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# INTERCEPTOR MISSILES IN AIR DEFENSE 1944 - 1964

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by RICHARD F. McMULLEN

FEBRUARY 1965

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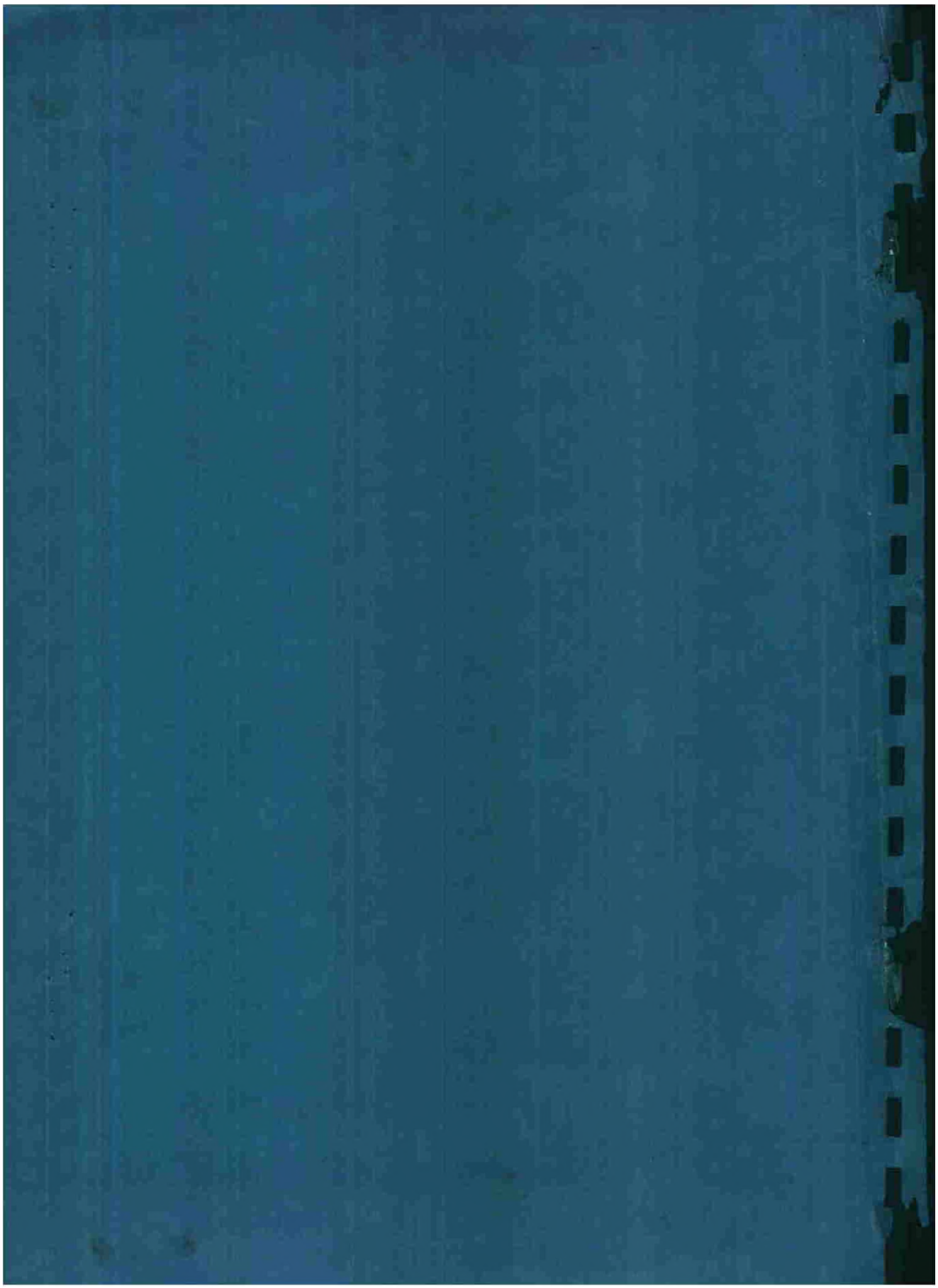

