.

In an effort to determine the cause of the malfunction, XB-63 No. 21 was returned to Air Force Plant No. 38 where an extensive test program was performed. Although the program was inconclusive in determining the cause of the malfunctions, several decisions were made:

(1) For more complete telemetered data, certain rocket engine parameters will be more thoroughly instrumented and continuously monitored during flight.

(2) The safety system for the thrust chambers will be removed for flight testing, but the safety system for the turbine pump will be retained.

(3) Since the thrust chamber safety system will be removed, launch and power plant operation will be the "free-drop lanyard launch". A timer will initiate thrust chamber ignition approximately 1.4 seconds after the PPB leaves the launching rack.

b. At Aerojet-General

An investigation on pump seals was undertaken at Aerojet-General to determine the amount of leakage that could be tolerated. The program consisted of starting turbine pumps in which leakage was simulated by introducing certain amounts of propellants into the turbine case housing, tests were conducted at sea level and simulated altitudes.

The investigation indicated that the leakage rate tolerable was two cubic centimeters per minute of oxidizer, and zero fuel leakage. Aerojet is making an effort to reduce oxidizer leakage to an amount less than two cubic centimeters per minute. Two methods are being tested: one involves the testing of a Kennametal-on-Kennametal seal, and the other concerns the use of a double oxidizer seal.

3. COMPONENT DEVELOPMENT

a. 4000-Pound Thrust Chambers

(1) Injectors

The fabrication and testing of production-type injectors for the 4000-pound-thrust chambers was continued. Four 72-pair, stainless steel, impinging showerhead injectors were tested and accepted for assembly into 75 L* thrust chambers.

The injector program during this quarter also included tests on several experimental injector configurations, valve-in-head tests, and the evaluation of annealing effects on an aluminum injector after long-duration runs.

The drilling pattern of a stainless steel, 72-pair, impinging showerhead injector was modified to obtain the same propellant-stream momenta characteristics at a mixture ratio of 4.9 as are normally obtained with the standard injector at a mixture ratio of 4.3. This modification was made by altering the pressure drops through the propellant orifices. Operation of the injector was satisfactory and a peak characteristic exhaust velocity of 4990 ft/sec was recorded at design mixture ratio. Additional evaluation firings are scheduled.

Another stainless steel, 72-pair, impinging showerhead injector was fire-tested in this quarter. This configuration, which incorporates counterbored oxidizer orifices, was modified to increase the propellant distribution across the face by rotating the inner propellant streams 5° toward the centerline and the outer streams 5° away from the centerline.

The performance of this second stainless steel injector was satisfactory except that a decrease of 1 percent was noted as compared to the standard counterbored injectors. The heat rejection rate of the nozzle was 10 percent lower than that of the standard configuration.

Three new aluminum injectors were drilled to conform to the orifice pattern of the 72-pair stainless steel injectors. The first of these injectors was modified to give a more symmetrical hydraulic flow pattern into the entrance of the oxidizer orifices. Flow tests with water showed that a more symmetrical peripheral flow had been achieved, although a slight misalignment had been induced in one-quarter of the oxidizer jets. On fire tests, little change in performance was noted, however, nozzle burnout occurred and this was attributed to the misalignment of the impinging streams.

The second aluminum injector was drilled to conform directly with the configuration of the 72-pair stainless steel injector. The results of fire tests indicated unsatisfactory heat rejection rates for the nozzle. This was attributed to a discrepancy in the counterboring operation.

The third experimental aluminum injector was then fabricated so that the length of the fuel orifices was 75 percent of the length of fuel orifices in the standard, stainless steel configuration. Performance was good - a combustion efficiency of 97 percent was obtained at rated conditions. However, the nozzle heat rejection rate of 5 Btu/in^2-sec at rated conditions was higher than average.

An aluminum injector, specifically heat-treated to the 61S-T6 condition prior to testing, was fired in full-duration runs to determine the extent of local annealing that might occur. The first 280-second run resulted in a 13 percent decrease in the ultimate tensile strength in the region of the fuel orifice exits; no decrease in strength or hardness was observed at the periphery of the injector. Although the accumulated time of firing was extended to 1000 seconds, no further changes were observed.

A test aluminum injector was utilized to determine the strength requirements for a test malfunction shutdown of the gas-actuated, valve-in-head. On bench tests, negligible deformation occurred after 100 cycles of operation. However, on the shutdown following the second fire test, a material failure occurred. One additional cycle following this failure caused the fuel dome to separate from the injector face. The failure is being investigated.

In conjunction with the aluminum injector valve-in-head tests, a steel injector was employed to determine the approximate (water-hammer) surge pressures resulting from fast shutdown. The average peak pressure was 445 psi above the fuel inlet pressure; the peak value existed for durations up to 0.007 second. No measurable deflection or elongation of the steel injector was observed as a result of these tests.

A 75 L* thrust chamber assembly was fire-tested to determine its performance throughout the temperature range of -30°F to 130°F. As shown in Figure 9, no appreciable variation was observed.

An axial deflection indicator, utilizing a strain gage, was designed for the purpose of determining the relationship between injector deformation and performance. Three firings were made with durations up to 60 seconds. The results indicated approximately a 0.007-inch deformation due to static chamber pressure loading, and an additional 0.006-inch thermal deformation at the end of 60 seconds. This latter deformation did not stabilize. In future tests, a differential transformer deflection transducer will be used instead of the axial deflection indicator.

(2) Thrust Chambers

Fourteen production 75 L* thrust chamber assemblies were acceptance-tested during this quarter, bringing the total to 25. Only one unit was rejected. Also in this quarter, preliminary fire tests were conducted on the first six thrust chamber assemblies (62-470-020-1) to be used on XB-63's Nos. 57, 59, 62, and 68.

One production-type 75 L* chamber was evaluated to determine the effect of eliminating the 3-S ceramic coating from its interior. Although similar evaluations had been conducted on another thrust chamber, the test was repeated on a thrust chamber which incorporated the latest design changes and was assembled by the latest manufacturing techniques. Only one full-duration run was completed without leaks. After five full-duration firings, the leakage rate became excessive (1.43 lb/sec) and tests were discontinued. (In previous tests leakage of this magnitude was attained after only two runs.) These tests indicate that the useful life of this thrust chamber is decreased by approximately 40 percent if the 3-S ceramic coating is not used.

The evaluation of thrust chamber 26-CP was completed. This unit, which has an increased throat radius, does not have a coolant-tube retaining wire located at the throat. In all, ten full-duration firings were completed. As was observed on both the production-type and other CP-type thrust chambers, leakage on the 26-CP increased from a relatively low rate to an excessive rate on final firing. The performance and durability of 26-CP were comparable to 20-CP and 24-CP which were reported in BMPR's 36 and 37, respectively.

Testing was completed on thrust chamber 36-CP. This is the first unit with Nicrobraze applied to the convergent and throat sections of the coolant tube bundle. The durability of this thrust chamber was approximately equivalent to that of the production-type 75 L* thrust chambers. However, 36-CP completed

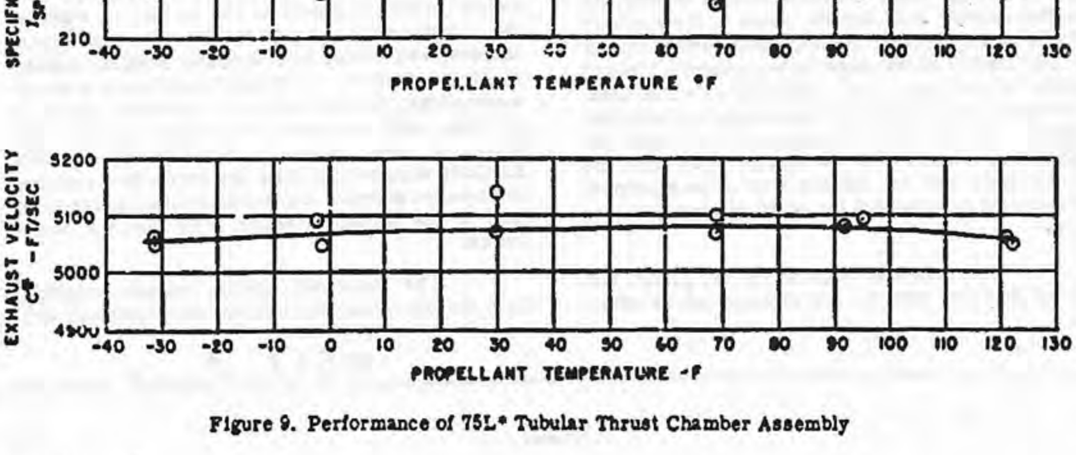


Figure 9. Performance of 75L* Tubular Thrust Chamber Assembly

seven full-duration tests with no leakage, the eighth firing produced only minor leakage. (NOTE: Leakage usually occurs on the fifth or sixth firing on the production-type units.) The ninth and final run resulted in excessive leakage. While a metallurgical examination has not been completed, it is assumed that the eventual failure was a result of internal corrosion.

Tests were conducted on a second thrust chamber, 35-CP, incorporating Nicrobrazed throat and convergent sections. This unit was not lined with 3-S ceramic coating. Only one full-duration run was completed without leakage. After six 280-second firings, testing was discontinued because of excessive leakage. These tests indicate further the need for the 3-S ceramic coating.

Two additional firings were completed on the Al-Fin thrust chamber 11-AF, making a total of nine to date. At approximately 25 seconds after the start of the last firing, a burnout occurred through the chamber casting in the area where the coolant tubes had previously buckled. On examination, the Al-Fin bond was found broken over approximately 75 percent of the chamber's surface. Examination of the throat revealed several small leaks which were in line with the chamber failure. Sections of the coolant tubes at the chamber and throat regions were examined for carbide precipitation and internal corrosion. As was noted on thrust chamber 10-AF, carbide precipitation on the 11-AF was more predominant than in the production-type unit. It is believed that the excessive precipitation is a result of the manufacturing process, because samples of tubing subjected to 1300°F for approximately two minutes exhibited similar carbide precipitation. (The 1300°F and the two minutes correspond to the temperature and time required for the Al-Fin bonding process.)

Evaluation of another Al-Fin thrust chamber, 12-AF, without 3-S ceramic applied to the coolant tubes, was completed during this quarter. Five full-duration firings were completed without leakage, but on the seventh run, several tubes in the chamber region buckled inward. No discrepancies were evident in the injector which might have caused the tubes to buckle by creating a local, high-heat rejection area. The eighth and last firing produced no further chamber damage, but the rate of leakage at the throat was excessive. Sections of the coolant tubes from the 12-AF unit will be subjected to a metallurgical examination to determine the extent of internal corrosion.

The series of tests on 10-AF, 11-AF, and 12-AF indicates that the 3-S ceramic had no effect on the total useful life of the Al-Fin thrust chambers. However, coolant-tube buckling did not occur on the 10-AF unit that had 3-S ceramic applied to its interior. Additional tests will be conducted on Al-Fin units using the 3-S ceramic. Delivery of three additional Al-Fin thrust chambers is expected during the next quarter. The vendor has modified the casting procedure to assure a more uniform bond between the aluminum casting and the coolant tubes.

During this quarter, emphasis in the 4000-pound drilled aluminum thrust chamber program was on the determination of thrust chamber durability. Tests of 30 seconds duration were also conducted at the temperature and chamber pressure extremes stipulated in the specification requirements. These latter tests were completed without mishap.

Evaluations were conducted with two thrust chambers, Nos. E-18 and E-19, each of which incorporated a different design refinement. The E-18 assembly was thoroughly coated with a 0.010-inch layer of Norton alumina. Sixteen runs were conducted totaling 37 minutes. A nozzle throat burnout occurred during the last run which necessitated scrapping the thrust chamber. A water flow investigation of the R-184 aluminum injector indicated definite misalignment in the impingement pattern. Subsequent fire tests of this injector in an uncooled thrust chamber with a water cooled unexpanded nozzle, substantiated the water flow (test stand) results. Severe erosion of the water cooled nozzle occurred at the same location, relative to the injector face, as the burnout in thrust chamber E-18. The Norton alumina coating which had been intact in the throat of E-18 prior to the burnout run was badly spalled along the entire periphery of the throat. The failure of Norton alumina is, perhaps, due more to faulty propellant injector rather than to fatigue and thermal shock. Evaluation of the alumina coating will be continued on thrust chambers similar to E-18.

The second drilled thrust chamber to be evaluated, E-19, was similar to E-18, except that helical inserts are used in the coolant passages of the throat and convergent nozzle. The combustion chamber was coated with Alumlite Hardkote instead of Norton alumina. This thrust chamber now has an accumulated running time of 67 minutes, including 26 runs with maximum single-run durations approaching seven minutes. Although the Alumlite Hardkote disappeared from the nozzle throat after a few minutes of thrust chamber operation, the aluminum wall at the throat remained intact for the entire period.

The increased cooling margin resulting from the use of helical inserts, when combined with

Norton alumina coating in the combustion chamber and nozzle will provide the high degree of durability and reliability necessary for missile application. Thrust chambers of this type have been assembled and are now being prepared for tests.

b. Turbine Pump

The turbine-pump assembly for the XB-63 rocket engine is being developed to supply liquid propellants, JP-4 and WFNA, to the thrust chambers. The turbine pump will also provide hydraulic and electrical power for the servo and electronic components. The drawings for the turbine pump, which will be installed in No. 75 and subsequent missiles, have been released for manufacturing. Four of the first 20 production-type turbine-pump assemblies will be installed in the rocket engines of XB-63's Nos. 57, 59, 62, and 68 to demonstrate operation of the power plant equipped with the Bell-Aircraft-designed unit.

Prior to this quarter, 88 runs were made at A. F. Plant No. 36 on turbine pump assemblies Nos. P-1T, P-2T and P-4T. In accordance with turbine pump model specification 56-947-418, P-1T and P-4T were acceptance-tested for installation into rocket engines. During the acceptance testing, a minor difficulty was experienced - a leakage occurred at the gasket seal between the turbine manifold and its support. It was found that the gasket was too stiff to seal the hot manifold flange which became slightly distorted because of the differential thermal expansion of the mating parts. This difficulty has been eliminated by using a more flexible gasket and six longer, high-temperature bolts with locknuts.

Turbine pump assembly No. P-2T is being used for the preliminary qualification test program which consists of 1 water spray test, 27 short-duration tests of two minutes each, 10 long-duration tests of eight minutes each, 2 short-duration tests at low tempera-tur., 2 short-duration tests at high temperature, 12 malfunction tests using specification acid, and 12 malfunction tests wherein acid diluted with 5 percent water by weight is used. The malfunction part of the program is to determine the effect on the operation when a single malfunction is introduced at various places in the turbine pump assembly.

To date, unit No. P-2T has completed 12 malfunction tests with the specification acid, and 8 malfunction tests with diluted acid, 5 percent water by weight. In the ninth test with diluted acid, a 40 psig fuel start reservoir pressure and an 875 psig oxidizer start reservoir pressure were imposed on the system - a nonignition malfunction occurred at 0.26 second. At approximately 0.57 second during the postfire purge period, an explosion occurred in the entrance to the turbine manifold. The manifold, the gear case, and two gears were damaged. To prevent this in the future, the sequence control box was redesigned to eliminate postfire purge when ignition does not occur.

c. Propellant Tanks and High Pressure Gas Storage

Seven sets of Type 347 stainless steel oxidizer tanks and CORTEN fuel tanks for XB-63's through No. 64 were received. Two were of the large-cone type with flexible outlets and five incorporated the small cone with flexible outlets for improved expulsion efficiency.

The first set of 61S-T aluminum alloy tanks with large cones and flexible outlets, scheduled for installation in XB-63's 65 through 74, is expected early in October.

The receipt of two sets of 61S-T aluminum alloy test tanks completed the outstanding orders for test tanks of the large-cone type. A set of 61S-T aluminum test tanks has already been satisfactorily fatigue- and burst-tested. The remaining test tanks will be used in the "static test" PPB to test the design for XB-63's 65 through 74.

Bladder-expulsion-type test tanks will be used to test bladder compatibility with the propellants at specification conditions and to prove their adaptability to the XB-63.

The first set of 61S-T, bladder-expulsion-type test tanks was received. The fuel tank was burst-tested and the oxidizer tank was fatigue-tested; both tests were satisfactory.

An extensive test program was undertaken to determine the durability of the teflon bellows used in the flexible outlet tube of the tank. In addition, a few tests were conducted to prove the over-all design. A test rig, designed to permit the required 34.25° deflection of the flexible tube assembly, was rotated at the rate of one revolution per second. Following 500 cycles with the rig empty, WFNA was loaded into the drum. After a 200-hour soaking period, the rig was rotated for 1000 cycles. Since no visible effects were found, it was concluded that the bellows and gimbal are satisfactory with respect to flexure and immersion.

Several bellows that did not meet specification were subjected to conditions existing during PPB operation. (These tests will be repeated when specification bellows are received from the vendor.) A thin-walled bellows was subjected to 36 cycles of transitions from cruise-to-boost flow rates; failure occurred during the 36th cycle when a convolution of the bellows ruptured.

A heavier-walled bellows was subjected to 45 similar transitions without any apparent effect. This second bellows was then subjected to 12 cycles of instantaneous stoppage of boost flow rate; on the 12th cycle several convolutions ruptured.

Pending the outcome of the tests with specification bellows, it appears that the bellows can withstand several shutdowns with a margin of safety at the boost flow rate.

During the course of these runs, the possibility of a vortex occurring around the end of the flexible tube was investigated. Sawdust was added to the water to aid in observing the flow as motion pictures were taken through sight tubes. Water action around the outlet tube gave no indication of a vortex formation.

The nitrogen gas required for propellant tank pressurization and valve actuation was originally carried aboard the missile in high-pressure tube bundles. A mechanical failure of a tube bundle in XB-63 No. 11 made it necessary to redesign this component. To prevent a delay in the flight testing program, high-pressure storage bottles were installed in the radome as temporary containers for the pressurizing gas (see BMPR-37, Figure 23).

The redesign of the tube bundles for No. 46 and subsequent XB-63's has been completed and fabrication has started. The major change in the design is an increase in wall thickness from 0.042 inch to 0.065 inch. Acceptance testing procedures for the tubes have been revised to ensure the use of nondefective materials in fabrication. Fabrication techniques and the qualification tests have also been revised. Metal-to-metal contact between the tubes and their related parts has been eliminated by the use of silicon rubber.

d. Valves and Controls

A program has been initiated to develop a fuel-actuated propellant valve for use with the 75 L* tube-formed cast-aluminum thrust chamber. This valve will replace the hydraulic oil-actuated unit now in use on 65 L* thrust chambers.

Development of the "fuel" valve was started by first fabricating a hydraulic oil-actuated valve for use on 75 L* chambers. This valve had operating characteristics equivalent to the propellant valve used on 65 L* thrust chambers. Simulated tests on the water flow stand indicated the need for a smaller actuating orifice to achieve the same performance. A No. 72 drilled orifice was established as the correct size after testing various sizes; the valve for 65 L* chambers employs a No. 70 drilled orifice.

A reduction in fuel throttling time reduces off-mixture running time during the starting transient, and also permits transition from hydrazine to JP-4 at a higher chamber pressure. Theoretical calculations indicated a fuel throttling of 0.25 second and the fuel pintle was revised accordingly. Simulated firings were then made to time the valve from uniform throttling action to full-flow conditions.

The modified valve was then assembled with a 75 L* chamber and three 5-second hot firings were made. An examination of the oscillograph records indicated essentially no plateau in the trace of the chamber pressure during the start, hydrazine exhaustion occurred at 70-80 percent of rated chamber pressure. Approximately 0.1 second elapsed between ignition and the attainment of rated chamber pressure.

The valve was then rearranged to deliver a maximum rate of fuel flow and a minimum rate of oxidizer flow during the throttling time. (Maximum and minimum refer to the variance in flow rates incurred by the tolerances in machining the valve components.) Oscillograph records of fire tests made with this valve were approximately equivalent to those reported in the preceding paragraph.

The test valve was again altered; this time it was designed to effect minimum rate of fuel flow and maximum rate of oxidizer flow during throttling. On the first of three scheduled hot firings the oscillograph trace was similar to those reported previously. At 10 percent rated chamber pressure during the second run, a sharp pressure rise occurred which "peaked" at 20 to 30 percent and then fell back to a normal curve. The same phenomenon occurred on the third run except that the peak of the sharp rise was at approximately 50 percent.

This last series of three runs was repeated twice and the results were identical. Since this clearly indicated that the fuel throttling time for the valve was too short, a decision was made to use the fuel-throttling configuration of the 65 L* chamber valve which provides a throttling time of approximately 0.5 second.

By using JP-4 as fuel and trichloroethylene instead of the acid oxidizer, fuel actuation of the valve was tested under simulated firing conditions. A small receiver tank was used as the missile's fuel tank. These tests indicated that the No. 72 drilled orifice was satisfactory as an "actuation time" control orifice, however, at fuel tank pressures of 60 psig and above (65 psig maximum allowed on missile tanks), the oxidizer side of the propellant valve would not shut down because the oxidizer pressure locked the actuating piston. If additional spring force were provided to balance the high tank pressure, a substantial weight penalty would have been incurred in that the redesign would have increased the size of the valve appreciably. Therefore, it was decided to overcome this difficulty through pressure balancing by exposing the actuating piston to fuel tank pressure at all times. A minor redesign balanced out the effective areas on both sides of the piston.

A reworked valve was then subjected to simulated firings and performed satisfactorily at fuel tank pressures from zero to 65 psig. However, the increased displacement in the actuating cylinder made it necessary to increase the actuating orifice to a No. 71 drill size.

Following the installation of the larger orifice, the valve was installed on a test stand and 22 hot firings were made. Of these, nine were made with the XB-63 tubing configuration - three runs at each tank pressure of 0, 40, and 65 psig. All starts were smooth, the usual chamber pressure plateau appeared on the oscillograph trace after ignition, and the transition to rated chamber pressure was smooth. The shutdown time averaged 0.35 second at 0 psig and 0.33 second at 40 and 65 psig.

The valve was then adjusted for minimum oxidizer flow and maximum fuel flow during throttling. Three runs were made at each tank pressure of 0, 40, and 65 psig. The oscillograph traces indicated satisfactory performance.

The valve was then adjusted for maximum oxidizer flow and minimum fuel flow during throttling. Three runs were again made at each of the aforementioned tank pressures and the results were satisfactory.

At the present time, the valve is being subjected to simulated firings at 165°F and -65°F - results are not yet available.

4. RESEARCH

a. Heat Transfer Tests

The investigation of the heat flow through the walls of a 4000-pound, drilled aluminum thrust chamber was completed. In addition to this work, an investigation was made of the effect design modifications on the drilled passages and a blocked passage had on heat transfer.

The heat flow in a drilled aluminum thrust chamber indicated that the maximum heat flux, which occurs at the throat section, is approximately 4.5 times that occurring in the chamber. It was also revealed that 65.5 percent of the total heat rejection of 832 Btu/sec occurs at the throat section. These data are within the range of heat rejection rates obtained from experimental tests.

It was noted that the combustion wall temperature varies between 650° and 700°F within 1.5 inches of either side of the throat section. This substantiates the assumption that longitudinal heat transfer does not occur in this section of the thrust chamber.

Electrical analogy models were made for the purpose of determining the relative heat transfer characteristics of the 24-hole, 36-hole, and 60-hole drilled-passage nozzle. These represent some of the possible design modifications to the drilled-aluminum thrust chamber.

The 24-hole model proved to be the least efficient in that it resulted in the highest wall temperature, 710°F. The combustion wall temperatures for the 36-hole and 60-hole were 640°F and 650°F, respectively. Of particular importance is the fact that the coolant velocity in the 60-hole nozzle is sufficiently high to prevent nucleate boiling under normal conditions. Thus, if local "hot spots" occur, a transition to the nucleate boiling range can absorb the abnormally high heat flux without an appreciable increase in combustion wall temperature. In the other two configurations, the increased heat flux would cause the bubbles to coalesce into a vapor film and result in a burnout.

In addition to varying the number of drilled passages, models were constructed to investigate the effect of modifying the coolant passages by broaching or using spiral inserts. No decided advantages were apparent from the tests of either of these modifications.

In the investigation of the effect of a blocked coolant passage, a section at the throat was studied. The blocked passage resulted in a rise of the combustion-wall temperature from 670° to 885°F. This temperature would result in a burnout of this section of the throat.

A study of the heat flow in a tube-formed, cast-aluminum thrust chamber has been initiated. Preliminary results indicate that the combustion-wall temperature is 720°F in the chamber and 1350°F at the throat (assuming nucleate boiling occurs). It was noted that most of the heat transfer occurs through 20 percent of the surface area of the coolant passage; the remaining surface is relatively ineffective.

b. Hydraulic Research

The study of the starting transients of small orifices such as those used in gas generator igniters was continued. Tests made in the last quarter clearly showed violent oscillations in the jet stream when the propellants, WFNA and JP-4, were injected into an evacuated chamber (29.5 inches of mercury vacuum). These tests were repeated in this quarter and the previous observations were confirmed. Another series of runs was made under identical conditions except that the propellant temperatures were -35°F instead of 70°F. In these latter runs the violent oscillations were not observed.

Studies were also made of the effect of chamber pressure, discharge pressure, and jet velocity on the appearance of both single and impinging jets. Visual observation of jet behavior was supported by photography.

For the single jet, an increase in chamber pressure increased the rate of atomization; a quantitative approximation of this increase was made by measuring the diameter of the jet. An increase in the injection pressure or jet velocity also increased the rate of atomization, but the effect was not clearly defined nor readily measurable.

In impinging-jet studies, an increase in jet velocity at a constant chamber pressure increased the amount and rate of atomization. Similarly, an increase in chamber pressure at constant jet velocity increased atomization, the most notable changes in the rate of atomization were obtained in the 0 to 100 psig range.

Incidental to the studies, was the observance of hydraulic flip under certain conditions. For the particular orifices used, nonimpingement was clearly evident after flip.

As an introduction to the design of an injector for a "double rocket engine," a study was made of the penetration of water into a sonic nitrogen stream. The double rocket engine consists of a 400-pound thrust chamber, with a convergent nozzle only, which is fired through a central hole in the injector of a 4000-pound thrust chamber to provide a pilot flame for the larger thrust chamber; this might insure the efficient combustion of the propellants without requring an accurately drilled and fabricated injector. The experimental work consisted of injecting streams of water at varying velocities and angles into a sonic nitrogen jet. Maximum penetration of the sonic stream occurred at an impingement angle of 90°. However, the maximum breakup of the stream occurred at a negative angle of impingement toward the sonic nozzle. Therefore, as a compromise between the best atomization and the limitations of the injector geometry, an impingement angle of 60° to the sonic jet axis was used in the design of the injector.

c. Propellant Investigations

(1) Additives

(a) RFNA Stability

The RFNA being tested for storage stability has shown no appreciable change in composition over a period of approximately 12 months. The acid is stored outdoors in an aluminum drum which is vented and sampled at monthly intervals. Tests were started in August, 1953, and analytical procedures were revised in January, 1954, to obtain more accurate results. Results of several analyses are given in Table I.

TABLE I

STORAGE STABILITY OF RFNA

Constituent	24 August 1953	4 January 1954	7 September 1954
HNO_3	82.65	81.44	81.32
NO_2	15.54	16.53	16.58
HF	0.44	0.63	0.52
Al	Trace	Trace	Trace
Fe	Trace	Nil	Nil
H_2O	1.37	1.40	1.58

(b) Sodium-Wax Dispersions

As a method of improving the reliability of ignition, when an electrical igniter is used with the JP-4/WFNA combination, metallic sodium can be introduced into the fuel upon starting. This is done by means of sodium particles dispersed in wax. The JP-4 dissolves the paraffin and picks up the sodium. The effectiveness of this additive was evaluated at two pressures by determining ignition delay as a function of temperature.

The dispersions of sodium (50% by weight) in paraffin wax were made with a Waring blender equipped with a stainless steel bowl and an electric heating mantle. A slug of the dispersed sodium was placed in the JP-4 feed line downstream of the propellant valve. For tests in which the sodium was not used, a "dummy" slug was placed in the line to keep the line volume constant.

Since there is a slight fuel lead, ignition delay was taken as the interval between the entrance of WFNA into the igniter (signaled by a conductance probe at the acid orifice) and the start of chamber pressure rise. Although use of dispersed sodium improved the starting characteristics of the igniter, the data nevertheless showed an appreciable degree of scatter with or without the sodium.

(2) Starting Fluids

The investigation of the reliability of unsymmetrical dimethyl hydrazine as a starting fluid at reduced temperatures was continued. In the last quarter, test of this starting fluid in a start chamber at -65°F were satisfactory. A regeneratively cooled chamber was then substituted for the start chamber and five successful starts were made at -65°F.

As with the previous runs, the start tests conducted in this quarter were made with the propellants, starting fluid, and hardware at -65°F. The propellants were JP-4 and Type III RFNA with 0.5% HF added as a corrosion inhibitor. Including the five starts made in the previous quarter in the regenerative chamber, a series of twelve successful starts was made. In all instances, the transition from start to main fuel was smooth. The slow start in these tests was attributed to the low temperature of the actuating fluid in the propellant valve.

On three of four additional starts, explosions were encountered. In each case, the cause was attributed to improper propellant valve actuation. (The propellant valve was not designed to operate at temperatures as low as -65°F.) Before continuing these tests, a propellant valve was thoroughly tested in dry runs at -65°F. Following satisfactory valve operation at the reduced temperature, two successful firings were made.

The reliability of unsymmetrical dimethyl hydrazine as a starting fluid has been adequately demonstrated for the temperature range of ambient to -65°F. There has been no evidence that the starting fluid contributed in any way to the difficulties encountered in the test program.

(3) Safety Program

Following the abortive launching of XB-63 No. 12 an investigation was conducted to determine if an explosion of nitrated hydrocarbons caused the malfunction at turbine start — more specifically, the effect of thermal and mechanical shock on nitrated turbine soot.

Prior to nitration, samples of turbine soot, soot from the ramp beyond the test rig, and extract and residue of a chloroform extraction of ramp soot were tested for stability. No violent reactions were obtained when these samples were subjected to heat, liquid WFNA, or hot WFNA vapors. It was concluded that the soot tested was inert.

The turbine soot was then nitrated under conditions which paralleled those at turbine start aboard XB-63 No. 12. It was assumed that a carbon deposit had formed in the low spot of the turbine housing. This deposit would include carbon and alkyl nitrates. The products formed by the nitration of the soot under these simulated conditions were subjected to thermal and mechanical shocks imposed by open flames and blasting caps. The nitrated products proved to be stable. However, it is believed that the failure to uncover evidence of instability does not eliminate the soot as a possible cause of the explosion. Conclusive results can be obtained from tests in which the exact conditions in an operating turbine are duplicated.

(4) Quality Control

The quality control program has been initiated, after acceptable field-test methods for analyzing WFNA were established. A daily analysis is made of the acid used in each cell. Should the iron content exceed 0.03 percent, operations are postponed until the acid is replaced. The 0.03 percentage has been selected as the maximum safe operating limit. For each test, analytical data of the acid are recorded on the IBM card along with performance data on the rocket engine.

A daily test is also made of a sample of JP-4 selected from a cell assumed to be representative. Density is determined with a pycnometer at 77°F, and boiling range is determined by an ASTM distillation. When sufficient samples have been tested, a correlation of data will be made and the results will be reported as they become available.

d. <u>Material Evaluation</u>

Six bladder-expulsion tests were made with the oxidizer propellant tanks. The bladders were fabricated from a 0.02-inch R33X416-14 polyethylene-polyisobutylene blend (a Goodyear Tire and Rubber

TABLE II SUMMARY OF ACID EXPULSION TESTS WITH GOODYEAR BLADDERS				
Test No	Shroud (Enveloping Bladder)	Storage Time	Percent Expelled	Remarks
1	None	24 hours	—	Failure due to acid action
2	0 005 inch Kel-F	—	98	Acid cooled to -10°F and expelled immediately
3	0.005 inch Kel-F	24 hours	—	Failure due to strangling of bladder by shroud
4	0.005 inch Kel-F	72 hours	98	
5	0 003 inch Kel-F	18 hours	—	Failure at seams after 18 hours storage
6	0 005 inch Kel-F	—	—	Stress risers in shroud broke during acid loading

TABLE III BLADDER MATERIAL TESTS			
Material	Manufacturer	Test	Results
Teflon glass cloth*	DuPont	Gas leakage	In air - no leak In contact with WFNA: at 6 psig - no leak** at 9 psig - small leak at seam
FBA plastic	Minnesota Mining and Mfg. Co.	Capatibility	JP-4 - compatible N_2H_4, WFNA - incompatible
		Temperature	-10°F - brittle
Polethylene-Vistanex B-80 blend	Connecticut Hard Rubber Co.	Compatibility	WFNA - compatible (48 hrs., room temperature)
		Temperature	-15°F - flexible -35°F - stiff, but not brittle

* Fabricated into METEOR-size bladders.

** Glass cloth impregnated with Fluorolube LG leaked under these conditions.

Company product). The variables included the storage time and the thickness of the shroud enveloping the bladders. Table II is a summary of the results.

White fuming nitric acid was not able to penetract three 0.005-inch plies of Kel-F coated with Nordcoseal grease during a 62-day storage period at room temperature It was also found that the surface finish of Kel-F could be improved by subjecting it to 350°F and 6200 psia for 15 minutes, and then quenching.

Table III summarizes the results of the preliminary evaluation of several potential bladder materials. Table IV presents the results of several WFNA compatibility tests.

TABLE IV

WFNA COMPATIBILITY TESTS

Material	Intended Use	Results
Silicone oil (SF 96(40), General Electric	Compressor	Incompatible. Delayed reaction between 5 ml oil and 95 ml acid.
Phenolic treated cellulose	WFNA filter	Incompatible. Reaction occurred.
Dynel board	WFNA filter	Incompatible. Became spongy.
Stainless Steel (304,316)	WFNA filter	Incompatible. Corroded.

C. Guidance

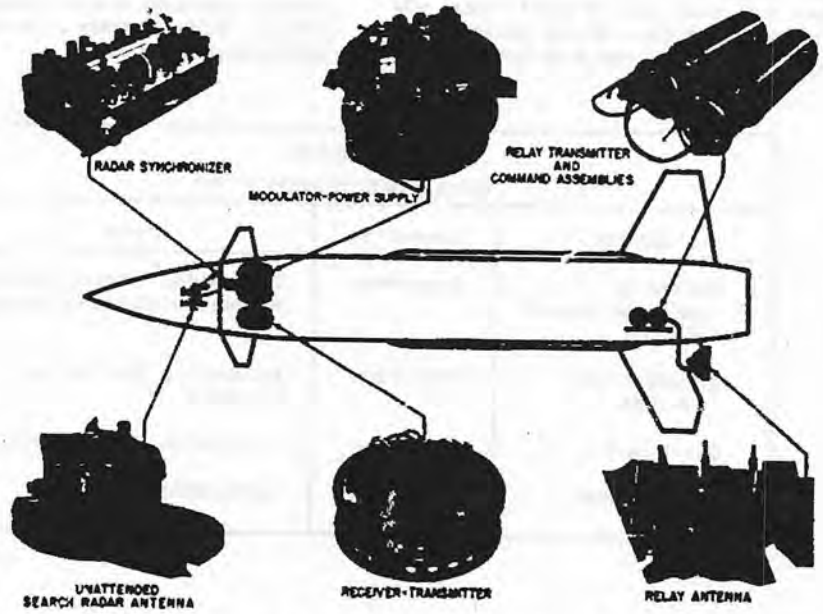
1. GENERAL

At the beginning of the Rascal program, research and development was started on a radar-relay and command guidance scheme for directing air-to-surface missiles to a target. This development was essentially concerned with a radar scanning system in the nose of a missile by means of which a radar picture of the area ahead of the missile is relayed via a microwave link to the launching aircraft. With this information, commands from the launching aircraft could be sent to the missile directing it to the target. (The name "RASCAL" was coined from the first letters of the words RAdar SCAnning Link.) At first two B-17 aircraft were utilized in guidance development, one simulating the launching-director aircraft and the other the missile. Later, data from tests using this experimental radar-relay and command link led to an improved guidance system which was subsequently installed in a B-17/F-80 combination to simulate more closely the guidance performance of a director aircraft and missile in flight.

Guidance for the Rascal weapon system consists of an inertial range-computing system with a radar-relay command override. Components of the system are located both in the director aircraft and in the missile.

Basically, the system operates as follows*: The director aircraft carrying the missile is navigated to the launch point by means of its modified K-series radar bombing system (MA-4 or MA-5) utilizing a long-range search radar and computer. A range measuring system, called the inertial range-computing (IRC) system, measures ground range to target by double integration of a signal from a pitch-stabilized accelerometer. Immediately prior to launch, initial-

* This guidance description applies only to Model 56F XB-63's No. 36 and subsequent. For interim missiles, a track and command midcourse guidance system as described in Bell Aircraft Specification 56-947-001 is used.



condition data of director aircraft velocity and range-to-target, are fed through an "umbilical" cable to the missile. After the missile is launched, this information enables the missile's inertial system to dictate a programmed flight path. At a predetermined range from the target, the IRC system initiates the terminal dive signal and the missile automatically enters a 30-degree dive. By controlling the flight path in this manner, the servopilot and guidance systems establish a preset collision course to the target.

The search radar system is included to improve the accuracy of target acquisition. Just prior to terminal dive, unattended search radar equipment in the nose of the missile is automatically energized. This scans the area over a 150-degree sector ahead of the missile. Radar video is transmitted by means of a microwave relay link to the director. Here radar information on a plan position indicator (PPI) scope enables a guidance operator to correct the flight path of the XB-63, and obtain a high degree of accuracy in target bombing. The operator guides the Rascal by means of a tracking stick that positions range and azimuth cursors over the target radar return on the indicator. The displacement of the tracking stick determines the flight path corrections which are automatically transmitted to the missile.

The B-17/F-80 team (now EB-17G/EF-80B), along with a laboratory terminal guidance control station, has been kept up to date, and is being utilized to evaluate various guidance improvements prior to their incorporation into B-63 pilotless parasite bombers. Also, a Rascal guidance system is being installed in an F-89C so that more realistic flight testing can be performed at high altitudes and at greater ranges and speeds.

Early in 1952 the Air Force established that the ultimate guidance system for the Rascal weapon would be of a completely nonemanating type. Development work on this nonemanating system, presented in the latter part of this section, is progressing concurrently with the development effort on the guidance system just described.

The following information for the most part parallels the "objective aims" and work statements as appearing in Project MX-776 Program Planning Report, Bell Aircraft Report No. 56-989-003 dated 30 June 1954.

2. EMANATING GUIDANCE

a. Missile Equipment

(1) Unattended Search Radar (USR) System

In order to reduce "moding" by the modulator tube a new pulse transformer which lengthens modulator pulse rise time has been designed for the PPB's USR system. A rise time of approximately

210 kv/usec was obtained, however, after a brief period of operation a short circuit occurred. The cause of this difficulty is now being investigated.

(2) Command System

The command package, located in the aft guidance section in the missile, decodes and transmits guidance command information received from the director aircraft to the servo autopilot.

Two engineering models of a new command package, Figure 10, with improved decoder and memory circuits have been constructed and will be tested during the last quarter of 1954. An evaluation of the effects of noise and continuous-wave (CW) jamming signals on the operation of laboratory-model command packages shows a good correlation with anticipated results.

Command receiver AGC (automatic gain control) circuits have been modified to improve receiver performance in the presence of CW and noise-type jamming.

(3) Video Relay System

A contract is being negotiated with Raytheon for additional QK-282 magnetrons. These additional magnetrons will be used, as required, to replace "burnouts" on Model 56B PPB's.

The relay transmitter in the EF-80B aircraft has been modified to use the A-1016 magnetron manufactured by RCA and thus more nearly reflect the configuration of No. 30 and subsequent PPB's. The work on the A-1016 was directed toward elimination

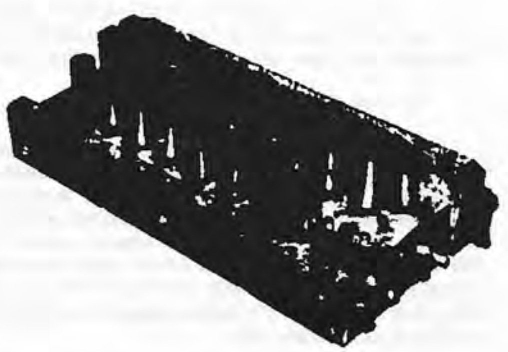


Figure 10. Command Package

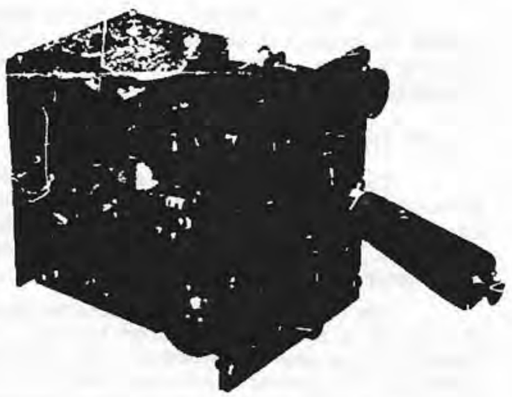


Figure 11. Computer Control Unit

of power slump and improvement of linearity. Life tests on the RCA A-1016 magnetron are currently under way.

b. Director Aircraft Equipment

(1) Terminal Guidance Control System (TGCS)

The first laboratory model of a new computer control unit, Figure 11, for the director aircraft's TGCS, has been completed and has satisfactorily passed vibration and high and low temperature tests. The second laboratory model, now approximately 90% complete, is expected to be completed early in October 1954. Drawings have been completed and will be released shortly to manufacturing facilities pending ECP (engineering change proposal) approval by the Air Force.