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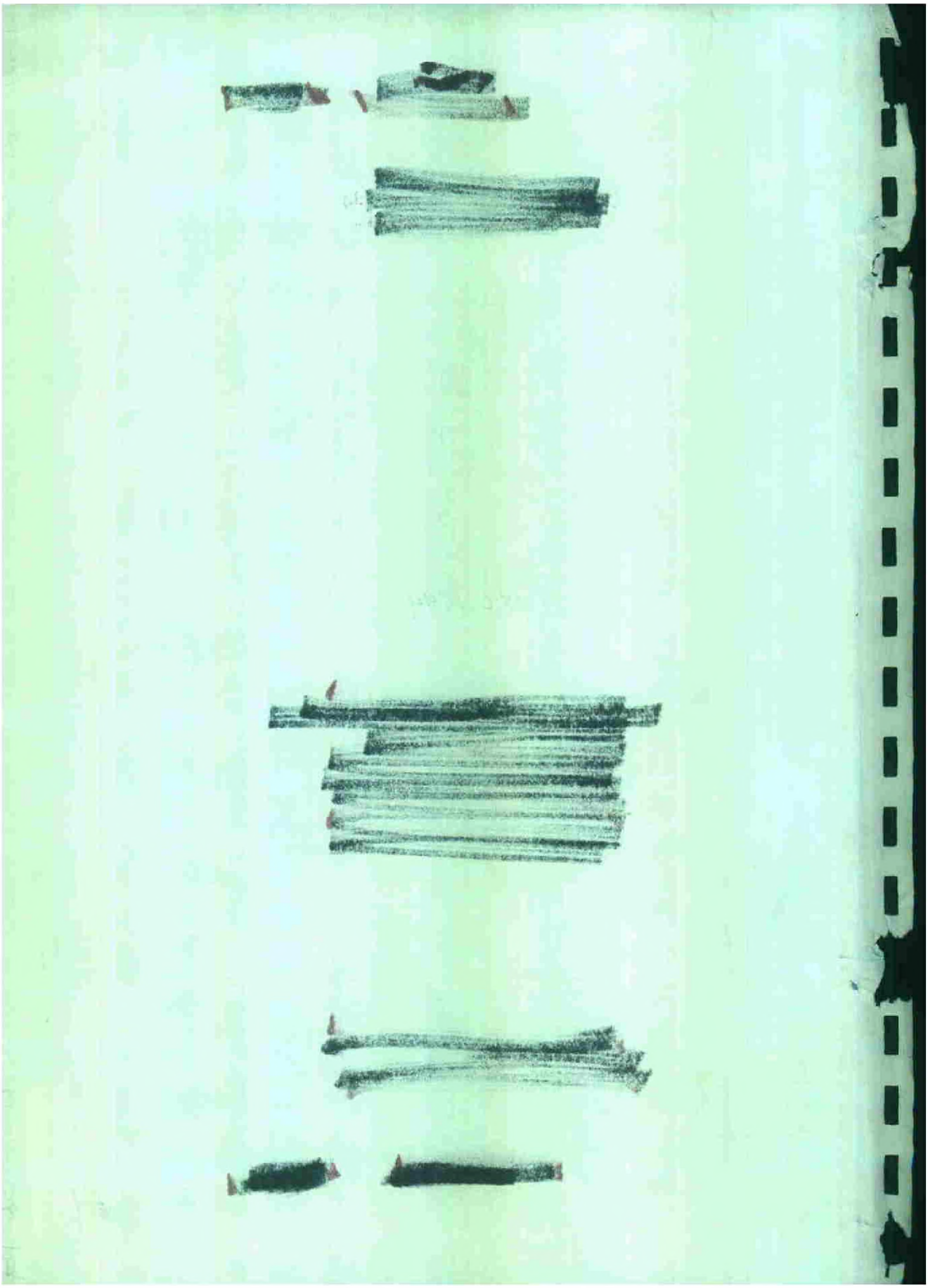

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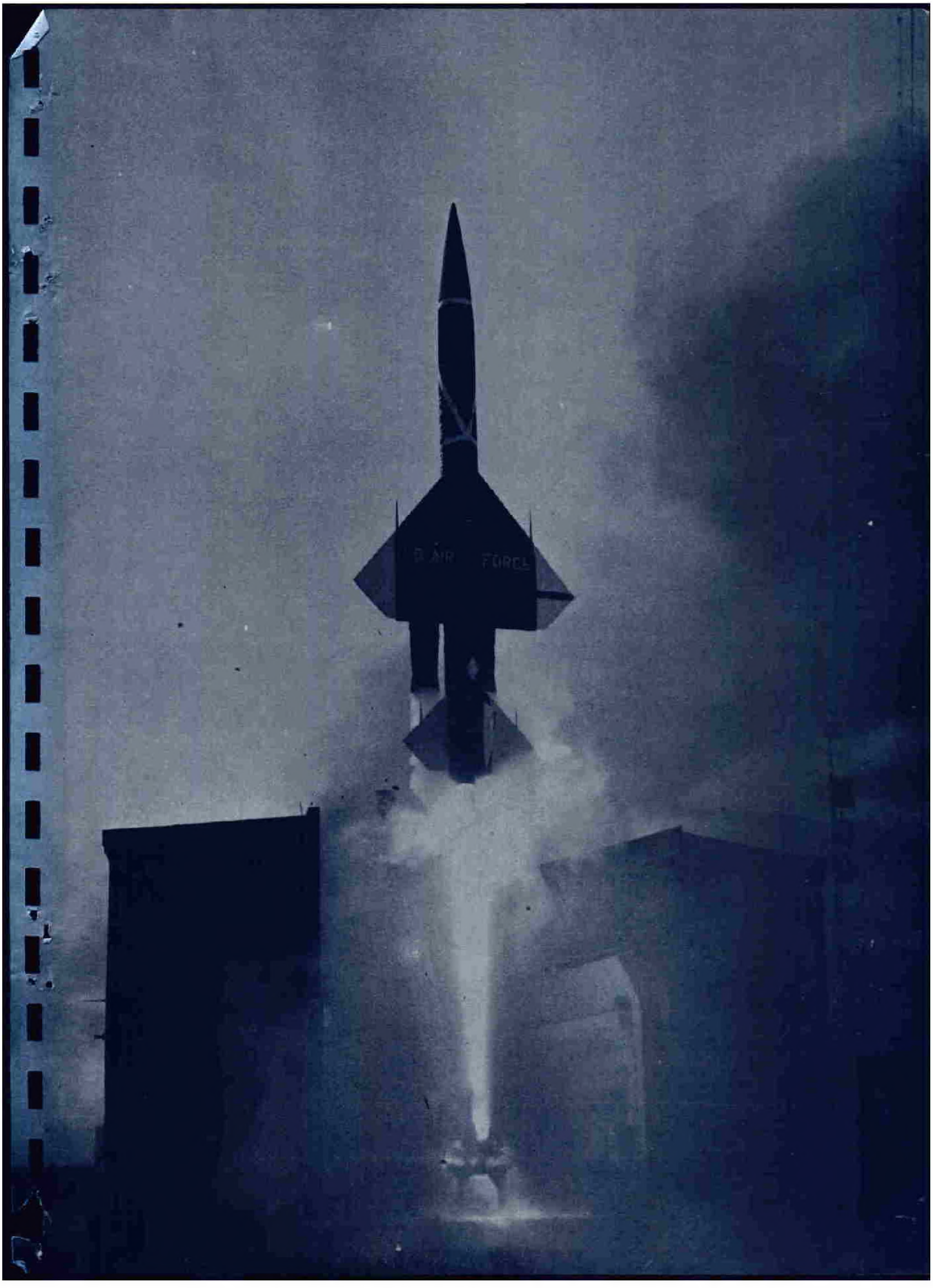