(2) Command System

Model 110 command transmitters have been installed in the two R&D director aircraft (EB-50D's, Nos. 075 and 111) now in use at HADC for the 56B flight test program. It is anticipated that installation of these improved transmitters will considerably reduce maintenance problems and increase reliability of the director aircraft's guidance system.

(3) MA-4 System

Laboratory tests of the ME-, computer (part of the MA-4 and MA-5 radar navigation bombing systems) with the inertial guidance system have been completed satisfactorily. Frequent checks of the computer during tests showed that its output voltages to the IG system were within the tolerances specified.

The ME-4 laboratory system is being checked periodically to assure that it is in proper operating condition. No parts failures have been encountered to date.

(4) Automatic Checkout System (ACS)

The automatic checkout system is a device which automatically checks certain B-63 and director aircraft functions directly concerned with the launching of the PPB. There are two development phases to the ACS program.

The earlier R&D phase produced the Model 56 ACS and the later phase, the Model 110 ACS. The Model 110 is the operational model and will be used for launching PPB's starting with No. 46. Model 110 ACS is an improved design and utilizes better packaging techniques than Model 56.

Prototype ACS equipment for the DB-36 and DB-47 aircraft has been modified to include new countdown requirements. One important change provides for the retransfer of PPB systems operating on internal power produced by the turbine, to external power, following a malfunction or failure in the rocket system. This gives added safety to the captive flight and assures continued operation of the electronic equipment within the PPB after a turbine-pump shutdown.

The following accomplishments were made during preproduction tests of the ACS:

(a) The hermetically sealed stepper-switches provided by the vendor were tested individually for stepper action under the high and low limits of the temperature specification and all defective items were returned. A procedure for adjusting and testing the switches has been established and it is anticipated that future shipments will meet specifications.

(b) A new temperature-controlled capacitor assembly was designed using a metal container filled with silicone oil. The new assembly, necessitated by the inability of the previous unit to withstand thermal shock, has been made effective on all Model 110 ACS.

(c) Teflon-coated wire and special lacing tape were substituted for the SRIR wire used in the subassemblies of the system, after the SRIR wire was found to be subject to cold flow under temperature extremes.

(d) The redesigned advance controller prototype is undergoing engineering evaluation.

(e) An override for either emanating or nonemanating guidance would permit the guidance operator to fire a PPB with either system inoperative but not with both systems inoperative. Circuitry has been devised to accomplish this purpose and will be incorporated in all systems unless a revised requirement is received from the Air Force. Advance information indicates that the override of emanating guidance may be deleted.

c. <u>General Product Improvement</u>

(1) K_u-Band USR System

Flight tests have been completed comparing the performance of the K_u-band and X-band unattended search radars. An aircraft with a maximum altitude of 30,000 feet was used in the comparison tests. The following information on altitudes in excess of 30,000 feet was obtained by inserting an attenuator in the unattended search radar waveguide, thereby simulating increased altitude. Reasonable results were obtained with the K_u-band unattended search radar at a simulated altitude of 50,000 feet under ideal weather conditions. Under adverse conditions K_u-band performance was marginal above 40,000 feet. The X-band unattended search radar was found to present acceptable PPI displays up to a simulated altitude of 70,000 feet under ideal weather conditions and to a simulated altitude of 60,000 feet under slightly adverse weather conditions. Since the test aircraft could not be flown in severe weather, test results were not obtained which would be valid for very adverse conditions.

The first K_u-band search antenna manufactured by Dalmo-Victor has been received. All remaining antennas will be delivered by June, 1955.

(2) High-Power USR System

A breadboard model of the modulator unit for the high-power USR system has been completed except for inverse diode circuits. This modulator has been used to drive a 4J50 magnetron at power outputs up to 250 kw. At power outputs in excess of 200 kw, spectrum difficulties occur which have been traced to the short-rise-time of the modulating pulse. The pulse transformer is being redesigned to increase modulator-pulse rise time.

A laboratory model of the receiver assembly has been tested. Receiver sensitivities with one-to-one signal-to-noise ratios at -98 dbm* have been obtained using 1N23C crystals.

(3) Bandwidth Reduction, Radar-Relay System

The study to determine optimum parameters for a narrow-band relay link and for the USR system is continuing. This study is directed toward improving both the USR signal-to-noise ratio and the relay-link range. A breadboard model of a new synchronizing code circuit for this relay link has been constructed and is now undergoing tests.

(4) Anti-Jam Circuits, USR System

A study is being made to determine the feasibility of utilizing a tunable magnetron and anti-jam circuitry in the USR system. Preliminary tests are to be made with a 2J51 magnetron; two 4J50T magnetrons also have been ordered for additional testing. Because of duty-cycle limitations of these tunable tubes, it has been necessary to reduce the pulse width to 0.4 microsecond. The use of pulse-forming lines and pulse-width discriminating circuits as anti-jam features are being evaluated. Circuits to detect the presence of jamming are also being investigated.

(5) Extended-Range Relay System

Studies on the use of C-band for an extended-range relay system, between missile and director aircraft, have continued. Several tube manufacturers have been visited in an effort to obtain a suitable relay transmitting tube. Tubes now under consideration include a klystron oscillator and traveling-wave amplifier combination, and a carcinotron (backward-wave oscillator tube).

(6) Extended-Range MA-4 System

Modification of the missile-release navigational computer, MRNC, to an extended-range configuration is in progress at A. C. Spark Plug, Milwaukee. This extended-range configuration will be effective on A. C. Spark Plug production system Y-24. The immediate effect on the Bell Aircraft program will be that different capsule wiring will be required to mate the present capsule with system Y-24. Monthly progress reports are being forwarded by A. C. Spark Plug reflecting the status of the work being done. A trip to A. C. Spark Plug was made during August.

* dbm - decibels with respect to one milliwatt

(7) Azimuth, Range, and Altitude (3D) Offset

Study has continued on the 3D offset guidance computer and some initial work has been completed. Several methods of solving the geometrical problems unique to a 3D computer have been proposed. Each method has some inherent difficulty either in equipment complexity or accuracy. A choice in the method of solution is guided by the following considerations:

Avoidance of multiple-loop servomechanisms to permit good over-all response.

A method of solution which avoids ambiguous or indeterminate solutions.

The number of computing elements necessary.

Accuracy attainable with computing elements used.

Correlation of direction of movement of range and azimuth cursors with respect to operator control stick movement.

(8) Simplified TGCS

A breadboard model of the proposed simplified terminal guidance control system has been partially constructed prior to its evaluation. Circuitry revisions have been made to the TGCS to permit including an indirect bomb damage assessment system. Further study is now under way to ascertain the TGCS design most completely compatible with a three-dimensional offset guidance computer. Work is also continuing to improve the circuitry from the standpoint of reducing the number of calibration controls and to increase system reliability.

(9) Indirect Bomb Damage Assessment (IBDA)

The preliminary design of the IBDA marker unit, which provides range marks on the PPI to determine the distance of the missile from the target, has been completed and is ready for final packaging. An engineering report is approximately 75% complete. Flight tests are now being performed to obtain data required to complete the report.

(10) Stabilized Automatic Tracking Relay Antenna System (SATRAS)

A laboratory model of the stabilized version of the relay antenna system (Rascal director aircraft equipment) is now installed in the R&D EB-17G aircraft for flight evaluation. Prototype systems are being fabricated to facilitate further bench and environmental testing.

(11) Developmental Flight Tests

Flight testing at Bell Aircraft is being conducted with an EF-80B aircraft, into which an XB-63 emanating guidance system has been installed, and with an EB-17G aircraft that contains guidance equipment normally used in both the director aircraft and the XB-63. During this quarter, eight flight tests were made with the EB-17G "flying laboratory" and nine flights with the EF-80B.

Flight tests were conducted to evaluate relay link capabilities, a developmental TGCS lumped-constant decoder, and over-all guidance system performance.

An F-89C aircraft was received at Bell Aircraft on 13 May 1954 and is being modified to include a complete XB-63 guidance system with the exception of equipment that provides commands to the airframe. Preinstallation bench checks on the guidance equipment will be completed shortly. High-altitude flight tests on the USR system will start during the next quarter.

3. NONEMANATING GUIDANCE

a. Inertial Range-Computing (IRC) System

The ME-4 missile-release navigational computer in the director aircraft furnishes initial-condition data to the IRC system. During this period, compatibility tests were run between a bench model of the ME-4 computer and the IRC system in the development laboratory. Checkout procedures for setting up carrier and PPB velocity and range signals during ground tests were finalized.

A bench set of the IRC system was put in operation at HADC. This set will be used to familiarize HADC personnel with the Model F missile configuration (airframe Nos. 46 - 78) and provide a means (substitution of units) for checking components during the flight test program on this configuration.

Improvements have been made in the IRC power supply to reduce leakage paths to ground in the floating 200-volt section. This section supplies the excitation voltage for the IRC accelerometer.

Evaluation of Teflon capacitors under high-temperature conditions have shown marked improvement over the Polystyrene variety. The Teflon capacitor will be used in the feedback loop of the IRC integrators.

b. Multiaxis Guidance System

(1) Description

The nonemanating, multiaxis, inertial guidance system for the ultimate B-63 weapon system can be divided into four subsystems: a stable platform, a position computer, a flight computer, and a prelaunch initial-condition system. The stable platform serves (a) to keep two accelerometers properly aligned, one in the north direction and the other in the east direction, and (b) provides a reference for attitude control of the PPB. Signals from the accelerometers are transmitted to the position computer which computes instantaneous velocity and position. The computer also applies the proper voltages to torque the platform in compensating for the earth's rotation and curvature. From the computed position of the PPB and the location of the target, the flight computer produces the proper inputs to the autopilot for directing the PPB to the target. The prelaunch initial-condition system performs two important functions: it levels the platform, using as a velocity reference the ground speed indicated by a Doppler radar system in the carrier aircraft, and aligns the platform in azimuth, using an astrocompass for the true-north reference, a photogoniometer bending angle, and a gimbal correction angle. A modified navigation system in the carrier aircraft, in conjunction with a range-to-go computer, supplies initial conditions of range-to-go between carrier and target to the position computer. A comparison of the inertial system and the navigation system can be made, after a check run between two aim points, by a performance check system.

(2) System Analysis

It was determined that the resultant errors in the Doppler drift-angle under conditions of strong wind (when the director aircraft turns) would be large enough to necessitate switching from the Doppler system of platform leveling to a memory-type system. This memory system eliminates erroneous Doppler information and continues the leveling operation on the basis of information received prior to the occurrence of the disturbance.

(3) Guidance Studies

Preliminary schematics have been prepared for the directional and terminal guidance systems and a design specification has been written.

An error analysis of the flight computer instrumentation has begun in which actual components will be used. To perform these studies the three-axis hydraulic test table, Figure 12, used for platform evaluations, and analogue computers will be utilized.

(4) Instrumentation

The photogoniometer is an instrument that is used to measure deflection angles between the alignment of the platform of the PPB and the base of the astrocompass in the director aircraft. Fabrication of the photogoniometer has been subcontracted and the vendor states that the basic concepts presented by Bell Aircraft have been investigated experimentally and found satisfactory. Detail designing has been started.

Progress made in the development of initial-condition computers includes the decision to transfer all initial conditions from carrier to PPB with multi-speed synchro systems. This was done to achieve the required accuracies and to minimize the noise and leakage problems.

Initial conditions for three different targets can be set into memory servos before take off. Provisions are now being made to allow an operator to choose a target by adjusting a selector switch.

Specifications for the mechanical components of the initial-condition computers are being prepared. Upon completion these specifications will be sent to various instrument companies for bids.

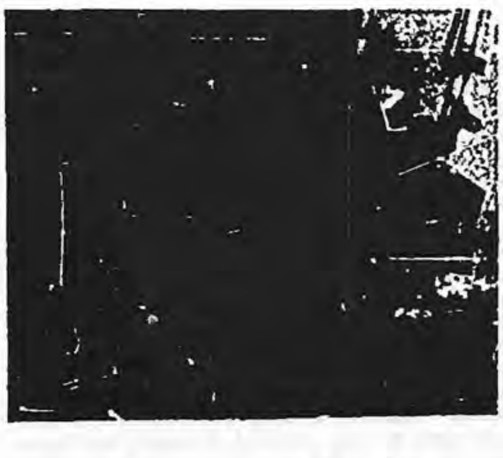


Figure 12. Three-Axis Hydraulic Test Table

(5) Gyros and Platforms

The prototype three-axis platform (for providing a reference co-ordinate system), utilizing three single-degree-of-freedom HIG-6 gyros, was assembled and is being evaluated as a possible replacement for the HIG-5 platform on the ultimate weapon system.

The platform stabilization loop is under test with new magnetic amplifiers used to drive the gimbal torquer motors.

(6) Accelerometers

The simple-pendulum and inverted-pendulum accelerometers are being developed by Bell Aircraft for use on the multiaxis stable platform (see BMPR-36, pp 25, 26). The more suitable type will be used in the final design.

The simple-pendulum accelerometer utilizing four sapphire ball bearings has shown good repeatability (10^{-5} g) and linearity (10^{-4} g), and has been evaluated under temperature variations and found to be satisfactory. Final evaluation tests are being conducted.

Preliminary development tests of the inverted-pendulum accelerometer were begun on 20 July 1954. An error in machining the spring to support the pendulum was found to be the source of trouble disclosed during these tests. A new spring has been machined and installed and the tests are continuing.

(7) Integrators

A new design of the multiaxis integrator (for the position computer) has obviated the need for an infinite resolution potentiometer. Infinite resolution potentiometers are both costly and difficult to procure. A breadboard model of this new design is being evaluated in the servo development laboratory.

(8) Power Source

The original promise date for delivery of two inverter-regulator units from Ford Instrument Company for the PPB's power supply system has been delayed 8 months due to design changes originated by Redstone Arsenal.

Letters were written to several vendors pertaining to the design and development of the magnetic power supply. (Three flux oscillators have been designed for the magnetic power supply and the Inland Transformer Company in Buffalo has been contacted to see if they can wind the toroidal cores.) A conference was held with the eastern representatives of Magnetic Research Corp. at which time the Bell Aircraft proposal for a magnetic power supply was studied in detail. Further discussions will be held with Magnetic Research Corp. engineers before a bid is forthcoming.

(9) Test Tables

The August completion date which had been set for the combination gyro dirft and rate test table has been delayed due to difficulty in obtaining some of the mechanical parts for the drive assembly. However, this table should be assembled by 15 November 1954.

The three-axis hydraulic test table, Figure 12, for evaluating the multiaxis inertial platform, was put in operation in all three axes. Preliminary tests indicated that strengthening of the pitch-gimbal frame would be required prior to further testing.

(10) Guidance Cooling System

The basic approach for controlling the temperature of the inertial guidance electronic compartment has been decided. Briefly, the multiaxis platform will be insulated and individually controlled at a temperature of approximately 130°F. (The preliminary design of the temperature-control system for the multiaxis platform has been completed and will be evaluated in the laboratory.) The over-all compartment which houses the platform and electronic black boxes will be sealed and controlled at an ambient temperature of approximately 70°F.

D. Telemetering and Instrumentation

1. GENERAL

Two groups of telemetering systems are used in XB-63 PPB's. Group I is in current use with research and development missiles, while Group II will be used with AFOST missiles equipped with simulated warheads.

Group I is used to transmit both qualitative and quantitative data on vital components and systems. The number of continuous telemetering channels varies from 6 to 18. By commutating 2 or 3 of these channels, data transmission up to a maximum of 74 functions is obtained. Telemetering instrumentation of Group I on early XB-63's includes accelerometers, angle-of-attack and side-slip vanes, various types of pressure pickups, rate gyros, position potentiometers, and numerous a-c and d-c voltage-measuring units. Later R&D XB-63's, in conformance with specific test schedules, will contain telemetering instrumentation on vibration pickups, flow meters for hydraulic flow data, and strain gages for the measurement of control-surface hinge moments. Oscillographic recorders will be used on certain PPB's to obtain strain data on control surfaces. Two accelerometers, a ground relay station, and automatic-starting oscilloscope cameras will be used to obtain PPB deceleration data on impact.

In the Group II telemetering systems, four subcarrier channels will be used: three continuous and the fourth commutated to provide 27 subchannels. Automatic decommutation will not be incorporated. Accurate pressure-altitude data will be obtained by means of a continuous channel, but in general, most of the end instruments will supply the commutated channel with qualitative data.

2. TELEMETERING

a. Flight Plan Changes

In accordance with flight plan revisions, changes in telemetering instrumentation were made on all of the remaining Model 56B PPB's through No. 28. In general, these changes consisted of adding continuous telemetering channels to the power plant instrumentation to obtain information on chamber pressures, fuel pressures, and oxidizer-pump discharge pressures. Provisions were also made to telemeter rocket firing, and turbine arming and firing switch actions. To provide for the continuous-channel telemetering of these items, some of the less critical data were removed from continuous channels and fed to a commutator. Since there was not a sufficient number of continuous channels on XB-63 No. 21 to accommodate these additional functions, the Century oscillographic recorder recovered from XB-63 No. 14 was reworked, retested, and installed in the warhead section. Instead of using the potentiometer-type instruments already installed, pickups of the strain-gage type were added to monitor propulsion system pressures. These strain-type instruments are less susceptible to vibration, and should provide more reliable data in the event of another power plant shutdown. Drawings, installation, and checkout of this telemetering circuitry for PPB No. 21 have already been completed. Rework of the channel assignments on other PPB's of the Model 56B series has also been completed and final tests are under way.

Because of the short flights of PPB's 16 and 17 — the last of the XB-63's specifically instrumented for telemetering certain critical servo functions — sufficient servo data were not obtained. Consequently, the telemetering instruments that were recovered from PPB No. 11 were quickly reworked, retested, and installed in PPB's 19 and 21 to obtain in-flight data on servo valve current, accelerometer, and demodulator signals.

To conform with the latest revisions in the flight plans for Model 56B missiles, a new cam was designed for the proportional programmer (see BMPR No. 37, p. 10). Since procurement difficulties have delayed the fabrication of these cams, two step-type programmers were reworked to approximate the function required. The reworked programmer will be used in XB-63's 22 and 24.

b. Equipment Testing

Rework and retest of the remaining 16-channel type telemetering transmitters were completed on all existing units. This included the addition of R-C type filters in the Vibrotron outputs and the placing of magnetic shields around adjacent Vibrotron amplifiers. When this was completed, noise and preemphasis problems in the transmitter were eliminated.

The special tests being conducted on PPB No. 22 to determine the sources of certain data inaccuracies were completed. Follow-up tests will be made after discrepancies have been corrected. Both corrective action and follow-up tests will be accomplished during the next quarter, if scheduling does not interfere with the present workload.

The first captive flight of PPB No. 21 indicated that a considerable amount of 400-cycle pickup and noise existed in the six-volt d-c telemetering filament leads of the director aircraft. This problem was solved by designing and fabricating a 400-cps rectifier to replace the carbon-pile regulated dynamotor. In addition, it was necessary to reroute the 400-cycle and six-volt d-c leads which had been in a common cable in the director aircraft.

During the checkout of PPB No. 48, wiring discrepancies and compatibility problems usually associated with a completely new installation were quickly discovered and corrected prior to the release of the PPB for shipment to HADC. Compatibility tests are scheduled at HADC with the DB-36 and DB-47 director aircraft.

As a result of the differences in data obtained at HADC from three commutated channels being used to monitor the same function (i.e., alternator voltage on PPB 14), the recovered transducer from the PPB was returned to Bell Aircraft for investigation. The results of the investigation indicated that the time constant of the output circuit was too low to permit accurate sampling of the function more than once in every revolution of the commutator. A correction factor was determined and applied to the recorded data to obtain the correct in-flight information. To avoid this difficulty in subsequent missiles, the alternator voltage will be single-sampled instead of triple-sampled.

Continuing investigations of the phasing and tension problems inherent in the design of the commutator-gating brush assemblies have brought about the following changes:

(1) New linear backup springs for the brushes were designed and fabricated to replace the nonlinear springs.

(2) New brushes were designed and fabricated.

(3) New sanding and honing discs were designed; prototypes were fabricated to permit the refacing of existing brush assemblies and commutator face plates.

(4) New contacts were used to replace those worn beyond repair.

(5) The measuring jig for brush tension was reworked to eliminate sources of error.