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# INTERCEPTOR MISSILES IN AIR DEFENSE 1944 - 1964

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## ILLUSTRATIONS

## FOREWORD

For many years the phrase "interceptor missile" has been synonymous with "BOMARC" in Air Defense Command. At the end of 1964 eight squadrons of advanced BOMARC "B" missiles stood ready around the northeast perimeter of the United States and in southern Canada. How BOMARC got to this point involves following a tortuous trail that leads all the way back to the German V-weapons of 1944. There was general agreement from the very beginning that development of a guided missile capable of destroying a supersonic target at a great distance would be difficult and require considerable time. If these early missile planners had been completely aware of the full amount of time and trouble involved they might have been tempted to drop the whole idea. There was also heady talk in the early years of BOMARC development that the guided missile would eventually supplant the manned interceptor. This, of course, did not come about and was unlikely to happen until a truly dependable long-range anti-missile missile had been developed and there was solid evidence that all potential enemies foreswore use of manned bombers as delivery vehicles for nuclear weapons.

Though care has been taken to verify the facts in the present history, readers are cautioned not to make this history the basis for official action.

## A NOTE ON THE SOURCES

In the footnotes to this study, whenever the symbol [DOC ] appears, this means that the document cited is included among the supporting documents to this study. The supporting documents are bound separately and may be consulted by authorized persons by contacting the Historical Division, Office of Information, Headquarters ADC or the Historical Archives Branch, USAF Historical Division, Aerospace Studies Institute, Maxwell AFB, Alabama. When the symbol [HRF] appears in a footnote, this means that the document cited has not been included among the supporting documents to this study, but is available in the ADC Historical Division.

# CHAPTER ONE

## GAPA AND THE "FAR OUT" STUDIES
## 1944 - 1949

Dr. Robert H. Goddard of Clark University conducted extensive experiments with rockets and guided missiles from 1914 to 1940, but, after World War I, none of the military services, except the German, seemed to pay much attention. Using many of Goddard's theories and many of his patents, the Germans had succeeded, by 1944, in developing primitive guided missiles (V-1 and V-2) that caused some anxious moments in the British Isles. The V-1 was a crude device

involving an unmanned aircraft loaded with explosives. It was so slow that it could be intercepted by fighter aircraft or anti-aircraft artillery. The V-2, however, was a liquid-fueled missile that flew at supersonic speed and was felt before it was heard. The V-2 could reach an altitude of 60-70 miles and had a range of about 300 miles. Although the United States conducted various experiments with guided bombs and anti-aircraft rockets during World War II, nothing approaching the V-2 had been attempted and there was immediate interest in all types of weapons in the V-2 mold, although the V-2 was a surface-to-surface weapon of slight accuracy. Such a great number of plans for guided missiles of various types emanated from the Army Air Forces and the Army Ordnance Department in the summer and early fall of 1944 that Lt. Gen. Joseph T. McNarney, Army Deputy Chief of Staff, felt constrained to issue some ground rules on 2 October 1944. The Air Force, the directive said, would confine itself to development of missiles which depended on the lift of aerodynamic forces. Army Service Forces (Ordnance), on the other hand, was to concentrate on missiles which depended on momentum.[1]

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1. Ltr, C/S, WD to CG, AAF, "Guided Missiles," 2 Oct 1944 [DOC 1].

Despite this division of labor, the initial Air Force attempt to develop a surface-to-air missile for air defense use was a cooperative effort with Ordnance. In February 1945, three months before the end of the war in Europe, Bell Laboratories was given a contract, jointly sponsored by Ordnance and AAF, to study the possibilities of such a weapon. The co-sponsors had in mind a supersonic missile capable of destroying an aircraft flying less than 450 miles an hour and at an altitude lower than 40,000 feet. Range was not mentioned. The code name of this new development was NIKE. By 15 July 1945, however, when Bell had completed the basic research plan, the AAF had pulled out of the project.[2]

Meanwhile, the AAF had asked the Boeing Airplane Company to study a similar weapon for exclusive Air Force use. This was envisioned as a missile which would offer ramjet power, a solid-propellant booster and be capable of supersonic speed, an altitude of 60,000 feet and a range of 35 miles. It was to be called the Ground to Air Pilotless Aircraft (GAPA). In the course of general studies from June to September 1945, Boeing came to the conclusion that

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2. AMC Historical Study No. 237, "Development of Guided Missiles Through 1945," Part III, p. 12.

the project was feasible. AAF agreed with the Boeing conclusions and in December 1945 asked Boeing to make a definite contract proposal. Design studies began in February 1946.[3]

Since GAPA appeared to come perilously close to the fence dividing Air Force and Ordnance responsibilities as outlined in the McNarney directive of October 1944, the AAF went to considerable pains to explain that "any missile capable of intercepting an aircraft or missile, traveling at speeds approaching or exceeding that of sound, appears to obviously require corrective guidance after launching, and, since such guidance appears at the present time to be most logically obtained by use of aerodynamic forces, the development of such guided missiles are believed to be definitely within the sphere of responsibility of the Army Air Forces."[4] Acknowledging, by indirection, the Ordnance grumbling in this matter, the AAF defense of GAPA concluded

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3. AMC Historical Study No. 238, "History of the Development of Guided Missiles, 1946-50," p. 69 (cited hereafter as "AMC Study No. 238").

4. Memo, Brig. Gen. Alden R. Crawford, Chief, Research and Engineering Div, AC/AS-4, AAF, to Maj. Gen. E.M. Powers, AC/AS-4, AAF, "Guided Missiles," 28 Feb 1946 [DOC 2].

that "the efficiency of the system which has been established depends upon an appreciation on the part of all concerned, of the necessity for a prosecution of the guided missile program for the benefit of the country and without regard to inter-service or personal pride or jealousy.[5]

The mumblings of dissatisfaction over the division of responsibility under the McNarney directive continued, however, so approximately two years later, 7 October 1946, the War Department issued a new directive which gave the AAF complete responsibility for all research and development in connection with guided missiles. This directive was clarified three days later by another which exempted existing guided missile research and development projects of Ordnance and the Signal Corps from any but the most general guidance of the Air Force. In November 1946, the Army Air Forces Technical Committee was designated as the agency which would determine whether new guided missile projects should be begun and whether existing projects should be continued, cancelled or consolidated. Other Army agencies were given representation on the AAF Technical Committee and in the event the Technical Committee failed to reach unanimous agreement on a recommendation, the matter was to be forwarded

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5. Ibid.

to the War Department Director of Research and Development for decision. Thus, while the AAF appeared to control the research and development machinery as regards guided missiles, there was little comfort in the fact that the War Department Director of Research and Development was Maj. Gen. H.S. Aurand, a former Ordnance officer.[6]

While the political in-fighting over the control of the guided missiles program was going forward, Boeing was providing what Lt. Gen. Nathan F. Twining, commander of the Air Materiel Command, chose to call an "outstanding example of technical progress" in connection with GAPA development. By March 1947 Boeing had launched 31 test missiles on the range at Wendover AFB, Utah, and had discovered much valuable information concerning launch techniques, guidance problems and the aerodynamics of supersonic flight.[7]

Boeing was actually dealing with hardware, but two other research and development contractors in the surface-to-air missile field were also involved in studies and concepts.

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6. Memo, C/S, WD for CG, AAF, "Guided Missiles," 7 Oct 1946 [DOC 3]; Memo, R&D Div, WDGS for CG, AAF, "Review of Guided Missiles Projects," 10 Oct 1946 [DOC 4]; Memo, R&D Div, WDGS for CG, AAF, "Guided Missiles-Responsibilities and Procedures," 26 Nov 1946 [DOC 5].

7. Ltr, AMC to AAF, "AAF Guided Missiles Research and Development Program -- Where We Stand," 25 Mar 1947 [DOC 6].

The problem, which led to the writing of contracts with General Electric in March 1946 and with the University of Michigan the following month, was suggested by the German V-2. The General Electric THUMPER effort was aimed at provision of a short-range "collision intercept" defense missile to deal with hostile invaders of the V-2 type. The University of Michigan put its talent to work on defense against more sophisticated ballistic missiles -- those at altitudes between 60,000 and 500,000 feet and speeds up to 4,000 miles an hour. Destruction was to occur at a range sufficient to prevent damage to defended areas. This was the WIZARD project.[8]

When, on 23 December 1946, the War Department slashed the AAF guided missiles budget for Fiscal 1947 from $29 millions to $13 millions and the number of active missile projects was cut from 28 to 17, the three air defense projects survived. This was figured to be only a temporary respite, however, because it was anticipated that the $19 millions tentatively budgeted for Fiscal 1948 would also be reduced.[9]

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8. AMC Study No. 238, p. 72.

9. Ltr, AAF to AMC, "Countermeasures Against Guided Missiles," 4 Jan 1947 [DOC 7]; Memo, AC/AS-3, AAF to AC/AS-2, AAF, "Guided Missile Information for Proposed Lecture at the Air University," 14 Mar 1947 [DOC 8]; Ltr, AMC to AAF, "AAF

As predicted, the Air Force missile program was again run through the budget wringer in the late spring of 1947 and various projects were again squeezed out. The three surface-to-air missile projects also weathered this re-appraisal, although at a lower level of funding. At this time it was planned that development of GAPA would be completed in 1949 at a development cost of $16.4 millions. Work on WIZARD was to continue indefinitely at a level of a million dollars a year, with THUMPER to continue at a rate of $500,000 a year. The new AMC guided missile program of May 1947 called for development of 12 distinct types of missiles. In addition to the three surface-to-air types, two were air-to-air missiles (one for bombers and one for fighters), two were air-to-surface (100-mile and 300-mile ranges) and five were surface-to-surface (two of 500-mile range, one of 1,500-mile range and two of 5,000-mile range). While AMC proposed to continue full support of the Boeing GAPA, this 35-mile-range antiaircraft missile had plenty of competition in other quarters. Army Ordnance was going ahead with the 19-mile-range NIKE. The Navy's Bureau of Aeronautics was interested in the subsonic, short-range LARK, an 18-mile-range Fairchild missile and a 33-mile-range