(6) A new (brush-contact) assembly jig for fabricating brush assemblies was designed. This eliminates the costly delays encountered in obtaining units from vendors.

Only prototypes of the items just mentioned have been fabricated. Production drawings and fabrication of parts will be accomplished during the next quarter.

c. Four-Channel Telemetering Systems

The entire four-channel telemetering system scheduled to be used in PPB's 46 through 64 has been reviewed to conform with changes in flight planning. Telemetering of the warhead fuzing system and a monitoring circuit for the crystal current of the USR were added. The telemetering junction box was redesigned to eliminate the shock-mounted relay assembly, the SRIR-type wire was replaced by Teflon-insulated wire and the old relays were replaced with new ruggedized type. Prototypes of the junction box will be tested during the next quarter.

The program initiated during the last quarter to design a power supply to replace the battery pack for the four-channel system to be used in No. 66 and subsequent PPB's was completed. The primary purpose of this program was to make packages which would successfully undergo the same qualification testing that is required for an operational system. Thus, all assemblies were sealed to meet humidity requirements, and a Bell-designed r-f transmitter assembly was added in place of the commercial unit. The unit designed by Bell Aircraft was added after all attempts to obtain a transmitter that conformed with Bell Aircraft specifications had failed. Prototypes of the foregoing items are being completed.

3. INSTRUMENTATION

a. Vibrotron

The first units of the type 544 temperature-stabilized Vibrotron assemblies designed by Bell Aircraft have been received from Byron Jackson. After minor corrections have been made, these units will meet all of the required specifications. Tests have revealed that the center frequency drift with temperature-cycling was due to the vibrating-wire mounting technique, the manufacturer is investigating this problem.

b. Vibrotron Data Reduction

As described in BMPR-37, page 28, investigations are continuing on improved methods of receiving and recording Vibrotron data. In line with this, work on the high-precision, data-reduction method for use with Vibrotron-transmitted data has been delayed by the more urgent work brought about by changes in flight planning. However, prototypes have proved that the recording method is basically sound. It is anticipated that the system will be in operation by the end of the next quarter.

c. Impact Instrumentation (See BMPR-35)

The matching network for instrumenting the PPB for impact data has been completed and the initial installations have been accomplished. This will provide for the monitoring of data from the MC-300 fuzes in all PPB's equipped with the 16-channel telemetering system.

d. Detonation Instrumentation - Thyratron Network

Initial packages of this system are being constructed and should be ready for evaluation during the next quarter. They will effect a shift of transmitter frequency at the time of detonation. Recording of the transmission by photographing oscilloscope screens will provide data relative to the performance of the contact fuzes.

e. Vibration Data Reduction

Present usage of the filter-network type of vibration data reduction equipment has resulted in considerable savings of manpower. An analysis will be conducted to determine the optimum number of filters needed for an ideal reduction system.

E. Aerodynamics and Structures

1. AERODYNAMICS

a. General

A major portion of the aerodynamic work on the XB-63 has been completed. The results of this work, consisting of both theoretical and experimental analyses, have been published in the following reports:

(1) Rascal Design Proposal	Report No. D98-945-035
(2) A General Study of the Performance Capabilities of the XB-63	Report No. 56-978-010
(3) Basic Aerodynamic Characteristics of the XB-63	Report No. 56-978-003
(4) Aerodynamic Heating and Thermal Analysis of the XB-63	Report No. 56-978-013
(5) Static Stability, Control, and Maneuverability of the XB-63	Report No. 56-978-011

b. Flight Plans

Aerodynamic portions of the detailed flight plans have been completed for XB-63's through No. 35, as well as for XB-63 No. 49.

c. Dynamic Stability

A report on the dynamic behavior of the XB-63 is being prepared. It contains sections dealing with the dynamic stability of the aero-servo system in pitch, yaw, and roll, and analyses of terminal dive maneuverability, roll control, and launch safety.

d. Fuzing

The primary fuzing system of the Rascal PPB (see Section G, Armament) utilizes the relationship between altitude and static pressure. Its accuracy in detonating the warhead at a given altitude depends largely upon the accuracy to which static pressure can be measured at the PPB, as well as the accuracy to which the target height and target atmospheric conditions can be predicted.

To obtain static pressure, a series of orifices are drilled in the circumference of the PPB body at a station between the propellant tanks. The orifices are connected by means of a manifold leading to a pressure-sensitive switch. The pressure at these orifices, however, differs from the true ambient static pressure. This difference, or error, depends upon the position of the orifices along the PPB body, as well as upon flight variables such as Mach number, angle of attack and sideslip, and control surface deflections. Thus, the accuracy with which the fuzing system detonates the PPB at a predetermined altitude depends upon determining the pressure-sensing errors, and then compensating for these errors in the aneroid switch.

Mach number appears to be among the most influential factors affecting pressure-sensing errors. Therefore, the question arises as to how accurately the detonation Mach number can be predicted, assuming that all subsystems which may influence the Mach number are operating within their design tolerances. Small variations in thrust, launch speed and altitude, winds, range to target, as well as terminal dive maneuvers, can influence the Mach number at detonation. This general problem has been under investigation for some time. Since it is essentially a performance problem containing a large number of variables, methods were devised for rapid calculation of performance. Accordingly, the airframe-servo section of the Rascal Simulation System was set up to permit accurate solution of the complete flight path problem. By using this rapid performance computing device, the major task becomes one of determining the possible variations of the many pertinent quantities, and assigning a degree of probability to them.

e. Operational Planning

In conjunction with B-63 operational planning, the problems concerned with the transition of the Rascal PPB from an R&D vehicle to an operational weapon are being studied.

Considerable effort is being devoted to determine precisely the adjustments to such control parameters as climb angle, cruise altitude, dive angle, and thrust duration, which are necessary to prepare a PPB at squadron level for a specific mission in a minimum of time. These adjustments will be influential in determining the degree of readiness required of PPB's maintained in squadron "ready storage." With a PPB in a particular state of preparedness, and with intentions of making final adjustments prior to a specific mission, it is of considerable interest to know the potential flexibility of the system under these conditions. More specifically, the questions arise as to whether the Rascal weapon can accomplish missions involving shorter ranges than the maximum, and whether the launch conditions can be altered without necessitating additional adjustments to the PPB. A study has been initiated to obtain answers to these and similar questions.

2. STRUCTURES

a. General

The following appendices covering structural analyses for Model 56F airframes were submitted to WADC for approval:

(1) Report No. 56-941-012, Appendix B, "Aft Horizontal Wing"

(2) Report No. 56-941-014, Appendix B, "Aft Vertical Surface"

(3) Report No. 56-941-015, Appendix B, "Rudder"

Fuselage structural reports, listed as Volumes IV and V, Part II, Appendix B of Report No. 56-941-017, are being prepared for the Model 56F PPB. These volumes are expected to be submitted to WADC during the next quarter.

Preliminary structural design effort was completed during this quarter on a new aft horizontal wing with a thinner section (4% instead of 6% at the root) and a half-blunt aileron.

New concepts in the method of shipping and storing Rascal PPB's has resulted in stopping all structural work on the shipping containers originally planned for these applications. Other ground handling equipment is also being reviewed for possible design improvements.

Estimated weight and balance data for PPB Model 66 were prepared for insertion in Specification No. 66-947-011. These data, summarized in Table V, cover a basic missile configuration wherein fuel and oxidizer tanks utilize internal bladders for expulsion, and an alternate configuration consisting of a "bladder" fuel tank and a "mechanical" oxidizer tank with an internal small-cone-shaped compartment to facilitate expulsion.

A report of actual weights for Model 56B PPB No. 16 was submitted to WADC for approval. This report, No. 56-942-111, shows detailed weight and balance data for No. 16, which is an R&D vehicle that has interim guidance and is recoverable.

Design revisions are nearly complete for the nose and aft body of the F-89C airplane which will be used to simulate the XB-63 (see Section I, Support Aircraft). An analysis report covering the major structural changes to this aircraft is being prepared for submittal to WADC during the next quarter.

b. Criteria and Loads

Work is continuing on the design loads distribution for the production version of the Rascal PPB airframe. The basic total loads calculated earlier were utilized to determine the load distribution for the critical supersonic flight conditions. Similar load distributions for the critical subsonic flight conditions are nearly complete. A formal report providing basic load and load distribution data will be issued after the calculations for subsonic flight conditions are complete.

The structural strain-gage analysis is complete for PPB 0914, the first XB-63 to be equipped with structural strain-gage instrumentation. This analysis, presented in Bell Aircraft Report 56-941-025, "Strain Gage Analysis — Rascal PPB 14B Flight," was submitted to WADC for their information.

Calibration data as well as numerous changes in maneuvers, weights, and telemetering for PPB's 21 and 25 are presented in Revision I of Bell Aircraft Report 56-941-024, "Preflight Data — Structural Flight Load Survey, XB-63." This report has been submitted to WADC for approval.

The Bell Aircraft Specification for nitrogen tube bundles was amended to incorporate the final proof-test pressures and volumetric sets which serve as criteria in acceptance testing. The specification was also revised to include the latest structural requirements relative to vibration tests.

c. Static Test

Bell Aircraft Report 56-929-019, "Static Test of XB-63 Series 56F — Program Report," was submitted to WADC. This report defines in detail the structural tests to be conducted on an XB-63 airframe. A preliminary draft covering the structural test program was previously discussed with WADC, and the final report as submitted incorporates WADC comments. The start of the structural test program has been postponed to 15 October 1954 because of a rescheduling of delivery of a PPB airframe to the Structures Laboratory.

TABLE V WEIGHT AND BALANCE SUMMARY RASCAL PILOTLESS PARASITE BOMBER USAF B-63A, Bell Aircraft Model 66				
	Basic Configuration		Alternate Configuration	
	Weight (lb.)	Hor CG (Fuse. Sta.)	Weight (lb)	Hor CG (Fuse. Sta.)
Gross Weight	18161.5	226 0	18220.6	224.6
Launch Weight	18096.7	226.3	18149.2	224.5
Empty Weight	5872.3	234 8	5836.1	234.8

A structural test report, No. 56-929-021, "Static and Operational Tests — R&D Modified Transport Carriage," was submitted to WADC. An operational transverse test will be conducted on the PPB transport carriage after modification of the transverse drive has been completed.

An aluminum alloy "mechanical" oxidizer tank has been subjected to two aging cycles during a corrosion fatique test in WFNA. Both the "mechanical" and "bladder" configurations of the 61S-T aluminum alloy propellant tanks have been tested at a proof pressure of 150 psi. A fatigue test, consisting of a series of 2000-cycle runs at 0 to 60, 0 to 72, and 0 to 96 psi, was successfully performed on a "mechanical" oxidizer tank. A similar test is being conducted on a "bladder" oxidizer tank; a run of 2000 cycles at 0 to 60 psi has been completed.

The development testing of the nitrogen tube bundles (with 0.065 walls) was completed. A proof pressure for production-type tube bundles was established at not lower than 13,000 psi nor higher than 16,000 psi. Proof and burst testing of qualification coils was completed and fatigue testing has started.

d. Laminated Plastic Airframe

As recommended by Bell Aircraft and approved by AMC, subcontracts will be awarded to the Goodyear Aircraft Corporation and the Young Development Laboratories for the study and design of plastic laminate airframe components of the XB-63. Study and design specifications defining this work were submitted for subcontractor approval in September 1954. After receiving a revised cost estimate from Goodyear, Bell Aircraft issued a letter of intent and work was initiated on the materials study for the selected components. It is anticipated that agreements will be reached with the Young Development Laboratories early in October. This will enable them to proceed with their portion of the materials study.

F. Dynamics

1. GENERAL

Mathematical analyses, dynamic analyses, and data processing and reduction are essential steps in the development of the B-63 Weapon System.

Mathematical analyses deal with the operational problems of the weapon system and the conversion of engineering problems to mathematical statements including the computation of their resultant solutions. Current programs include error analyses, logistical requirements, and evaluations of alternate developments.

Dynamic analyses to date have included flutter analysis and ground vibration tests, the determination and simulation of the vibrational environment of the missile during its various phases of operation, and miscellaneous vibration problems.

During 1950 it became evident that the reliability of the Rascal weapon would be seriously affected if the over-all vibration problem were not solved. Vibration surveys since then have established that weapon system components should be designed to requirements including the 5 to 500 cps frequency range. Originally, the range limits were 5 to 60 cps. In 1951 construction was started on a vibration simulator that would be used to vibrate the complete missile during its final systems test. This simulator, Figure 13, was completed in May 1953 and, beginning with PPB No. 1117, was used during final checks to determine the reliability of XB-63 missiles under simulated vibrations that paralleled operational conditions.

More recently XB-63 flutter analyses have indicated that surface flutter at various altitudes does not occur at subsonic and supersonic speeds up to Mach number 2.5.

Missile data processing techniques, which had their beginning with the earliest testing of the MX-776A Shrike missiles, were used for both presenting and interpreting data obtained during tests. Presentation includes the translation of original data into graphic expressions to facilitate data analysis. These test data are then compared with the final flight-test performance of the PPB, and used to segregate recording and instrumentation errors as well as to highlight various correlations which may exist. By using automatic data processing facilities and preliminary analysis techniques, it is now possible to furnish test results within 12 hours after raw data are received.

The B-63 weapon reliability program was initiated in July 1953. Its general purpose has been to collect and analyze data from which the reliability of the tactical B-63 weapon system can be predicted. During the research phase of weapon development, a secondary purpose has been to point out and emphasize problem areas in the various weapon components to aid in early recognition and solution of these problems.

To date major emphasis has been placed on determining and improving the reliability of individual components, and data collection and analysis techniques have been established. As more flight data become available, while the weapon approaches its operational status, weapon system reliabilities will become more definite. At the present time, increasing emphasis is being placed on component system analysis. Detailed discussions of the reliability program are presented in Bell Aircraft Quarterly Reliability Reports, Nos. 56-989-101, -102, and -103.

2. RELIABILITY

The process of evaluating and analyzing the reliability of components and systems was continued during this quarter. A study of Rascal rocket engine reliability, for example, indicated that a majority of all malfunctions occurred during the initial bypass

Figure 13. Rascal Vibration Simulator

operation.* This also indicated that most malfunctions could be expected during the first ten seconds of bypass. Subsequent bypass operations bore this out and an intensive investigation was launched. As a result, several changes are being made to the power plant. The modified power plant will then be carefully tested and the results will be compared with those obtained from past analyses. The specific techniques used in these analyses as well as the detailed results obtained are described in the Bell Aircraft Quarterly Reliability Reports mentioned previously.

To improve the techniques which have been used in calculating reliability, several IBM procedures are being revised. In the past, all reliabilities were calculated by hand. But, if the results of selected samples are sufficiently repetitive, all reliabilities can be calculated mechanically. It will then be possible to maintain a continuous check on each component by directing the IBM equipment to provide a periodic list of all components which fall below a preset standard. In this manner, a more accurate, up-to-date listing of units with lower reliability will be obtained. Also, personnel who have been calculating reliabilities will be free to investigate more completely those units which exhibit lower reliability and to establish methods for determining both missile and weapon system reliabilities.

* During bypass, the gas generator of the power plant drives the turbine propellant pump to which the electrical and hydraulic power units are attached. In bypass, electrical and hydraulic power is provided but the propellants are returned to the tanks.

The techniques described here, as well as the more common ones which are used in other phases of reliability work, will be presented to a group of WADC personnel on 12 and 13 October 1954. Part of Bell Aircraft's reliability effort has been to prepare charts and samples of IBM runs and other descriptive material which will make clear the basic methods used in the reliability program. In answer to a specific request by WADC, similar material (i.e. Sample Forms, Codes, etc.) is being prepared for transmittal.

Although not a planned part of the over-all reliability program, reliability data have proven invaluable in determining spares requirements. Reliability personnel have, on several occasions, been called upon to assist in determining the number of spares needed to maintain certain phases of the Rascal test program. Methods of "mechanizing" all spares requirements, as based on past performance, are being considered. Reliability records were used to determine the number of spares needed to support the "Hi Valu" items which will be used in the AFOST program. From the foregoing trend, it is expected that reliability will assume an increasing role in the spare parts program.

3. WEAPON INSTRUMENTATION ANALYSIS

Pilotless parasite bomber No. 0914 was flight-tested with a low-pressure power plant at HADC on 22 June 1954. One purpose of the flight was to test the telemetering instrumentation and data reduction methods to be used for obtaining structural flight load data on three future PPB's.

The following can be said of instrumentation capabilities during this test:

(1) As with the previous flight test of Rascal No. 0812, telemetered power-plant data on 0914 continued to show scatter due to vibration of the end instruments. This scatter did not seriously hamper power-plant analysis which indicated successful operation during all planned phases of initial bypass, boost, cruise, and final bypass.

(2) The first reduction of structural (flight-load) data from strain gages mounted on the aft horizontal surfaces of the PPB was completed during July. Information from load calibrations performed at HADC, 9 May 1954, was used in reducing these data. The HADC calibrations consisted of applying loads of 0, 1000, and 2000 pounds downward at known locations on each aft wing. With known arms between load applications and strain-gage locations and a known trace deflection for certain bending moments at each gage location, the determination of bending moments versus time at various spanwise locations presented no difficulties.

There was no recalibration between 9 May and 22 June 1954, the date of the final flight. Since there were obvious zero shifts on some gages, this complicated the problem of determining the best curves of trace deflection versus bending moment of each gage.

Flight load data were obtained from 7 of the 10 gages mounted on the wings. Quantitative and qualitative results were encouraging when compared with wind-tunnel data and telemetered flight data.

Missile No. 21, which has strain gages installed on forward and aft vertical and horizontal surfaces, is expected to be flight-tested early in the next quarter. It is planned to recalibrate these gages immediately prior to the flight by using resistors to simulate loads.

Rascal XB-63's 1016 and 1117 were flight-tested primarily to test power plant operation and servo pilot control during climb and dive, and to evaluate the pressure-sensing system for development of the warhead fuzing system. A secondary objective was to evaluate the guidance system. The ability of instrumentation to provide adequate data on these objectives was as follows:

The power plants of both missiles shut down prematurely immediately after umbilical separation occurred. Available flight-test data revealed no reason for the malfunction, but a careful correlation of all other data provided information regarding the time of engine cut-off relative to rocket firing and separation of the missile from the umbilical cable. This information was compared with test data from ground firings at AF Plant No. 38 to establish the most probable causes of the premature shutdowns.

As a result of this investigation, PPB No. 21 was modified to simplify the rocket control system and the method of launching was changed. Rascal No. 21 is now equipped with instrumentation to analyze launch and power-plant operation.

Because of the premature engine shutdowns on missiles 1016 and 1117, in-flight evaluation of the servo and guidance systems was not possible. All data from these systems were adequate for analyzing the performance of systems during the prelaunch phase of operation.

The objective of evaluating the pressure-sensing system for development of the warhead fuzing system was limited by the effect unstable flight had on static pressure and instrumentation. The desired test of the pressure-sensing system was not obtained. It can be concluded in the case of No. 1117, however, that the Vibrotron altimeter provided the best source of altitude data. In the case of No. 1016, Vibrotron data were affected by difficulties at the receiving stations; this did not reflect on the capabilities of the altimeter itself.

4. OPERATIONAL ANALYSIS

More than one-thousand simulated runs have been made to determine the combined effects of midcourse errors, terminal guidance errors, and delayed target recognition on the dispersion of ground burst against ideal point-targets. The following equipment was used:

(1) A guidance operator's station, complete with control stick and cathode ray oscilloscope.

(2) A network of analogue computers and servos as described in Bell Aircraft Report 56-978-015.

(3) An automatic plotting board for recording altitude versus range and azimuth versus range during the terminal dive.

For each simulated flight, initial conditions that were assumed to exist at the initiation of terminal dive were introduced into the computers. The "dive" switch was then used to cause the PPB to dive at an angle of 30°. The changes in position of the target relative to the PPB were noted by a guidance operator who sent appropriate commands to the PPB. The range and azimuth errors at the target were recorded and converted to miss-distances.

A study of the resulting data indicated that for each given condition of weight, velocity, and target recognition, it was possible to establish in a horizontal plane at 60,000 feet an area of terminal dive initiations wherein the miss-distance was less than 1500 feet.

The probability that dive initiation would occur within this area of terminal-dive positions was determined. Since midcourse accuracy deteriorates with increasing range, the percentage of terminal dives starting within this area decreases at longer range, emphasizing the importance of early target recognition.

Figure 14A represents the results obtained when the following conditions are assumed to exist as the terminal dive is initiated:

Velocity	2950 ft/sec
Weight	10,000 pounds
No winds during dive	
Altitude	60,000 feet

The simulated data have been analyzed in an attempt to determine the dispersion of miss-distances as a function of the time which elapses between initiation of dive and target recognition. The same flight conditions were used. Figure 14B shows the variation

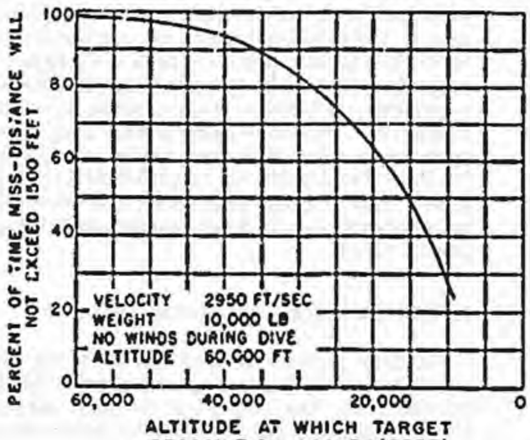


Figure 14A. Accuracy vs. Altitude of Target Recognition

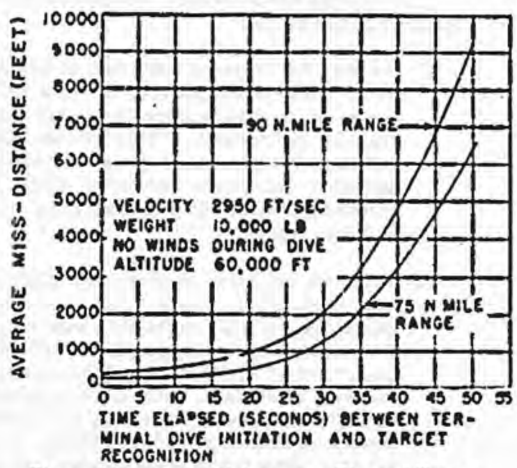


Figure 14B. Miss-Distance vs. Time of Target Recognition

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of the average miss-distance as a function of target recognition time. A report on this analysis is being prepared.

5. B-63 AEROELASTIC STUDIES

A report on the flutter analyses of the Rascal B-63 is being compiled. This report will include:

(1) Symmetric flutter analysis of the forward horizontal surface up to Mach number 2.5 and at altitudes of sea level, 30,000, and 60,000 feet.

(2) Symmetric flutter analysis of the forward horizontal surface including the effects of fuselage bending.

(3) Symmetric flutter analysis of the aft horizontal surface for subsonic speeds at altitudes of sea level and 30,000 feet.

(4) Antisymmetric flutter analysis of the aft horizontal surface for subsonic speeds including the effects of roll degree-of-freedom.

(5) A two-degree-of-freedom, subsonic flutter analysis of the aft vertical fin.

The five-degree-of-freedom symmetric flutter analysis of the forward horizontal surface including the effects of fuselage bending was completed for subsonic speeds at sea level. It was found that fuselage bending has a negligible effect on the flutter stability of the forward horizontal surface, and the roots corresponding to the fuselage mode have essentially zero damping.

Flutter analyses investigating the possibility of coupling of the vertical fins and rudder system with fuselage side bending are now being conducted.

A preliminary flutter study of a (proposed) thinner aft horizontal wing surface indicated stability for subsonic speeds and a supersonic speeds of M = 2.5. A more complete analysis is being prepared for current speeds and altitudes and those likely to be considered in the future. All parameters necessary for this flutter analysis will be detailed in Bell Aircraft Report No. 56-984-013.

6. B-63 FULL-SCALE VIBRATION SIMULATOR

The study of XB-63 malfunctions resulting from shock and vibration has been continued. Composite systems tests under full-scale vibrations (simulated) have been completed on six missiles, Nos. 21, 22, 23, 24, 26, and 28. The resulting data on the malfunctions obtained are now being analyzed.

Analysis to date has yielded the following pertinent information:

(1) The sensitivity of the various component systems of the B-63 to vibrational excitation has been established. Of the total number of malfunctions which occurred during the vibration tests, 59 percent occurred in the pitch, yaw, and relay antenna systems.

(2) A definite tendency toward correlation appears between the plane and frequency of vibrations and the incidence of malfunctions. This indicates that to obtain more conclusive results, vibrations must be applied in both the vertical and longitudinal directions. The greatest number of malfunctions occurred during low frequency (15 to 125 cps) vibration.

(3) Malfunctions that occurred during vibration tests were usually those malfunctions that appeared most frequently in PPB s undergoing preflight and captive flight tests.

7. STATIC FIRING VIBRATION SURVEY

In conjunction with telemetering activities (Section II, D), methods of reducing vibration data from the static firings of PPB No. 1319 have been established. Preliminary results of the method which utilized only band-pass filters correlated well with hand-reduced data; this method proved less time-consuming than other methods.

The data reduced from the static firings of PPB No. 20 were found satisfactory for only two of the firings. During static firing No. 2, data were recorded directly from six Consolidated velocity pickups (type 4-102A); during firings Nos. 2 and 4, telemetered data were obtained from seven velocity pickups (type 128). These data along with other data will be used to determine standards for PPB vibration testing.

8. VIBRATION TEST OF THE XLR-67-BA-1 ROCKET ENGINE

The vibration tests described in Bell Aircraft Specifications Nos. 56-935-027 and 56-947-027 were performed upon the XLR-67-BA-1 flight approval engine, Serial No. 12. The test results are presented in Section II, B, Propulsion.

9. CAPTIVE FLIGHT VIBRATION SURVEY

Preparations are being made to conduct a vibration survey of the DB-36/XB-63 combination during the

PPB mating and captive flight program scheduled for the next quarter at HADC.

The information desired is the vibratory response of Rascal PPB during captive flight in a DB-36 director aircraft. This is a part of the over-all program to determine the vibration environment of the XB-63 from which vibration test criteria can be established.

10. VIBRATION TESTS ON N_2 TUBE BUNDLES

In accordance with requests from WADC, preparations have been made to vibration-test nitrogen tube bundles. (Tube bundles, integral part of the B-63 propulsion system, are described in Section II, B, Propulsion.) The purpose of this test is to ascertain the adequacy of tube bundles under vibratory conditions. Test specimens are to be vibrated at critical frequencies for a period of 25 hours with a force of not less than 2g.

The tube bundles will first be placed in containers that simulate sections of the PPB where bundles are normally located. Each container will then be mounted to a stand resting on vibration isolators. Containers and stands have been fabricated and test preparations are being made.

G. Armament

1. GENERAL

In order to achieve weapon status, the armament system of the Rascal PPB must undergo extensive testing. Sufficient test planning is included in the over-all development program to ensure proper functioning and to obtain ultimately a high degree of accuracy and reliability for both primary and secondary warheads and their respective fuzing systems. However, at the direction of WADC, work on secondary warheads is being held in abeyance. The armament system specification, No. 56-947-377, was released after deletion of all references to secondary warheads.

2. WARHEAD

The Rascal missile has been designed to accommodate warheads up to 5000 pounds.

The warhead is carried in a section of the Rascal B-63 between the forward wing and the oxidizer tank. The lower part of the airframe at this section serves as a structural door for warhead installation. A dorsal door, approximately fourteen inches square, provides access for arming the warhead. The warhead compartment, Figure 15, is essentially cylindrical with a maximum diameter of 44 inches and an over-all length of 75 inches.

3. FUZING

Through a sequence of safety features, the fuzing system arms and detonates the warhead. Detonation is triggered by an aneroid switch which can be preset to operate at a proper pressure altitude to satisfy altitude-detonation requirements of various warheads and targets. The pressure-altitude setting can be changed remotely from the director aircraft during the prelaunch phase.

a. Design Configuration

The fuzing system specification, No. 56-947-320, which indicates the latest design requirements, has been submitted to WADC for approval.

b. Pressure Sensing

Static and dynamic lag tests on PPB's Nos. 26 and 48, and on mock-ups of the pressure-sensing systems of these PPB's, have been completed. The results of these tests are being evaluated.

Starting with airframe No. 16, pick-ups are used for gathering pressure-altitude data during final flight testing. These data are telemetered to a ground station and are compared both with Askania data from the flight and with the pressure data ordinarily telemetered from the pressure-sensing system. Thus, this comparison provides an additional means of evaluating the over-all accuracy of the pressure-sensing system.

c. Components

(1) Fuzing Baroswitch

Results of the evaluation tests on the MC-5 baroswitches are being studied. Some modifications may be recommended.

Development of improved baroswitches is continuing at Marning, Maxwell & Moore, Inc.

(2) Arming Baroswitch

The results of the evaluation tests on several MC-273 baroswitches are also being studied. Some retests are being conducted to verify the original test results.

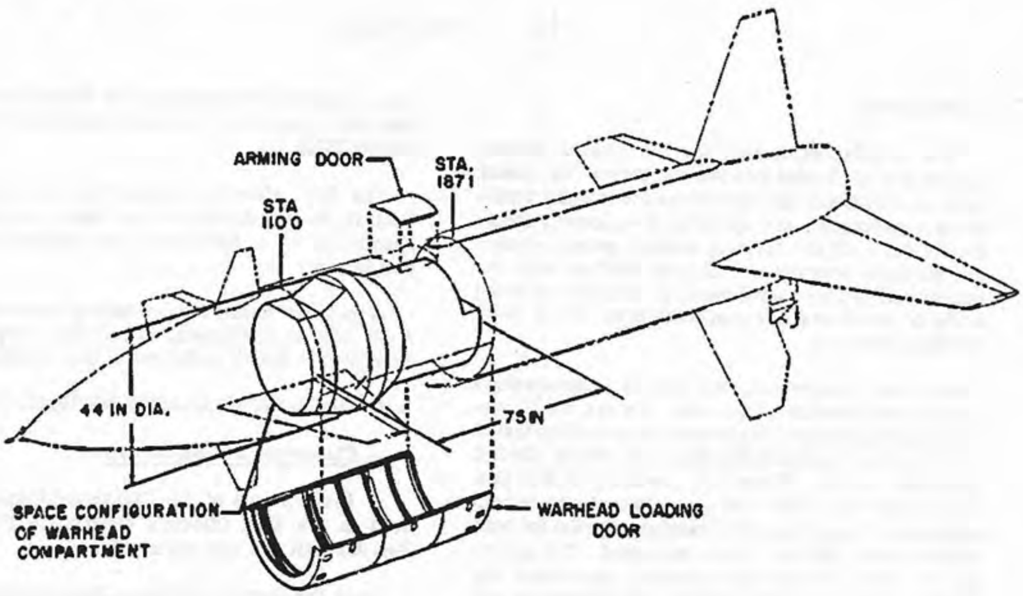


Figure 15. B-63 Warhead Compartment

Evaluation tests have been completed on two arming baroswitches devel(, 1by Manning, Maxwell & Moore, Inc. Certain vibration susceptibilities were indicated. More extensive vibration tests are under way to substantiate the original test data.

(3) Timer

Evaluation tests on the repeat-cycle d-c motor-driven timer manufactured by A. W. Haydon Company have been completed with satisfactory results. The possibility of conducting rotary acceleration tests on these units is being investigated.

(4) Contact Fuze

The equipment to test the MC-300 crystal contact fuze (supplied GFE) has been received from the Air Force Special Weapons Center. Calibration and general information tests are being conducted on a number of these units.

(5) Power Supply

The MC-272 battery assembly, available GFP, has been selected as the source of power for the PPB armament system. To date, batteries and test equipment for use in evaluation tests on this power supply have not been received.

H. Training

1. GENERAL

The training equipment for the Rascal Weapon System can be divided into two categories equipment such as classroom demonstrators for training maintenance personnel, and operational equipment specifically designed for training tactical personnel such as guidance operators. Closely tied in with the operational training equipment, an analysis is being made of the duties and responsibilities of the B-63 guidance operator.

As work progressed, two sets of demonstrator-type training equipment evolved. One set, the Classroom Demonstrators, has been designed and fabricated with an R&D configuration based on WADC Exhibit MCREXE 95-339. These are now being used to gain "know-how" with this type of equipment, and to help establish a weapon system training program for both Bell Aircraft and Air Force personnel. The second set of demonstrator-type training equipment are Mobile Training Units (MTU's) as defined in AF Exhibit WCE-280. (The requirement for MTU's was established by ATRC.) These MTU's will be similar to the Classroom Demonstrators, but will incorporate equipment from the operational rather than the R&D PPB and its director aircraft.

Representing the operational-type training equipment, the Rascal Guidance Operator Trainer (RGOT) has a configuration which is based on AF Exhibit MCREXE 95-340. The RGOT will provide guidance operator training as realistically as possible.

Classroom Demonstrators for the PPB and director aircraft have been completed and are being used in conjunction with an Orientation Program for Air Force Staff Officers, Figure 16. This program began at Bell Aircraft on 12 July 1954 and will continue until 22 October 1954. After this date, the demonstrators will be used by the Bell Aircraft Service and Training Section as training aids in the Contractor-conducted Factory Training Program at Lowry and Chanute Air Force Bases.

The prototype RGOT is in the hardware stage and it is anticipated that this trainer will be operative by December 1954 when a demonstration for the Air Force will be made. Since 19 August 1955 has been established as the starting date for training guidance operators under the Factory Training Program, the delivery date for the AN/APQ-T2A (to be combined with the prototype RGOT) has been established as 1 March 1955. This schedule will provide the lead time required for setting up the T2A with the RGOT, and will allow for test and problem setup prior to August 1955.

The Bell Aircraft specification for a simplified Optical Radar Simulator has been completed and negotiation of a subcontract for fabrication of this unit is under way.

A tentative outline for conducting an analysis of the B-63 Guidance Operator's job was prepared and submitted to WADC at the end of this quarter.

2. MAINTENANCE TRAINING EQUIPMENT

a. Classroom Demonstrators

Performance of the Classroom Demonstrators used in the Staff Officer's Orientation Program at Bell Aircraft has been satisfactory.

Since the Inertial Guidance Demonstrator, Figure 17, was incomplete when the Air Force conducted its recent inspection of XB-63 demonstrators, this training aid together with the Director Aircraft Demonstrators will be presented for Air Force inspection late in December 1954.

Design of the Fuzing System Demonstrator has been completed and is being released for fabrication.

Figure 16. Orientation Program for AF Staff Officers

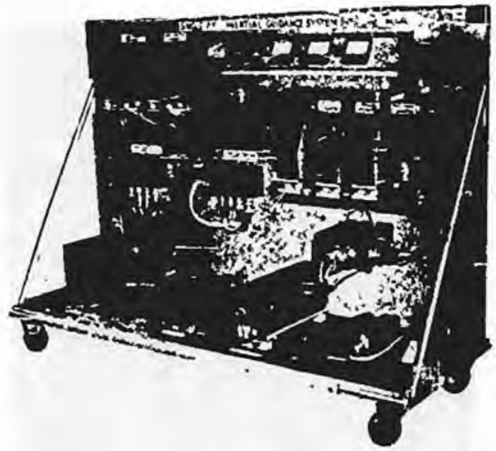


Figure 17. Inertial Guidance Demonstrator

To ensure that this design is up to date, work was delayed until design of the PPB fuzing system became finalized. Manufacture of this demonstrator is expected to be completed by the end of December 1954.

The Model 112 test equipment for director aircraft will be complete and ready for use in conjunction with the Air Force inspection of Director Aircraft Demonstrators. Fabrication of this test equipment proceeded on schedule throughout this quarter.

b. Mobile Training Units (MTU's)

Design of the PPB MTU is being delayed until a finalized and approved configuration for the B-63A is established. It is expected that construction of the PPB MTU will begin concurrently with the manufacture of the B-63A. However, design of the Director Aircraft MTU is proceeding, based on the present Model 110 operational configuration. Fabrication of the Director Aircraft MTU will be scheduled in a manner which will permit it to be completed concurrently with the B-63A MTU.

3. OPERATIONAL TRAINING EQUIPMENT

a. Rascal Guidance System Simulator (RGSS)

The RGSS, designed to serve both as an R&D tool for the Rascal Weapon System and as a design model for the RGOT, is being used for various Rascal R&D studies.

The Radar Simulator was received incomplete from the Hillyer Instrument Company in July 1954, and as yet has not been completely integrated with the RGSS. The work, which started on this equipment in July, has included setup, debugging, rework, modification, completion of some units, and evaluation of the optical system. In evaluating the optical system, a method had to be established for properly aligning the optics before the actual alignment could be accomplished. Preliminary results of this alignment and evaluation indicate that rigidity, light transmission, and resolution are limiting factors of the optical system. Plans for design improvement of this system have been held in abeyance pending evaluation of the entire optical-video system of the simulator. The present light source provides insufficient light. A solution of this problem is closely related to the optical system. Work in this area will continue during the next quarter. A report on the Optical System by Hillyer's optical consultant was received in September 1954 and is being studied in conjunction with Bell's own findings.

The Hillyer map (which was not tested at Hillyer) is incomplete and remains to be evaluated. The use of a Bell-developed map with the Hillyer Simulator is presently planned, and tests will be conducted as soon as the optical-video system of the simulator is ready for operation.

Design of jamming equipment to be used with the Radar Simulator is complete and preliminary units are being fabricated.

b. Rascal Guidance Operator Trainer (RGOT)

Design of the prototype RGOT (DB-47 version) is complete except for the permanent-type shipping crates. Design of a DB-36 station for use with the RGOT has been started and will be completed in time to allow manufacture of this unit by August 1955 (initiation of guidance operator training). Authority for fabrication of this unit has not been received from the Air Force.

The status of RGOT hardware is as follows: The power unit, Figure 18, is complete and will undergo testing in October; the DB-47 guidance station will be completely assembled and equipment installation will begin in mid-October; the instructor's console is 30 percent complete.

The Programmer Computer, Figure 19, received from Electronic Associates, Inc. late in this quarter will undergo testing early in October.

The USR Simulator, which will become a part of the prototype RGOT, was discussed in Section 3A.

Figure 18. Power Supply Cabinet and Motor Generator for RGOT

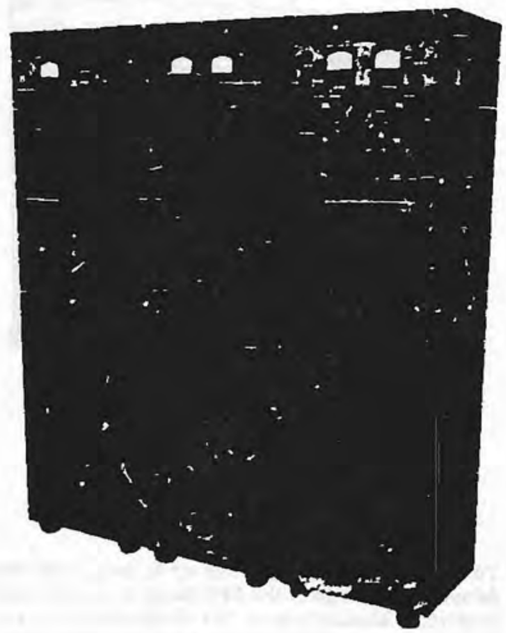


Figure 19. Programmer Computer for RGOT

Liaison was established with American Machine and Foundry Company to obtain information on any cabling modifications required to interconnect the AN/APQ-T2A and the RGOT. Some information was received and is being evaluated in terms of work to be accomplished.

A meeting was held at SAC concerning terrain maps to be used with the combined trainers. Personnel at SAC concurred in this contractor's conclusion that no exacting relationship need exist between the two maps.

The breadboard model of the Bell-designed Optical Radar Simulator has been used to demonstrate to Air Force Staff Officers the "blowup" of the Rascal radar picture during terminal dive. Procurement specifications for this unit, which combines computer-controlled map drives, movable cursors, and a superior optical system, have been completed and initial negotiations with a qualified optical subcontractor have taken place. It is anticipated that the subcontract can be placed by mid-October.

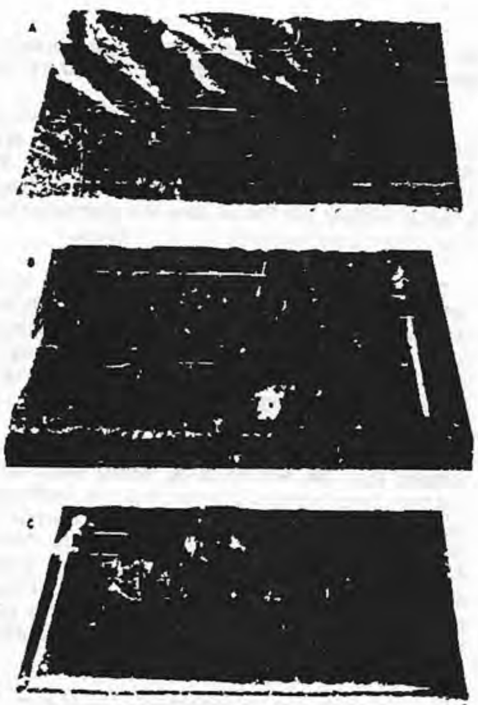
Development of map making techniques continues. As a result of a visit to SAC this quarter, Bell Aircraft was able to obtain prediction data for Kansas City; these data are in the most up-to-date form used by SAC. It is planned to fabricate a Bell-type radar simulator map of Kansas City and to obtain scope photos from the breadboard model of the Bell Optical Radar Simulator using this map. Then, actual scope photos of Kansas City will be provided by SAC to permit a preliminary evaluation of the Bell Aircraft map. Some of the basic techniques employed in this map making program are illustrated in Figure 20. Shown in this figure are the clay relief model of the area to be portrayed on the map, a female plaster mold of the clay model, and the final relief model which is a cast consisting of a fiber-glass-reinforced plastic backing with an aluminum foil surface. This latter model is now ready for surfacing.

c. RGOT Evaluation

An important requirement for this program is one of obtaining a variety of radar scope photos. It is planned to obtain most of these during the F-89C flight test program.