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[Cont'd] Guided Missiles Research and Development Program -- Where We Stand," 25 Mar 1947 [DOC 6].

missile proposed by Convair. The Navy's Bureau of Ordnance was working on the 25-mile-range BUMBLEBEE in conjunction with Johns Hopkins University. The Massachusetts Institute of Technology was conducting independent research on a 40-mile-range METEOR. As to the THUMPER and WIZARD projects, AMC contended that these comprised the complete national effort with regard to interception and destruction of ballistic missiles.[10]

Because of reduction in the AAF research and development budget for Fiscal 1948, AAF found it impossible to approve the full missile program presented by AMC, but the cuts were made in the surface-to-surface field. GAPA, THUMPER and WIZARD survived this review. AAF also established priorities as part of its June 1947 approval of a nine-missile development program. The surface-to-air missiles were given third priority in this listing. First priority went to missiles that would enhance strategic air warfare (air-to-surface and bomber-launched air-to-air missiles). Second priority went to short-range (up to 150 miles) surface-to-surface missiles intended for support of ground forces. The history of this ground support missile illustrated the

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10. Ltr, AMC to AAF, "AAF Guided Missiles Program," 6 May 1947 [DOC 9].

working of the "control by AAF Technical Committee, veto by War Department R&D Division" method of supervising missile research and development. The AAF contract with Curtiss-Wright was orded cancelled by General Aurand (WD R&D). Later, however, the AAF Technical Committee recommended the project be re-instated and assigned to Army Ordnance for supervision. This recommendation was approved. It was also noted that Maj. Gen. Curtis E. LeMay, AAF Director of Research and Development, favored intensification of research under the THUMPER and WIZARD projects, but that the shortage of funds would not permit it.[11]

GAPA appeared to be making great strides. In October 1947 USAF (it had been created from AAF in September 1947) felt enough confidence about GAPA that it could answer a question from the President's Air Policy Commission to the effect that GAPA should be operational by the middle fifties. By the end of 1947, too, USAF was reasonably sure what it expected of surface-to-air missiles. First, it anticipated

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11. Memo, Dep AC/AS-3, AAF for CG, AAF, "Operational Requirements (Priorities) for Guided Missiles, 1947-1957," 16 Jun 1947 [DOC 10]; Memo, DC/AS-R&D, AAF for AC/AS-3, AAF, "Operational Requirements (Priorities) for Guided Missiles, 1947-1957," 19 Jun 1947 [DOC 11]; Memo, TSEON, AMC for TSDEG, AMC, "Operational Requirements (Priorities) for Guided Missiles, 1947-1957," 5 Nov 1947 [DOC 12].

a "50-mile" missile (GAPA) capable of destroying a target flying as fast as .9 Mach at altitudes up to 70,000 feet. This missile would be used as part of the "interim" air defense system. Later would come advanced missiles (the products of THUMPER and WIZARD studies) with the ability to kill (1) high velocity missiles with high altitude ballistic trajectories, (2) high velocity missiles or aircraft flying in the lower atmosphere -- up to 70,000 feet, and (3) high velocity missiles flying at low altitudes.[12]

While the three Air Force surface-to-air guided missile projects had survived, albeit in somewhat modified form, the 1947 re-appraisal of the AAF missile program, the GAPA project ran into difficulty in 1948. The trouble developed when it appeared that only $11 millions of the $21 millions guided missile research and development money AMC thought would be necessary was likely to be available in Fiscal 1949. In this eventuality, AMC believed, in July 1948, that drastic curtailment of three of the eight missile projects currently being pursued would be required. Two of

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12. Memo, DCS/O, USAF to Sec/Air Staff, "Data for the President's Air Policy Commission Concerning Guided Missiles," 28 Oct 1947 [DOC 13]; Ltr, USAF to AMC, "Military Characteristics for Surface-to-Surface and Surface-to Air Guided Missiles," 3 Dec 1947 [DOC 14].

these projects involved surface-to-surface missiles -- the Northrop 5,000-mile subsonic type and the North American 1,000-mile supersonic missile. The third was GAPA, "the oldest guided missile project in the Air Force research and development program."[13]

AMC had planned to spend $5.5 millions on GAPA in Fiscal 1949 and $6.3 millions in Fiscal 1950. The severe restriction of R&D funds for Fiscal 1949, however, would force a reduction to $3 millions in expenditures on GAPA in that year and disorganize the "competent and experienced group of technical people" gathered together by Boeing. AMC pointed out that Boeing had launched 75 test vehicles of various types from Holloman AFB, New Mexico, in the year since testing had been transferred from Wendover to Holloman. Boeing had recently made test flights with 12-inch-diameter ram jets which had reached speeds approaching Mach 3. If the planned expenditures could be allowed, AMC was hopeful that Boeing could be making test firings of full-scale tactical missiles by early 1951.[14]

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13. Ltr, AMC to USAF, "Air Force Research and Development Program on Guided Missiles," 21 Jul 1948 [DOC 15].