4. JOB ANALYSIS, RASCAL GUIDANCE OPERATOR

An outline plan for accomplishing the job analysis program was submitted to WADC for review. Most of the work required for this analysis will be done at HADC using the prototype DB-36 and DB-47 aircraft now at that facility, and will be accomplished in conjunction with the captive flight test program on PPB No. 48. As presently planned, this work will begin during November 1954.



A. Clay Relief Model
B. Female Plaster Mold
C. Final Relief Model

Figure 20. Basic Map-Making Techniques

I. Support Aircraft

1. GENERAL

The director aircraft which form an integral part of the Rascal weapon system are converted B-36, B-47, and B-52 strategic bombardment airplanes, redesignated as DB-36, DB-47, and DB-52. Their primary mission is to carry the B-63 pilotless parasite bomber to a point not more than 90 nautical miles from a target, and to launch the PPB at a particular altitude and heading toward the target.

During the R&D phase of the Rascal flight-test program, three types of director aircraft are to be used. The DB-50 director airplanes, because of their availability, are being used early in the program. Later, the DB-36 and DB-47 directors will be used for flight testing Model 56F missiles (Nos. 46 to 78).

2. DB-36 PROTOTYPE DIRECTOR AIRCRAFT

The DB-36 has been designated the first-priority director for the B-63. The PPB is carried partially within its bomb bay, and is mounted with zero angles of heading and roll and as small an angle of attack as possible. Detailed installation requirements have been issued in Bell Aircraft Report No. 110-947-034.

The structural modification and the installation of Rascal guidance equipment in the first DB-36, serial No. 51-5710, has been completed by Convair. This director airplane has completed radio interference tests at Walker Air Force Base and contractor technical compliance inspection at Fort Worth.

The airplane was transferred to HADC in July 1954. At present, flight-test instrumentation is being installed and a flight crew familiarization program is being conducted. After a PPB mating and a captive flight program have been completed, the DB-36 will be used to launch PPB's.

Late in July 1954, Bell Aircraft Corporation was advised that the second B-36, serial No. 51-5706, had been transferred to Convair and that modification was in progress. Personnel from Bell's Service and Training Section were assigned duty at Convair, Fort Worth, on 1 August 1954 to assist in bench checking, installing, and ground checking the Rascal guidance equipment for this aircraft. The DB-36 is scheduled for delivery to Bell Aircraft/HADC on 15 December 1954.

3. DB-47 PROTOTYPE DIRECTOR AIRCRAFT

Detailed installation requirements for the DB-47, designated second-priority director for the B-63, have been issued in Bell Aircraft Report No. 110-947-005. The PPB carried by the DB-47 is attached to a spar protruding from the fuselage, and mounted in an attitude so that the heading angle is zero, the angle of attack is as small as possible, and the angle of roll does not exceed 13°. The Rascal guidance equipment aboard the DB-47 is essentially the same as that used in the DB-36.

The Boeing Airplane Company has completed the aerodynamic and compatibility tests utilizing DB-47, serial No. 51-5219, and a simulated pilotless parasite bomber.

On 3 September 1954, the DB-47 and the simulated PPB were transferred to Edwards Air Force Base where extensive flight tests are to be conducted. Since this DB-47 is structurally equipped to launch PPB's it will be used to drop the simulated missile after the Air Force flight evaluation is complete. The DB-47 is scheduled for delivery to Boeing, Wichita, early in January 1955 for installation of Rascal guidance equipment.

Modification of a second DB-47, serial No. 51-5220, and the installation of Rascal guidance components were completed by Boeing. Radio interference noise tests at Walker AFB and contractor technical compliance inspection at Seattle have been completed on this airplane. The DB-47 was subsequently transferred to HADC on 26 August 1954. In accordance with AF Form No. 263, inspection of this aircraft has been completed and installation of instrumentation is under way. After a PPB mating and a captive-flight program have been completed, this director aircraft will be used to launch PPB's.

4. R&D AIRCRAFT

In the R&D program, four B-50's, one B-17, two F-80's, and one F-89 are being used as follows:

(1) The EB-50D ferrying airplane No. 2 (USAF No. 48-069) is equipped to ferry PPB's. Either two-point or four-point support fittings may be used, and conversion to either configuration can be made in 24 hours.

(2) The EB-50D director airplane No. 8 (USAF No. 48-068) is at the Wheatfield Plant. Since this airplane is no longer required in the flight test program, it will be returned to the USAF early in the next quarter.

(3) The EB-50D director airplane No. 4 (USAF No. 48-075) is at HADC. This aircraft is equipped with four-point launch gear and two-operator guidance equipment for launching XB-63 airframes Nos. 12 through 35.

(4) The EB-50D director airplane No. 7 (USAF No. 48-111) is also in use at HADC. This aircraft is equipped with four-point launch gear and two-operator guidance equipment for launching XB-63 airframes Nos. 12 through 35.

(5) The EB-50D ferrying airplane No. 12 (USAF No. 48-126) is equipped to ferry PPB's. Either two-point or four-point support fittings may be used, and conversion to either configuration can be made in 24 hours.

(6) The EB-29K ferrying airplane No. 10 (USAF No. 45-28171) was returned to the USAF on 30 July 1954.

(7) The EB-17G airplane (USAF No. 44-83439) is being used for developing components of the director and XB-63 guidance systems. The aircraft is being operated at Bell Aircraft/Wheatfield in conjunction with the EF-80B airplane (USAF 44-8485).

Figure 21. F-89C Simulated Rascal PPB

(8) The EF-80B airplane (USAF No. 44-8484), being used to simulate the Rascal pilotless parasite bomber, is equipped with X-band search radar, and relay and command equipment. This simulated PPB is stationed at HADC to check out aircraft assigned as XB-63 directors and to train guidance operators.

(9) The EF-80B airplane (USAF No. 44-8485), also used to simulate the XB-63, is operated at Bell Aircraft/Wheatfield in conjunction with the EB-17G airplane (USAF No. 44-83439) to flight-test electronic equipment.

(10) The F-89C airplane (USAF No. 51-5814), received from the USAF in May 1954, is being

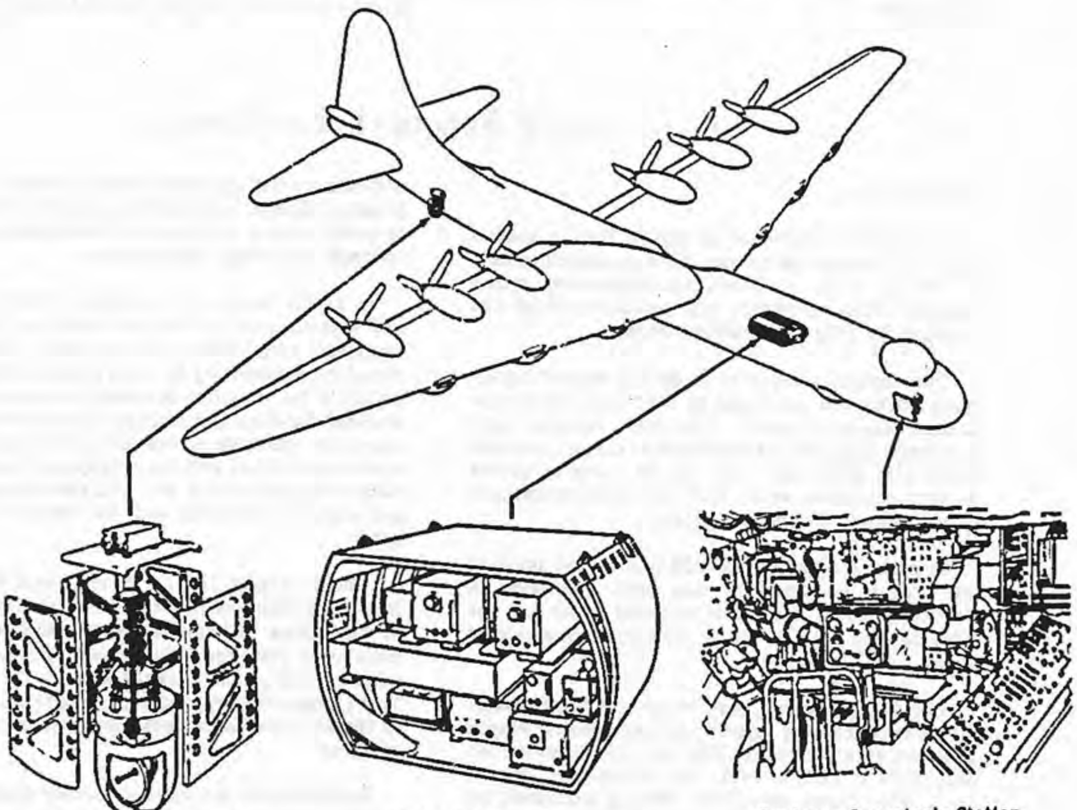


Figure 22. Model 110 Guidance System in DB-36

modified to simulate the Rascal PPB. Work on this modification is scheduled for completion during the next quarter prior to flight testing. The F-89C, Figure 21, will ultimately be used in the R&D program for developing components of the XB-63 and its director aircraft.

5. DIRECTOR AIRCRAFT GUIDANCE EQUIPMENT

That part of the Rascal guidance system which is installed in the director aircraft is referred to as Model 110 guidance equipment (see Figure 22). The terminal guidance station, the automatic relay antenna system, and the auto-check system are included in this equipment.

The first set of Model 110 guidance system components fabricated by Bell Aircraft was installed by Convair in the DB-36 director airplane, serial No. 51-5710.

The second set of Model 110 guidance components was installed by Boeing in the DB-47 airplane, serial No. 52-5220.

A set of Model 110 components was delivered to Convair late in July 1954 for installation in the second DB-36, serial No. 51-5706.

The set of Model 110 components previously scheduled for delivery to Boeing on 15 September for installation in the second DB-47, serial No. 51-5219, has been rescheduled for October 1954. Rescheduling will not affect the over-all program in view of the extended Air Force testing of this DB-47 in conjunction with the simulated PPB at Edwards AFB. Extending the test program has precluded the possibility of this aircraft being delivered to Boeing, Wichita, before October 1954.

J. Ground Support Equipment

1. GENERAL

A principal element of the Rascal Weapon System is ground support equipment. This equipment is used in the field for checkout, troubleshooting, minor repairs, field assembly, and ground servicing and handling the PPB and director aircraft.

Two distinct categories of ground support equipment (GSE) are furnished by Bell Aircraft for the Rascal Weapon System. The first includes units primarily designed and fabricated to support the R&D flight test program. The second category covers support equipment to be used during the operational employment of the weapon system.

In some instances, standard or modified standard Air Force equipment is also used. However, a relatively small number of standard items are applicable, and most of these are propellant servicing items.

During this quarter, several new Air Force specifications concerning support equipment for air weapon systems were received by Bell Aircraft. These include MIL-T-9412, MIL-W-9411, and MIL-S-6644, as well as a Procedures and Time Phasing Document for Ground Support Equipment. The specifications are being reviewed for the purpose of adopting them wherever possible. Bell Aircraft is preparing a document for ground support equipment that conforms with the format specified in MIL-T-9412. Also, the principal design specification, Bell No. 112-947-001, is being revised to reflect all established changes in concepts and design requirements.

In recent weeks, a complete review of efforts and expenditures for the R&D portion of the support equipment program has been conducted. This review, aimed at economizing in every possible way, has resulted in the reduction in quantity of certain items of warhead handling and nitrogen pressurization equipment. An extensive review of the future program was also accomplished with the objective of keeping within budgetary restrictions and still maintaining GSE requirements compatible with the over-all B-63 program.

Late in August 1954, a Development Engineering Inspection was conducted at the Wheatfield facility, at which time 36 items of operational support equipment were reviewed. Subsequently, action has been taken on Change Requests for all items in the mandatory change category, and reports have been submitted to the Air Force on several items placed in the study category.

In addition to the usual conferences among AMC, WADC, and contractor representatives during this quarter, Bell Aircraft personnel visited SAC Headquarters, Convair, and the Dallas Corps of Engineers in regard to ground support equipment.

2. R&D GROUND SUPPORT EQUIPMENT

a. Handling Equipment

Two additional handling and transport carriages for the Rascal PPB were received from the American Car & Foundry Company. This vendor has delivered a total of five carriages, of which two (along with some additional skids and cradles) have been shipped to HADC. All twelve carriages under subcontract to this vendor are scheduled for delivery by the end of 1954.

Except for certain minor rework, all cradles, skids, slings, and dollies required for the R&D program are complete and in use.

The warhead loader, which will support the R&D program at HADC, was completed in September 1954. A minor rework is required, however, and the article will probably not be delivered to HADC until early in January 1955.

Also completed during this period were other items of warhead handling and loading equipment, such as pans, slings, and adaptors (to adapt the pan to the H-185 container). Construction of the anti-deflection beam, required for alignment during warhead loading, is nearly complete. Bell-designed parts for two guidance-capsule lifts have been fabricated and are in stock. These parts are designed for installation on Mark VI bomb-lift trucks, converting them to guidance-capsule lifts.

b. Servicing Equipment

Two hydraulic fill-and-bleed units for servicing director aircraft were completed and shipped to HADC during this quarter.

Fuel and oxidizer servicing kits for No. 46 and subsequent PPB's were also completed and are being readied for shipment to HADC.

c. Director Aircraft Checkout and Test Equipment

Fabrication of two checkout trailers for the R&D director aircraft is proceeding on schedule. These units will be available for use in the program early in 1955. In the meantime, the prototype unit which was completed in August 1954 is undergoing tests prior to its delivery to HADC where it will be used and evaluated in conjunction with the PPB No. 48/DB-36/DB-47 program.

d. XB-63 Checkout and Test Equipment

An 18-test-position (station) program is required to test four XB-63's per month. The progress of these installations and their utilization during this quarter is summarized in the following paragraphs.

The eight test positions planned for the Wheatfield Plant and the four test positions planned for AF Plant No. 38 have been installed and are in full use. However, a maximum effort has been expended to modify existing test equipment to accommodate the system configurations of Model 56D missiles (Nos. 30 to 35) and Model 56F missiles (Nos. 46 to 72). The R&D prototype of the XB-63 Mobile Checkout Unit and test station A_1 has been modified to accommodate Model 56F PPB's. Also, changes to permit testing of Model 56D PPB's have been made in six test stations at the Wheatfield plant.

Of the six test stations planned for HADC, five are in full use. One of the production versions of the XB-63 Mobile Checkout Units, originally assigned to HADC and later transferred to Eglin AFB for use during the climatic testing of PPB No. 18, has been returned to the Wheatfield plant. This checkout unit is being dismantled and its equipment is being mounted on test carts. These carts will then become Station "X" at the XB-63 hardstand at HADC. Completion date for the carts is scheduled early in 1955.

The R&D Mobile Checkout Unit, previously used at the Wheatfield facility during composite systems tests on PPB No. 48, has been shipped to HADC where it is being used to check out PPB No. 48 during Phase II of the Interference Test Program.

Design work on a waveguide installation for all guidance stations is in progress. The new installation will reduce coaxial line loss, thereby improving operation of the test equipment.

To keep test equipment up to date with PPB changes, an R&D fixed (composite development) test station is being fabricated and installed at the Wheatfield Plant. Completion date of the installation has been set for January 1955.

To permit systems testing of PPB's without rocket engines, a Power Plant Simulator was fabricated for use on Model 56B PPB's (Nos. 7 to 29). This simulator has since been modified so that it can be used on missiles of Models 56D and 56F. These simulators provide a means for conducting circuitry checks when the power plant is not installed in the XB-63. In addition, a Sequence Checkout Assembly is used to perform tests on the power plant sequence box when the power plant is installed in the XB-63. A mock-up of this checkout assembly has been fabricated and is undergoing design tests. The first checkout equipment of this type will be installed in test stations during the next quarter.

Equipment for checking out the electrical and hydraulic systems of PPB power plants is also being fabricated for the R&D program. This equipment consists of two pressure-checkout consoles and two electrical-checkout consoles. The pressure checkout units will be available to the R&D program in the next quarter, and the electrical checkout units will be available early next year.

3. OPERATIONAL GROUND SUPPORT EQUIPMENT

Bell Aircraft's program for operational ground support equipment includes the design and development of contractor-furnished articles proposed for operational usage, as well as the establishment of requirements for standard Air Force items.

During this quarter designs were finalized for the following articles:

General Purpose Sling Set
Protective Cover (for PPB)
Anti-deflection Beam
Warhead Door Pan Sling
Adapter, H-185 to Warhead Pan
Warhead Hood
Relay Antenna Alignment Kit
Control Surface Locks
Power Plant Sling
Turbine Pump Stand
Sling Fitting, Turbine Pump
Rocket Engine Pressure Regulator Analyzer

Fabrication has proceeded on other Bell-designed items, of which the following have been completed:

Radome Stands
Forward Body Stands
Warhead Door Handling Pans

At the Development Engineering Inspection (DEI) held in August 1954, certain design changes evolved. Although designs for the following items were considered as final prior to the DEI, these articles are being redesigned according to the changes requested:

Aft Body Stand
Cowling Stand
Power Plant Dolly
Checkout Trailer (Director Aircraft)
Checkout Trailer (B-63)

Design of the following items continues and recommendations of the DEI are being incorporated wherever feasible:

Handling and Transport Carriage
Relay Antenna Dolly
Warhead Loader

As a result of information obtained during CTCI's at Boeing and Convair, Bell Aircraft undertook a major redesign of the handling and transport carriage. The decision which had greatest effect upon the design of this article was that the carriage should permit loading the PPB on either DB-36 or DB-47 director aircraft without the necessity of jacking up the airplane.

Requirements for the relay antenna dolly are being reviewed at Bell Aircraft, following changes recently made by Boeing in the relay antenna installation. Also, the requirements for the guidance capsule lift are being reviewed.

In addition to the items mentioned in the preceeding, design effort has continued on the following equipment:

Fuel and Oxidizer Drain Assemblies
Tool Kits (Review of Requirements)
Fuel Line Fill Unit
Bench Set (B-63)
Bench Set (Director Aircraft)
Rocket Engine Analyzer
Turbine Pump Analyzer
Propellant Flushing and Drying Equipment

The designing of the first five items of the preceding list is scheduled for completion by the end of 1954; design of the last three items will extend into 1955. The possibility of requirements for additional operational ground support equipment was considered late in this quarter. Accordingly, design studies for fuel and oxidizer vent adapters and a hydraulic oil filtering unit are in process.

Shown in Figure 23 is the Consolidated Diesel MA-1 Mobile Power Unit, which is similar to the Model 2100 unit recommended by Bell Aircraft as a power supply for B-63 checkout and alignment operations.

The test and evaluation model of the B-63 Checkout Trailer is shown in Figure 24.

Figure 25 portrays a mock-up of the USR portion of the B-63 bench set. This equipment was displayed during the Development Engineering Investigation in August 1954.