14. Ibid.

The short-range GAPA appeared to be in still further trouble in September 1948 when the research and development budget for Fiscal 1950 came under discussion. The combined requests of the three military services came to $800 million, but the first Secretary of Defense, James V. Forrestal, a year in office, did not think that amount could be justified. He asked the services what would happen if this amount were cut to $550 millions. In the case of the Air Force this would have meant a reduction from $350 millions to $220 millions for R&D in Fiscal 1950. The effect of such a reduction, the Air Force replied, would be close to disastrous, since it would mean that development of a medium bomber, a strategic reconnaissance aircraft, two helicopters and three guided missiles would have to halt and that many other development projects would have to be slowed appreciably. One of the three guided missile programs marked for death was GAPA.[15]

Meanwhile, supported by funds made available in earlier years, GAPA development continued into 1949 and 1950. And the dire predictions concerning the budget for Fiscal 1950 did not come to pass, since GAPA was not cancelled as

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15. Memo, Deputy Air Force Member to Chairman, Research and Development Board, "Secretary of Defense Request for Project Information," 8 Sep 1948 [DOC 16].

a result of fund reductions. In October 1949, USAF directed AMC to spend $960,000 of Fiscal 1950 money to buy a dozen GAPA test missiles. Added to an earlier purchase of another dozen, it was obvious that AMC was going to buy 24 test missiles for use in the development of GAPA. All 24 missiles were actually built, the last two being delivered in August 1950. The General Electric THUMPER project, however, was phased out at the end of Fiscal 1949, on the theory that the work under THUMPER and the University of Michigan's WIZARD were coming closer together and both were no longer required.[16] WIZARD was retained.

The October 1949 order to purchase GAPA test missiles did not indicate that the project was in robust health, however. While it was true that GAPA did not die of fiscal starvation, it was killed in late 1949 when the Joint Chiefs of Staff decided that too many short-range surface-to-air missiles were being developed. The death of GAPA left the Air Force with only WIZARD in the surface-to-air missile field and WIZARD consisted of theoretical studies of the

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16. Briefing, AMC Commanders' Conference, "Current Research and Development Programs of the USAF," Maj.Gen. F.O. Carroll, 17 Jan 1949 [DOC 17]; Ltr, USAF to AMC, "Procurement Directive 50-GM-2," 5 Oct 1949 [DOC 18]; USAF Aircraft and Guided Missiles Production Report, Aug 1950 [DOC 19].

problems involved in the interception and destruction of ballistic missiles. No hardware was likely to result for a great many years. It seemed reasonable, therefore, to bring together the missile know-how of Boeing and the advanced air-defense-system thinking of the University of Michigan. This was done in January 1950 and the result was BOMARC.[17] GAPA was completely phased out in 1951.

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17. AMC Study No. 238, pp. 71-72.

CHAPTER TWO

BOMARC: FROM CONCEPTION TO SUCCESSFUL FLIGHT
1950 - 1955

The Guided Missile Section of AMC took the initiative in asking Boeing and the University of Michigan, in January 1950, to undertake a cooperative study of a weapon described as a long-range, high-speed missile capable of dealing with the most advanced enemy bomber expected to be in service by 1956. It was also to be susceptible to continued improvement in order to enable it to counter increasingly sophisticated targets.[18]

18. Wright Air Development Center Study, "The

The GAPA and WIZARD contractors agreed to the joint effort and by June 1950 had produced a report which concluded that a missile capable of speed from Mach .9 to Mach 3, a ceiling of 80,000 feet and a range of 200 miles could be operational by 1956. It was proposed to call the missile BOMARC, the "BO" for Boeing and the "MARC" for Michigan Air Research Center. The technical specialists at AMC found the proposal technically feasible, although Col. Gilbert Hayden of the Electronics Subdivision found the operational date of 1956 highly optimistic. He suggested 1960 as a more realistic date.[19]

Air Materiel Command approved the project in the summer of 1950 and forwarded it to USAF, where it was also approved and sent forward to the Research and Development Board in September. Also in September 1950, AMC wrote military specifications for the missile. Reflecting a concept which dated back to 1947, these specifications foresaw a two-stage development. The BOMARC A of "reduced capabilities" would be an interim weapon until the ultimate missile was

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[Cont'd] Development of the BOMARC Guided Missile, 1950-1953," Donald R. McVeigh, Jan 1956, p. 9 (hereafter cited as "WADC BOMARC Study").

19. Boeing Document D-10705, Jun 1950 [HRF]; Ltr, University of Michigan Air Research Center to AMC, no subj, 9 Jun 1950 [HRF]; Memo, Chief Elec Subdivision, AMC to Chief, Aircraft and Guided Missiles Sec, AMC, "Bomarc Evaluation," 19 Jul 1950 [HRF].

available. It was anticipated that flight testing of BOMARC would begin in July 1951, that service testing of the interim weapon would be completed by October 1954 and that testing of the ultimate vehicle would be finished by the end of 1956.[20]

The Research and Development Board appointed an ad hoc committee to study the proposal. The findings were favorable and in November 1950 USAF was instructed to proceed. AMC issued implementing instructions on 6 December 1950, initially allocating $1 million of Fiscal 1951 funds to the project. Boeing was directed to proceed under the original GAPA contract.[21] Only the statement of work was changed.

These instructions were in effect only a short time, however. In reporting their joint study of January-May 1950, Boeing and the University of Michigan had recommended that the work be accomplished under two prime contracts, with Boeing responsible for the airborne portions of the system and Michigan dealing with the ground installations. The study partners continued to hold this position after the

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20. Msg, MC AD 703, AMC to USAF, 22 Sep 1950 [HRF]; Memo, Maj. Gen. D.L. Putt, Dir, R&D, USAF for Chmn, RDB, "Surface-to-Air Missile," 25 Sep 1950 [HRF].

21. AMC Technical Instruction 2003-113, 6 Dec 1950 [DOC 20].

development of BOMARC had been approved. USAF disapproved of this division of labor, however, and on 12 January 1951 Boeing was given a letter contract naming it the sole prime contractor. After some discussion of the fee to be included in the definitive contract (Boeing wanted seven per cent of cost while AMC originally suggested that four per cent would be proper), the contract as finally negotiated 25 June 1951 included a fee of six per cent. This was designated as a contract for "Development of a Prototype Long Range Defense Weapon System" and specified that the $9.4 millions made available under this contract would accomplish 11 per cent of the necessary development of BOMARC.[22]

There was little doubt that BOMARC was a high-priority project at this time, because in February 1951, K.T. Keller, Chrysler Corporation president and World War II production expediter, chosen by Secretary of Defense George C. Marshall in October 1950 as "czar" of the missile program, issued a dictum to the effect that while there were no current plans

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22. AMC Technical Instruction 2003-113, Amendment 1, 11 Jan 1951 [DOC 21]; Letter Contract AF 33 (038)-19589, 12 Jan 1951 [DOC 22]; Ltr, William M. Allen, President, Boeing Airplane Co., to Maj.Gen. Orval R. Cook, Dir, Procurement and Industrial Planning, AMC, "Letter Contract AF33 (038)-19589, Project MX-1599, BOMARC," 6 Jun 1951 [DOC 23]; Negotiated Contract AF 33 (038)-19589, 25 Jun 1951 [DOC 24].

[redacted]

for production of BOMARC, he wanted development accelerated to the point where a dozen full-scale test missiles would be launched by the end of 1951.[23]

Despite Mr. Keller's wishes, no BOMARC test missile was launched in 1951. About half of that year was consumed in getting the BOMARC production team organized. Boeing, a famous aircraft builder, would of course build the airframe. But the airframe was less than 25 per cent of the total missile. Much had to be subcontracted to experts in various specialized fields. It was eventually decided that the Aerojet Engineering Corporation would build the liquid-propellant booster required to lift the 40-foot, 12,000 pound, missile off the ground. Marquardt Aircraft Company was chosen to provide the ramjet engines the BOMARC would use to produce high speed during the cruise phase of flight. Westinghouse Electric Company agreed to furnish the necessary target seeker. The fuze and warhead were to be furnished by the government, specifically the Ordnance Corps of the Army. The fuze was to be the responsibility of the Diamond Ordnance Fuze Laboratory of Washington, D.C. The high explosive warhead originally planned for BOMARC was to be

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23. Extract from AMC Operations Report, 21-23 Feb 1951 [DOC 25].

designed and manufactured by Picatinny Arsenal in New Jersey.[24] The production team had been formed.

Although Boeing and its subcontractors had gained considerable experience in connection with the GAPA missile, much of this experience did not prove very useful when applied to the larger BOMARC. Aerojet had supplied boost rockets for the GAPA, but was not immediately able to guarantee combustion stability in a liquid-propellant rocket expected to generate 35,000 pounds of thrust. It was not until late 1952 that Aerojet thought it had perfected a previously faulty gas pressurization system. Marquardt had similar problems with its ramjets. Test firings in 1951 and 1952 were not encouraging, although one ramjet did burn for 10 seconds. These failures were difficult to understand, since ramjet investigations had begun in 1944 and the Navy had flown supersonic ramjets as early as 1947. Nevertheless, Marquardt was hopeful that use of Lockheed's X-7 test vehicle for flight testing of the ramjet would point the way to solutions. The first 28-inch ramjet (the

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24. Los Angeles Engineering Field Office, AMC, to AMC, "Milestones," 14 May 1951 [HRF].

size required for BOMARC) was flown on the X-7 on 17 December 1952 and burned, as mentioned above, for 10 seconds.[25]

Target seekers, fuzes and warheads were not immediately required for testing purposes, so Westinghouse and the two Ordnance agencies had more time in which to develop suitable components. None were tested as complete entities in 1951 and 1952. Despite the fact that none of the major components were close to complete development, BOMARC flight testing got off to a shaky start on 10 September 1952 when the first missile was launched from the Florida test center that later became known as Cape Canaveral and still later as Cape Kennedy. The test crew was successful in igniting the booster and the missile rose 500 feet before the gimbaling controls failed. The missile then performed several loops "and other unorthodox gyrations" before it crashed and exploded.[26]

Meanwhile, the Air Defense Command began making plans for the use of BOMARC. When USAF, in late 1952, asked ADC to sketch the outline of the "ultimate" air defense weapons

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25. Ltr, AFFTC to WADC, "Rocket Engine Report," 24 Nov 1953 [HRF]; USAF Annual Guided Missiles Report, ARDC, 1 Oct 1952 [HRF]; Ltr, Boeing to WADC, "Delivery of Ramjet Engines," 8 Jan 1953 [HRF].

26. USAF Standard Missile Characteristics, 10 Nov 1952 [HRF].

force, ADC figured it would require 3,000 BOMARC missiles (30 squadrons) in 1960 in addition to 151 squadrons of interceptor aircraft.