Figure 24. Test Model of B-63 Checkout Trailer

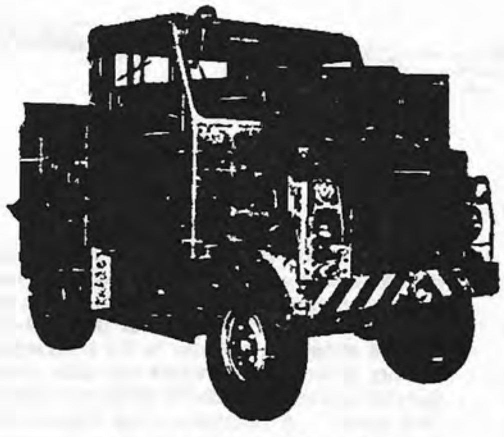
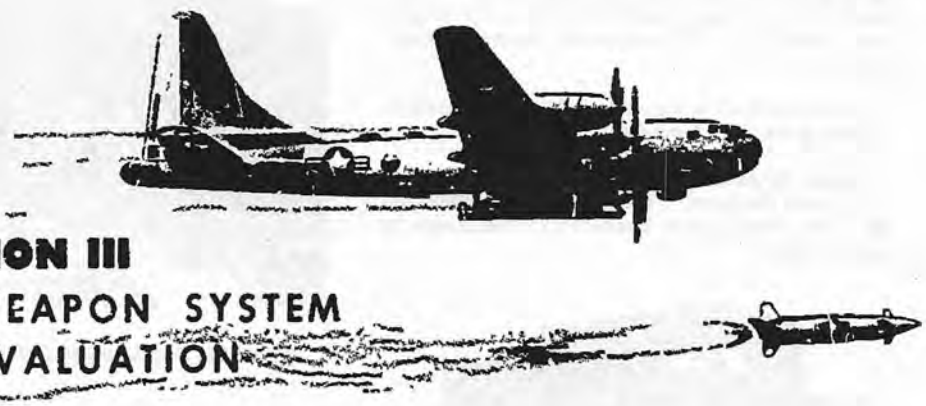


Figure 23. Mobile Power Unit

Figure 25. Mock-up of USR Portion of B-63 Bench Set



SECTION III
WEAPON SYSTEM EVALUATION

A. Introduction

As Project MX-776 progresses from R&D to the fabrication of prototype operational configurations, an increasing amount of final testing and evaluation of equipment is undertaken. At the present time the major effort is directed toward: (1) qualification testing* of components and subsystems, (2) flight testing of XB-63's, and (3) evaluating prototypes of director aircraft and ground support equipment. With such a program, system deficiences can be pinpointed so that corrective development work may be undertaken concurrently with the evaluation of the weapon system and its parts.

This section presents the progress being made in systems testing and flight testing various elements of the weapon system. Particular attention is directed not only to the "end result" or the miss-distance attained at impact, but also to the accuracy and reliability of individual systems and subsystems (both director aircraft and XB-63) which contribute to this "end result." It is axiomatic that weapon evaluation studies become more conclusive as the testing program progresses to the stage where final operational configurations are tested.

B. Systems Testing

1. COMPONENT AND SUBSYSTEM TESTING

a. General

Inspection testing** of components designed for the Rascal pilotless parasite bomber and the director aircraft, as well as testing and evaluating new or modified units, is a vital part of the MX-776 program; the reliability of the Rascal weapon system is directly related to the reliability of each of its units. Conventional as well as specialized environmental test facilities such as vibration, shock, and acceleration equipment, and temperature, altitude, and humidity chambers are used.

b. Component Testing

Qualification testing of Rascal components and subsystems applicable to No. 75 and subsequent PPB's is currently anticipated for late December 1954 or early January 1955. Necessary test equipment is being prepared and will be completed by the end of the next quarter.

*Qualification testing as defined herein is that testing necessary to demonstrate design adequacy for the intended usage.

** Inspection testing as defined herein is that testing performed to verify the continuing quality and proper functioning of items being produced for deliverable products.

Testing of the components for the Model 110 terminal guidance system (TGS) is proceeding. The five subsystems composing a TGS are: relay and command (R&C), automatic tracking relay antenna system (ATRAS), automatic checkout system (ACS), terminal guidance control system (TGCS), and auxiliary equipment. For the R&C and auxiliary equipment, testing is conducted on individual components, while each of the remaining systems is tested as a complete system.

Serial numbers applicable to the TGS are also applicable to all of the subsystems. The intended usage of each serial number follows. No. 7, DB-47, No. 10, R&D (DB-50) spare, No. 11, DB-36 spare; Nos. 12, 13, and 14, DB-36 or DB-47 spares.

Inspection tests have been completed satisfactorily on all auxiliary equipment for Model 110 TGS serial Nos. 7, 10, 11, 12, 13, and 14.

ATRAS inspection tests have been completed satisfactorily for systems Nos. 7, 11, 12, 13, and 14. An antenna on No. 10 was returned to the vendor for repair. Testing will resume in November.

Satisfactory inspection tests have been completed on ACS Nos. 7 and 11. Tests are still in progress on systems Nos. 10, 12, 13, and 14.

All six TGCS (7, 10, 11, 12, 13, and 14) have been inspection-tested and have satisfied all requirements.

Components for system No. 14 of the R&C will be tested early in November 1954. All inspection test requirements have been satisfied on Nos. 7, 10, 11, 12, and 13.

TGS No. 101 (considered typical of systems produced by Bell Aircraft's manufacturing facilities) is currently being inspection-tested. All auxiliary units have satisfactorily passed inspection-test requirements. This system will be delivered to the Air Force during the next quarter and subsequently returned for qualification tests.

During the qualification tests on system No. 101, the TGS will be subjected to conditions encountered during field use. These conditions and requirements are those contained in Bell Aircraft Specification No. 110-947-043, Qualification Tests of the Terminal Guidance System, Director Aircraft. This specification is currently being reviewed by WADC. Shielded rooms and test equipment necessary to conduct noise and interference tests on this system are available in Bell Aircraft laboratories.

Inspection tests on the Model 102 Rascal guidance operator trainer (RGOT) were satisfactorily concluded. All components of this system were delivered as scheduled to the Service and Training Section of Bell Aircraft Corporation.

c. Test Equipment

Qualification-testing of the weapon system will be performed to demonstrate design adequacy of the system for its intended usage. To perform these tests, both specialized and commercial test equipment are required. Each specialized test equipment assembly normally consists of: (1) a test panel or rack, (2) bench and environmental test cabling, (3) environmental test fixtures necessary to mount the item on environmental test equipment, and (4) other mounting fixtures or testing jigs as required. A typical example of test items for use in qualification-testing of Rascal servo components is shown in Figure 26.

Present planning indicates that Rascal servo, electronic, and telemetering systems will be qualification-tested on an individual component basis, whereas the USR system and relay and command system will be qualified as complete systems. Development of specialized test equipment for the qualification-testing of the aforementioned systems and components is 80 percent complete. A detailed breakdown of the status of this test equipment is presented in Table VI.

Development of qualification test equipment for Model 110 equipment in the director aircraft is also summarized in Table VI. Existing test equipment, built for R&D evaluation and prototype acceptance testing, is applicable and will be utilized for the initial phase of qualification testing. The test equipment now being designed will be utilized for the composite director aircraft system testing with the capsule. A cooling system is being developed to provide necessary cooling of the capsule during the tests.

During the next quarter, efforts will be directed toward completion of fabrication of the Rascal qualification test equipment and "mating" of the test equipment with the "hardware" to be tested. This "mating" consists of connecting the test equipment and item being tested to assure compatibility and proper operation prior to start of the tests.

In addition, the design will be completed for the test equipment for radio interference testing of the system in accordance with MIL-I-6181B. Also, effort will be directed toward development of an actuator system for the equipment operation controls while the equipment is undergoing hot and cold tests within a chamber.

1. Test Rack
2. Centrifuge Test Cable
3. Environmental Test Fixture
4. Roll Servo Pilot Amplifier (to be tested)
5. Test Equipment Instruction Manual
6. Pitch & Yaw Amplifier Adapter Plate (for environmental test fixture)
7. Bench and Altitude Chamber Test Cables

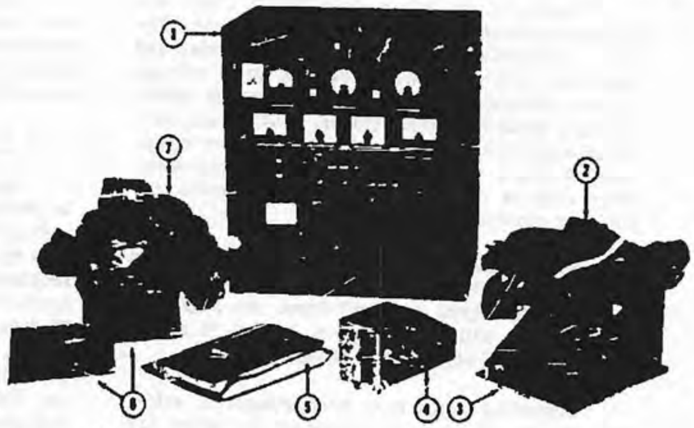


Figure 26. Servo Test Setup

TABLE VI

MISSILE TEST EQUIPMENT			
ITEM TESTED	TYPE OF TEST EQUIPMENT	DESIGN STATUS PERCENT COMPLETED	FABRICATION STATUS PERCENT COMPLETED
SERVO-ELECTRONIC COMPONENTS	ELECTRONIC		
	ENVIRONMENTAL TEST FIXTURES		
RELAY AND COMMAND SYSTEM	ELECTRONIC		
	ENVIRONMENTAL TEST FIXTURES		
USR SYSTEM	ELECTRONIC		
	ENVIRONMENTAL TEST FIXTURES		
TELEMETERING	ELECTRONIC	T/M CONFIGURATION NOT RELEASED THIS PERIOD	
DIRECTOR AIRCRAFT TEST EQUIPMENT			
SUB-SYSTEMS AND COMPONENTS	ELECTRONIC		
	ENVIRONMENTAL TEST FIXTURES		
COMPOSITE SYSTEM	ELECTRONIC		
	ENVIRONMENTAL TEST FIXTURES		
		0 25 50 75 100	25 50 75 100

2. COMPONENT CHECKING

In support of the reliability program, the following activities and accomplishments are reported for the third quarter of 1954.

Investigations and follow-up were conducted to determine the cause, extent, and the corrective action necessary to eliminate discrepancies indicated on failure reports originated at Bell Aircraft Corporation test facilities. Liaison reports were issued to summarize investigation findings and to indicate the corrective action necessary.

The following studies were conducted and the results are indicated.

a) Rascal telemetering system failures were analyzed to determine which failures were repetitive and constitute critical test problems or seriously affect the reliability of the system. These problems were examined in co-ordination with the development group to determine necessary corrective action. Forty-four percent of the 569 reported failures for the period of 1 January 1952 to 15 August 1954 were concerned with five components: dynamotor commutator gating unit, flight programmer, subcarrier oscillator assemblies, pressure gages, and r-f power amplifiers. Satisfactory solutions have been obtained on all problems except those affecting phasing and brush tension of the dynamotor commutator gating unit; these are being investigated further by the development group.

b) The results of investigations of unsatisfactory reports concerning the ability of systems to withstand environmental conditions were analyzed. These investigations have shown that the failures of various components during acceptance testing of the missile resulted from the deterioration of insulation on Suprenant KEL-F and SRHV-type conductors. For conductors requiring heat-resistant insulators, KEL-F wire has been replaced with Teflon insulated wire, and for conductors subjected to high voltage and corona effects, SRHV wire has been replaced with type 58416-R Packard high-voltage cable.

c) Summaries of all unsatisfactory reports on PPB Nos. 0914, 1016, and 1117 were prepared. These summaries reviewed the problems that arose during test and outlined the corrective action taken. An average of 64 unsatisfactory reports were made for each of these missiles and corrective action was initiated prior to the firing date.

d) Monthly summaries of investigations were prepared to draw attention to those problems which result in testing delays. As a result of such summaries, corrective action has been significantly expedited on critical engineering problems.

3. SYSTEMS TESTING

a. <u>General</u>

The individual electrical, electronic and hydraulic systems of the Rascal are tested in Bell Aircraft's Missile Laboratory. This consists of adjusting and aligning the systems to conform with applicable specifications, and "trouble shooting" to determine causes of nonconformance.

b. Rascal Test Setup

A line setup of fixed test stations (see BMPR No. 35) is utilized for testing all systems of the PPB except the propulsion system. When an XB-63 is delivered to the Missile Laboratory, it is placed in servo test, Station "D", where the hydraulic system and the servo-electrical system are tested to ensure correct operation. This includes bleeding the hydraulic lines, inspecting the system for leaks, and checking valve and actuator operation under full pressure. Tests on the servo-electrical system are then performed in the following sequence: (1) the power supply is checked and adjusted to obtain proper voltage outputs; (2) the control surfaces are aligned and the feed-back potentiometers are set; (3) all amplifiers are checked for balance and gain, (4) the search and relay antennas are pitch stabilized; (5) the drift rate on the directional and vertical reference gyros is checked; and (6) the gains of the pitch, yaw, and roll stabilizing subsystems are set.

b. <u>Climatic Tests</u>

Climatic testing of XB-63 No. 18 in the climatic test facility at Eglin Air Force Base, Florida was started 1 April and successfully completed 30 August 1954. All personnel, supplies, and support equipment were returned to Bell Aircraft's Wheatfield Plant by 17 September 1954.

The climatic test program included 26 composite systems tests in various environments as shown in Table VII. The primary objective of this series of tests was to establish environmental conditions imposed on individual missile components

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TABLE VII

CLIMATIC TEST SCHEDULE - 1954

TEST NO.	DATE	CLIMATIC CONDITIONS		REMARKS
C-1	30 April	+70°F	30% R.H.	1. Initial test to establish ambient temperature and performance conditions.
C-2	4 May	+100°F	27% R.H.	1. No discrepancies due to environment.
C-3	7 May	+40°F	---	1. Command system intermittent.
C-4	12 May	+10°F	---	1. No discrepancies due to environment.
C-5	13 May	-20°F	---	1. Pressure gage reaction slowed. 2. PPB timers running slow
C-6	14 May	-50°F	---	1. Pressure gages sluggish. 2. Boost and cruise timers very slow 3. Surface position pots (angular) unreliable. 4. Rupture of aft 2-cu. in. accumulator bladder.
C-7	21 May	+70°F	30% R.H.	1. Recheck of base line data at ambient conditions compared favorably with Test No. C-1. 2. Timer and pressure gage operation normal.
C-8	26 May	+130°F	10% R.H.	1. USR and relay systems voltages low 2. Command receiver AFC sweeping.
C-9	5 June	-65°F	---	1. 12-hour soak period at -65°F. 2. Leakage of nitrogen at accumulator flanges. 3. Rupture of diaphragms in propellant valve accumulators. 4. S-band beacon inoperative. 5. Umbilical plug contact not consistent. 6. Servo and telemetering operation satisfactory
C-10	14 June	-65°F		1. 72-hour soak at -65°F. 2. Telemetering calibrator failed to step through a complete cycle 3. Slight N_2 leaks.
C-11	15 June	-80°F		1. Crystal shutter stuck. 2. Calibrator operation satisfactory 3. S-band beacon inoperative 4. Hydraulic and N_2 leaks on boost No. 2 prop. valve.
C-12	16 June	+70°F	22% R.H.	1. All systems operated satisfactorily 2. Data concurs with that of Test Nos. C-1 and C-7
C-13	21 June	+160°F	30% R.H.	1. USR RT unit and Relay Command Assembly internal temperatures exceeded 200°F within a few minutes causing guidance shutdown.
C-13 (cont.)				2. Servo power supply maximum temperature exceeded 400°F. 3. Full temperature data were obtained, but composite check was not completed
C-14	25 June	+70°F	22% R.H.	1. Final temperature test. Temperature data confirmed previous +70°F ambient results.
C-15	10 July	110°F, 95% R.H., 1.5 cycles		1. End limits of humidity cycle established to provide specified moisture condensation within missile
C-16	13 July	110°F, 95% R.H., 5.5 cycles		1. Corrosion of bearing surfaces in the flight programmer unit.
C-17	21 July	110°F, 95% R.H., 40.5 cycles		1. Most severe environment encountered. 2. Servo and Guidance Systems failed due to short circuits. Telemetering 8-channel-mount output failed Numerous component failures. 4. Rocket System operation was satisfactory.
C-18	30 July	82°F	39% R.H.	1. No major difficulties. Normal systems operation restored.
C-19	4 August	+80°F 5 min. rainfall at 2 in/hr +80°F 15 min. rainfall at 3 in/hr +80°F 60 min. rainfall at 4 in/hr		1. Very little internal water 2. Composite test after 60-minute exposure 3. Loss of USR DC voltages. 4. Fuses blown in servo valves 5. J-50 test umbilical corroded excessively despite protective measures
C-20	13 August	+130°F, 20% R.H., 1 hr, sand & dust		1. No failures due to dust, although dust thoroughly penetrated missile interior
C-21	16 August	-20°F, 70% R.H., 1 hr, sand & dust		1. No discrepancies due to dust
C-22	16 August	+60°F, 70% R.H., 1 hr sand & dust		1. No discrepancies, dust blown on thoroughly soaked missile
C-23	20 August	+80°F, 85% R.H., Solar Radiation		1. Ambient test following solar radiation exposure Normal performance
C-24	26 August	90°F, 82% R.H., 8 hr exposure to salt spray		1. No discrepancies due to salt environment
C-25	27 August	92°F, 74% R.H., 16 hr, exposure to salt spray		1. No discrepancies due to salt environment.
C-26	30 August	96°F, 77% R.H., 32 hr, exposure to salt spray		1. Excellent systems performance despite operation in salt spray

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SECTION II

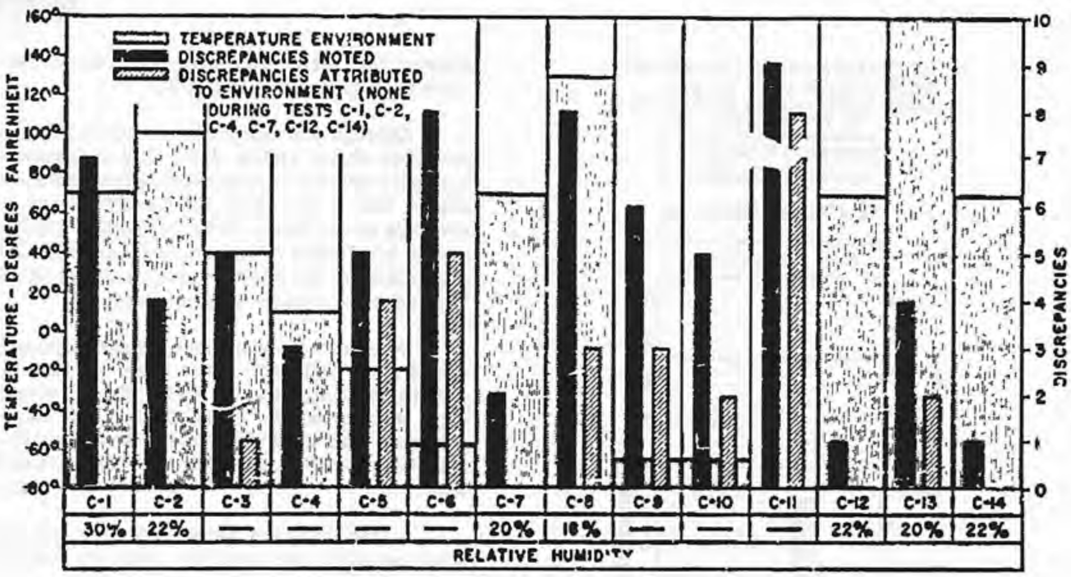

Figure 27. Temperature Test Results

when the missile as a whole was subjected to various climatic environments. Sufficient data are now available and on record in Bell Aircraft's Dynamics Section to determine these limits. A secondary objective was to observe the effects of various climatic conditions on performance of components and systems. Figures 27, 28, and 29 illustrate some of these conditions. This objective was also satisfied and has been made a part of the permanent record of the test program.

Temperature instrumentation included 277 thermocouples installed to provide skin temperatures and ambient temperatures of the missile and its components. Temperatures were recorded during soak periods, warm-up periods, and systems operation periods for each of the 26 tests. A massive amount of temperature information was gathered and has been compiled in ready reference form for the use of interested design-development and test personnel.

Two primary temperature results were the indication of a need for heat dissipation in the sealed and pressurized guidance components, and for low temperature protection of hydraulic accumulators containing diaphragms.

Humidity and rain test results indicated that a high relative-humidity environment will penetrate a

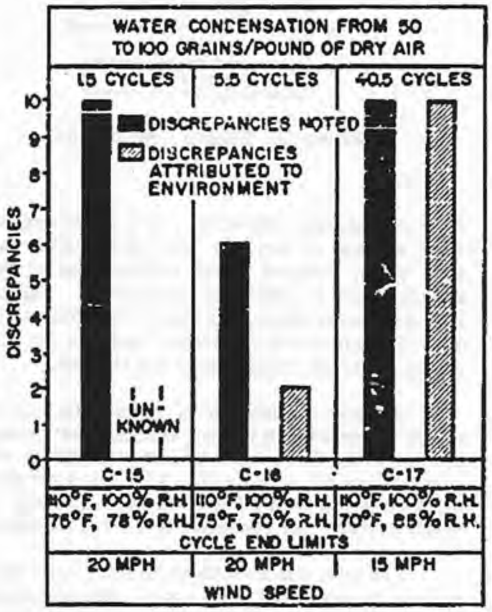

Figure 28. Humidity Test Results

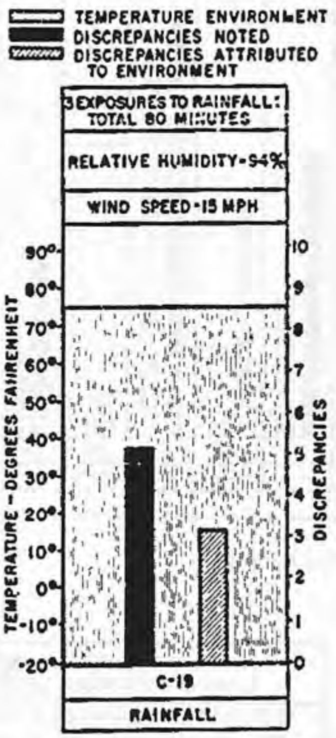

Figure 29. Rainfall Test Results

dry "buttoned-up" bomber in a very few hours. Constant cycling of humidity with condensation during each cycle, resulted in the accumulation of short-circuit paths in electrical connectors. Figure 30 indicates water damage to the P-50 umbilical plug. The moisture-proof connectors used in the rocket engine electrical harness were not affected.

Although the interior of the missile was thoroughly saturated with blowing sand and dust, as shown in Figure 31, there were no harmful effects on the performance of components. This bears out the results observed with XB-63 No. 48 at Roswell, New Mexico, which was unaffected by severe sandstorms.

The solar radiation tests also indicated that the missile is unaffected by that particular environment. Although the missile was subjected to solar loads in excess of the levels specified by MIL-E-5272A, no harmful effects were noted. Skin and ambient temperatures did not exceed the temperatures experienced during the high-temperature tests. The reflecting dish, which was designed to boost the total solar load, is shown in Figure 32.

Although salt spray did not appear to affect the operation of any system at the time of exposure, the corrosive effects of this accelerated exposure became evident after a few days. The relay antenna, which normally moves freely, froze in position. Salt crystal growth was evident around screw heads and at doubler plate sections. No attempt was made at the test site to wash down the missile after exposure.

On return of the missile and participating personnel from Eglin Air Force Base, the missile was partially dismantled and a static display of test results was arranged. This display was viewed by personnel from the Air Force and the engineering and manufacturing divisions of the Bell Aircraft Corporation.

A final technical report of the test program is being prepared and should be ready for distribution early in November.

The missile instrumentation system is tested at Station "C". Included are tests of the telemetering system, S- and L-band beacons, and the destructor-recovery system. Preliminary telemetering checks include tests of the ogive gages and pitot mast. When this is completed the telemetering transmitter is set up, and monitoring tests on the subcarrier oscillator frequencies are made to ascertain the acceptability of the subcarrier frequencies as designated by the applicable specification.

Figure 30. Umbilical Plug After Rainfall Test

Figure 31. Missile Section After Sand and Dust Test

Figure 32. Solar Radiation Dish Test

The S- and L-band beacons, which are used to track the XB-63 in flight, are tested in the Missile Laboratory to conform with the applicable specification. This includes checks and adjustments of receiver sensitivity, transmitter frequency, and transmitter power output.

During the final flight of an XB-63, pertinent information on the flight is obtained through the telemetering system by the time the missile has descended to 18,000 feet. Since the XB-63 contains much valuable equipment, certain sections of the missile are blown apart in flight and recovered by parachute. This system is called the destructor-recovery system, and is tested in the Missile Laboratory in the following manner:

One-half-ampere fuzes are placed in the blasting circuit which normally contains blasting caps. External power is then applied to the S-band and L-band beacons. When the pulse repetition frequency of the beacons is changed from "track" (732 pps) to "destruct" (854 pps), the fuzes must blow in 12 ±3 seconds to indicate satisfactory operation of the blasting-cap circuit.

The emanating guidance system of the XB-63 is tested at Station "B". The aft guidance equipment, which is used to direct the flight of the PPB, is adjusted and aligned to receive coded commands from the polycode driver that simulates the director aircraft guidance equipment. Adjustments are also made on the unattended search radar, the X-band guidance power output, and the receiver-transmitter frequencies.

At the composite-systems-test station, Station "A", all PPB systems, excluding active propulsion, are operated simultaneously according to the applicable specifications.

c. <u>XB-63 Testing</u>

(1) XB-63 No. 30

Systems tests were completed successfully on XB-63 No. 30 and the latest modifications are being incorporated. This missile will then be shipped to Air Force Plant No. 38.

(2) XB-63 No. 48

Individual systems tests and a static composite systems test were performed on XB-63 No. 48. The test data were reduced and found satisfactory. The latest modifications were incorporated and missile No. 48 was transported to Holloman Air Development Center for DB-36/DB-47/XB-63 compatability testing.

(3) XB-63's Nos. 21, 22, 24, 26, and 28

Because of recent modifications and changes in flight planning, XB-63's Nos. 21, 22, 24, 26, and 28 were returned to the Missile Laboratory for retests. The tests were completed and XB-63 Nos. 21, 22, and 24 were transported to Holloman Air Development Center and Nos. 26 and 28 are being prepared for shipment.

4. SPECIAL TESTING PROGRAMS

a. Vibration Tests

Tests were conducted in the Missile Laboratory to determine the over-all operation of the various systems of the XB-63 under vibratory conditions. All of the systems of the XB-63 were operated simultaneously while simulated vibrations were applied in the vertical and longitudinal axes at frequencies ranging from 15 to 250 cps. During the test on XB-63 No. 26, a false command problem was encountered, and was corrected by replacing several parts, including the search antenna waveguide assembly. The vibration test on XB-63 No. 28 was successful.

5. TESTING AT AIR FORCE PLANT NO. 38

a. General

The MX-776 testing program at Air Force Plant No. 38 consists of rocket engine inspection testing and composite systems testing. During the composite testing, all systems of the XB-63 including rocket engine are operated and checked simultaneously. Two test cells are used for engine inspection testing and four for composite testing. Additional qualification testing, such as attitude-tower testing as shown in BMPR-37, page 58, is also conducted at AF plant No. 38.

b. Rocket Engine Inspection Testing

After safety modifications were made on the Aerojet turbine pumps, the successful results of thirty-two inspection tests on rocket engines during this quarter were reflected in the acceptance of PPB rocket engines serial Nos. 16, 17, 19, and 26 through 31. A redesigned engine control harness and a pneumatic transitional delay system were incorporated in rocket engines serial Nos. 14, 16, 18, 19, 24, 28, and 32. Because of this change, these engines were subsequently subjected to "penalty" inspection runs.

Since increased efficiency was obtained through the use of a portable test-firing dolly and the modified test stand in the quonset cell E-4N (see BMPR-37, page 57), test cell E-4S has been converted to a similar configuration. The portable dolly and the standardization of the test stand for engine testing and test equipment allow complete interchangeability between cells E-4N and E-4S. The modified test stand is divided into two parts; a fixed section and a dolly. The propellant tanks and manifolds of the test stand are fabricated as a fixed section. The dolly, on which the PPB engine can be mounted, is attached to the fixed section for inspection testing purposes. The engine dolly has space for instrumentation that will allow complete pressure checks, electrical sequence checks, and power input calibrations to be made prior to the installation of the engine in the test cell. After these preliminary checks have been completed, the engine assembly is moved to the test cell and fastened to the test stand where various propellant and pressurizing lines are mated and electrical connections are made. Beyond this point and prior to inspection tests a minimum of electrical checks remain.

c. XB-63 Inspection

Before PPB's that have not received a special composite systems test under vibratory conditions are delivered to HADC, a final inspection test is made at AF Plant No. 38. This test is conducted with all PPB systems, including the rocket engine, operating simultaneously. After the successful completion of the test, the PPB is returned to Bell Aircraft's Wheatfield Plant for final inspection and painting, and then delivered to HADC for flight tests.

Flight tests at HADC have brought out the necessity for making changes in some of the component systems of the PPB. The following are some of the modifications which were made on PPB's at AF Plant No. 38:

1) Testing on the servo system of PPB No. 20 revealed that a series of changes should be made to eliminate servo-electrical noise. These changes were subsequently incorporated in all of the remaining Model B missiles (PPB's Nos. 7 through 29). PPB No. 20 was returned to the Wheatfield Plant, where modifications to this missile could be made more readily. After PPB's Nos. 21, 22, and 24 were modified, retesting was completed during June and July 1954. These bombers were subsequently sent to HADC for flight testing.

2) Because of the trouble with the power plants on XB-63's Nos. 16 and 17 during flight (see Section C, Flight Testing), XB-63 No. 21 was returned to Air Force Plant No. 38 where tests were conducted to determine the cause of power plant malfunctioning. Actual flight conditions were simulated as nearly as possible, and the XB-63 was prepared for firing. All cowling was installed and a means was devised for simulating the separation of the umbilical plug and lanyard from the missile after the rocket engines were fired. On the first attempt, a minor explosion in the engine compartment damaged

the aft cowl. Investigation revealed that a leak had occurred at the joint of the external exhaust duct to the missile; hence, combustible exhaust gases from the turbine had accumulated inside the aft cowl. The minor damage caused was repaired immediately. During the subsequent refiring, no malfunction of the engine occurred as the umbilical plug and lanyard separated from the missile and the rockets continued to fire satisfactorily.

Following this test, electrical modifications were made to convert the XB-63 from a "zero-rail launch" to a "free-drop launch" configuration. This configuration was ground-fired successfully on 16 September 1954. The engine assembly was then cleaned and reinstalled, and on 22 September 1954 the XB-63 was returned to HADC. Following successful test on the drop-type electrical configuration for the power plant on XB-63 No. 21, XB-63's Nos. 23, 25, and 27 were equipped with the same system. Retesting and composite systems testing on these XB-63's are proceeding satisfactorily.

C. Flight Testing

1. GENERAL

Bell Aircraft's flight testing activities for the Rascal weapon system are held at HADC. Flight tests are conducted on a step-program basis, progressing from the simplest possible arrangement to the final configuration of an operational warhead-carrying weapon.

PPB Nos. 21, 22, 24, and 48 were delivered to HADC on 28 July, 4 August, 27 August, and 8 September 1954 respectively. PPB No. 21 was returned to Bell Aircraft/Wheatfield Plant for modification and additional ground firing, after which it was delivered to HADC on 17 August 1954 for continuation of its testing.

Eleven captive flights were conducted on XB-63's; two with No. 1016, one with No. 1117, three with No. 19, three with No. 21, one with No. 22, and one with No. 24.

Rascal PPB No. 1016 was launched at HADC on 27 July 1954. Rascal PPB No. 1117 was launched on 9 August 1954.

2. XB-63 TESTING AT HADC

a. XB-63 No. 1016

Work prior to this quarter including incorporated modifications and the first captive flight of this missile are discussed in BMPR-37, pp. 61, 62.

After receipt of a power plant on 6 July 1954, the second and third captive flights of PPB No. 1016 were made on 15 and 16 July 1954, respectively. The second captive flight was halted, after approximately one-quarter of the countdown was complete, owing to an oil leak which developed in the No. 2 engine of the B-50.

The third captive flight proceeded satisfactorily until the 30,000-foot dry run where a leak developed in the USR pressure system. The leak caused sufficient electrical damage to make the USR system inoperative. The aircraft descended to 10,000 feet and completed the test. At this altitude the USR system was still inoperative; however, all other bomber systems were operative. An investigation revealed that the 18-inch flex guide connected to the USR antenna was broken and had caused severe damage to the modulator and receiver-transmitter units, necessitating their replacement.

[illegible] final preparations were made, PPB No. 1016 [illegible] launched at HADC on 27 July 1954. The main purposes of this test were to check the servo/airframe response characteristics (three-axis stabilization and relay and search antenna), the tank expulsion and low-pressure power plant systems, and the pressure-sensing portion of the warhead's fuzing system. Secondary objectives of this flight test were to test the operation of the guidance equipment, and to obtain aerodynamic zero-lift drag data in the supersonic Mach number range.

Prelaunch checks of the missile's systems were completed satisfactorily. Somewhere between 1.64 and 1.67 seconds after rocket fire, the power plant shut down. This early shutdown made it impossible to check any of the test objectives. A careful inspection of the recovered engine assembly, and applicable telemetering records, failed to reveal a specific reason for the power plant malfunction.

b. XB-63 No 1117

This missile was delivered to HADC minus a power plant on 4 June 1954; the power plant was delivered 26 July 1954. This time interval was advantageously used for the incorporation of field service kits and E O.'s (engineering orders concerning modifications, etc.).

The 30 July 1954 captive flight was moderately successful. Telemetering records, however, verified the suspected existence of false commands and also revealed improper operation of some power plant components. False commands and USR malfunctions were traced to a substandard magnetron in the relay transmitter and to oscillations in the preamplifier unit of the USR's receiver-transmitter assembly. The missile was considered ready for flight after these and the power plant discrepancies were corrected.

Rascal XB-63 No. 1117 was launched at HADC on 9 August 1954. The primary objectives of this flight were to test the operation of the servopilot system, propellant expulsion system, and pressure sensing portion of the fuzing system. The servopilot system test was to include three-axis stabilization with programmed climbs, servopilot/airframe response during terminal guidance commands, and relay and search antenna stabilization.

Secondary purposes for the PPB No. 1117 launching were to test the operation of the "dual operator" relay command guidance system, open-loop guidance system operation prior to terminal dive initiation, USR system operation with video presentation prior to launch, and missile operation during the terminal dive while guidance controlled from the terminal guidance azimuth and dive control stations.

Prelaunch checks of the weapon system were satisfactory. The missile was fired and between 1.61 and 1.67 seconds after rocket fire the power plant shut down, thereby making it impossible to check any of the bomber's test objectives. The recovery operation was normal; however, the point of impact of the forward and aft sections was virtually inaccessible. This has delayed the postfiring analysis on the recovered units.

c. XB-63 No. 19

Subsequent to the delivery of PPB No. 19 on 23 June 1954 and prior to the delivery of its power plant on 29 July 1954, mandatory service kits and E.O.'s were incorporated. The first captive flight was flown on 6 August 195.. Telemetering and beacon operations were satisfactory. Power plant operation was also satisfactory throughout the entire captive flight.

Discrepancies in other systems were corrected and the second captive flight for PPB No. 19 was launched on 17 August 1954. During this flight the USR, command, telemetering, and beacon systems all operated satisfactorily.

A modified power plant (drop-launch configuration, see II, B-2a) was received on 17 September 1954 and the third captive flight for PPB No. 19 took place on 22 September 1954. Bomber operation on this flight was satisfactory. Only slight difficulties were encountered with the midcourse guidance system and a microphonic tube in the roll system.

Hot firing preflights are now under way and a launching is scheduled during October.

d. XB-63 No 21

On 28 July 1954, PPB No. 21 was delivered to HADC. Because all service kits had been incorporated and testing had been completed prior to its delivery, the missile was scheduled for a captive flight on 2 August 1954.

Command system operation was satisfactory during the flight. Difficulties encountered with other systems were immediately corrected.

During the second captive flight, held 13 August 1954, the command, L-band beacon, and S-band beacon systems operation was considered good.

Before completing the repairs necessitated by the discrepancies evidenced on the second captive flight, PPB No. 21 was returned to Bell Aircraft/Wheatfield for additional power plant tests because of difficulties experienced with Nos. 16 and 17.

The bomber was delivered again to HADC with a drop-launch configuration and the third captive flight was held on 28 September 1954. The power plant operated satisfactorily and the only problems encountered were the noise in yaw surfaces and the failure of a high voltage dynamotor in the telemetering system.

At present, preparations for the hot firing scheduled early in October are being made.

e. XB-63 No 22

Rascal PPB No. 22 was delivered to HADC on 4 August 1954. Following the receiving and umbilical plug resistance checks and the installation of a power plant, the first captive flight was made on 20 August 1954.

PPB operations on this first captive flight were considered to be very good. The performance of this bomber indicated that it was ready for firing. However, the PPB was placed on a standby basis owing to the malfunctions experienced on PPB Nos. 16 and 17.

f. XB-63 No. 24.

On 27 August 1954, PPB No. 24 was delivered to HADC. On 9 September 1954, after preliminary inspection was completed, captive flight No. 1 was conducted.

The primary purpose for conducting this flight included a check on the weapon system exclusive of the power plant. Operation of the command/autopilot, L-band beacon, USR/terminal guidance, midcourse guidance, and telemetering systems was satisfactory. Minor troubles were encountered with the director aircraft's guidance equipment.

3. SPECIAL EVALUATION PROGRAM

A program is being conducted to establish compatability between Model 56F missiles and the DB-36 and DB-47 director aircraft prior to the flight test program. One each of both types of director aircraft was delivered to HADC. PPB No. 48 was also delivered to HADC and will be used in this "mating" program.

Director aircraft work consisted primarily of the incorporation of service kits and instrumentation circuitry into the guidance equipment.

Incorporation of minor changes and a functional check of all PPB equipment has also been completed.

APPENDIX

Trip Reports

1. VISITS AND SUBJECTS DISCUSSED

Organization Visited	Date	Topics Discussed
Bell Aircraft	6/30	Resins and glass cloth for component applications
WADC, Ohio	7/6 - 7/7	Support equipment operational sequence
Gabriel Electronics Division Norwood, Mass	7/8 - 7/9	Reworked antenna bearing installation
Bell Aircraft	7/13 - 7/14	Test equipment for MX-776 program
Kaydon Engineering Corp. Muskegon, Mich.	7/13 - 7/14	Bearing manufacture and test procedure
WADC, Ohio	7/21	Turbine pump seals
Boeing Airplane Co. Wichita, Kansas	7/22	Weapon system familiarization for Boeing personnel
WADC, Ohio	7/26 - 7/27	Presentation of "Manufacturer-to-Target Sequence"
AMC, Ohio	7/28	AMC proposed hold-order for OST missiles
WADC, Ohio	8/16	Weapons system specifications
WADC, Ohio	8/19	Reliability reports
WADC, Ohio	8/20	Turbine pump seals
ARDC, Ohio	8/23	Anti-radar missile cost program
WADC/ARC, Ohio	9/1 - 9/2	Model 110 Development Engineering Inspection reports
Bell Aircraft	9/9	Goodyear subcontract
WADC, Ohio	9/22	XLR-67-BA-5 Flight Approval Test Program

2. SUMMARY OF TRIP REPORTS

In connection with the choice of a resin for use in XB-63 components, Bakelite polyester and phenolic resins were discussed, as well as Owens-Corning glass cloth finishes.

A verbal presentation was made at WADC of an operational sequence and plan for Rasc``` support equipment using an Objective II Weapon System sequence chart and support equipment brochure. It was requested that a complete text be prepared to accompany the operational sequence chart, and that all data relative to support equipment be provided. A complete brochure is scheduled for delivery in about six weeks. A review of the status of operational support equipment currently under contract was also made. It was decided to conduct a development engineering inspection of support equipment, and 14 September was set as a tentative date.

Discussions held at Gabriel Electronics and Kaydon Engineering covered the rework, test, and assembly of search antenna bearings. Manufacturing and test procedures were **established** for future Kaydon bearings.

A conference with WADC personnel reviewed test equipment required for MX-776 program, and sought to establish technical justification for these items.

Several meetings were held with WADC personnel to determine certain performance requirements to be met by Aerojet turbine pumps in passing acceptance tests.

At Boeing Airplane Co., Wichita, Kansas, Rascal Progress Report Film No. 3 was shown, serving to familiarize approximately 70 Boeing staff and engineering personnel with the B-63 weapon system.

The proposed "Manufacturer-to-Target Sequence" was presented to WCSG personnel during a conference at WADC. It was agreed that the subject was covered in sufficient detail. WADC suggested that the title be changed to "Tentative Operational Sequence - B-63 Weapon System - Objective II," and that the sequence be formally presented to SAC. Packaging and transportation recommendations were also given to WADC. These recommendations were well received, and are being transmitted to SAC for approval.

In a conference at AMC, Bell Aircraft was advised that, instead of placing a hold order on 32 OST Rascal missiles, a contract change will be made directing revision of the existing delivery schedule.

At a WADC conference, material to be included in the Weapon System specification was discussed.

Discussions held at WADC covered quarterly reliability reports, data processing for failure reports, and a WADC-requested training program. In addition, copies of reliability reports issued by other contractors were obtained.

Discussions at ARDC were concerned with the anti-radiation program, and with anti-radar missile cost information, in particular.

As a result of DEI board reports issued in May, 1954, Bell Aircraft submitted engineering reports recommending further action, and discussed these reports with Rascal project staff and engineering personnel at WADC.

Goodyear Aircraft personnel provided data required to write the XB-63 Plastic Materials Study subcontract. Certain tests were eliminated from the program to permit completion within the desired six-month period.

The flight approval test program of the XLR-67-BA-5 engine was discussed at WADC, and agreement was reached concerning certain electrical changes to be made. In addition, the completed flight approval tests of the -1 engine were approved, and the specification for the -9 engine was discussed.

Distribution of this report has been made to parts A and B, and Abstracts to Part C, of the U S. R&D Board Guided Missile Technical Information Distribution List No. 5, MML 200/5, dated 1 June 1954.

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