Those responsible for development of BOMARC became increasingly pessimistic as to when it might be ready. The original BOMARC development program, published 31 December 1950, called for BOMARC I (the version offering a range of 125 miles) in 1954, the ultimate missile in 1961. A program issued in April 1951 estimated that BOMARC testing would be finished in October 1954, but offered no guess as to the date of operational readiness. Slightly more than a year later, but still before the first test missile had been launched, a development program of July 1952 gave the date for the completion of testing as August 1955. Thus, at the end of 1952, two years after Boeing had been selected as the prime contractor for BOMARC, only one test missile had been launched and major subcontractors were far from completing development of essential components.[27]

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27. Msg ADOPR 2494, ADC to USAF, 5 Dec 1952 [Doc 31 in Hist of ADC, Jul-Dec 1952]; USAF Annual Guided Missiles Report, ARDC, 1 Oct 1961 and 1 Oct 1962 [HRF]; Semiannual Progress Report of the Guided Missiles Program, AMC, 30 Dec 1950 [HRF]; R&D Project Card, Project R-448-48, WADC, 27 Apr 1951, 16 Jul 1952 and 6 Jan 1953 [HRF].

The following year provided an equivalent number of frustrations for Boeing, BOMARC subcontractors and Air Force development agencies. For example, Aerojet was convinced that it had solved gas pressurization problems in its booster rockets by the end of 1952 and satisfactory firings in February and March of 1953 seemed to bear out that optimism. In April, however, a major explosion seemed to indicate the need for a new approach to the situation. Aerojet responded by suggesting a "staggered start" for the booster in which pressure was raised in the oxidizer tank before the gas generator began operation. But the promise of May led to the discouragements of August and September, when three successive malfunctions badly damaged the test stand, made a shambles of the test missile and destroyed the thrust chamber.[28]

Aerojet was having such difficulty in developing a satisfactory booster that, despite the "duplication of costly components," Reaction Motors, Inc., was brought into the booster program in the spring of 1953 to provide a "hedge" in the event Aerojet's problems finally proved insoluble. The Reaction Motors booster had previously been

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28. Ltr, AFFTC to WADC, "Rocket Engine Report," 24 Nov 1953 [HRF].

used as a test bed for new booster fuels, but suddenly it became a full-fledged alternate for the Aerojet development. What was especially interesting was the possibility that the Reaction Motors booster might ultimately provide 50,000 pounds of thrust. At the end of 1953, Aerojet was working to improve the reliability of its product (which used a combination of red fuming nitric acid and JP-4 jet fuel plus a starting compound composed of 30 per cent aniline alcohol and 70 per cent furfuryl alcohol), while Reaction Motors experimented with a booster using a mixture of liquid fluorine and ammonia.[29]

While Marquardt had successfully flown its first 28-inch ramjet (10 seconds of burning time) in December 1952, one flight did not make a completed development program. It was not until the test flight of 8 April 1953 that a ramjet burned for as long as 20 seconds. On this occasion the Lockheed X-7 reached an altitude of 59,000 feet and a speed of Mach 2.6 when the fuel control failed and thrust decayed.

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29. Ltr, WADC to Boeing, "Alternate Rocket Boost System," 29 Dec 1952 [HRF]; Memo, Dir/Airborne Weapons Systems, WADC for Power Plant Lab, WADC, "Bomarc Alternate Boost Program at Reaction Motors, Inc.," 3 Jul 1953 [HRF]; USAF Annual Guided Missiles Report, ARDC, 1 Oct 1953 [HRF]; Memo, Power Plant Lab, WADC, for Dir/Airborne Weapons Systems, WADC, "Proposed Alternate Fuel," 29 Dec 1953 [HRF].

A flight of 12 September 1953 was equally promising, but a December failure produced disappointment again. Boeing was definitely dissatisfied with ramjet performance and at the end of 1953 ordered continuance of the test program.[30]

Westinghouse appeared to be making progress in the development of a BOMARC target seeker, but intensive testing had not begun by the end of 1953, so nobody was quite sure whether the Westinghouse development would be satisfactory or not. Westinghouse divided the development process in two parts. First came a "Model A" seeker, of which three had been built by the end of 1953. A satisfactory Model A would be followed by a smaller, lighter Model B. Early laboratory tests of the Westinghouse seeker, however, appeared to indicate that it would have limited capability at low altitudes because of ground clutter and would be susceptible to electronic jamming. Boeing therefore began development of a coherent pulse-doppler seeker which would avoid ground clutter through a technique described as "velocity gating." By the end of 1953 Boeing research had proceeded to the point where Boeing was ready to subcontract with Radio Corporation of America for further development.[31]

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30. BOMARC Newsletter, No. 13, Boeing, 30 Apr 1953; Hist of WADC, Jul-Dec 1953, pp. 122-23; Ltr, Boeing to AMC and WADC, no subj., 6 Jan 1954 [HRF].

31. USAF Annual Guided Missile Report, ARDC, 1 Oct

Missile testing in 1953 gave little reason for encouragement. A second test missile was launched 23 January 1953. On this occasion, the booster failed after only 1.5 seconds of flight. The BOMARC rose only eight feet in the air then settled back on the launch pad and exploded. The next test missile, launched 10 June 1953, suffered a somewhat better fate. The booster performed satisfactorily and the ramjets ignited, but after 23 seconds of flight a low-order explosion (apparently in the rocket chamber) abruptly ended the flight at about 10,000 feet and a speed of Mach 1.6. The two remaining test flights in 1953 -- 27 July and 4 September -- followed the pattern of the third flight. There were about 20 seconds of successful flight to an altitude of about 10,000 feet, or slightly above, and a speed of about Mach 1.5, followed by disintegration of the missile. There was such a disturbing similarity to the last three flights that "major problems in design and reliability of components" were indicated and flight testing was suspended indefinitely.[32]

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[Cont'd] 1953 [HRF]; Boeing Docs D-14415, 29 Jul 1953 and D-11511, Jul-Sep 1953 [HRF]; Ltr, WADC to Boeing, "Development of a CW Radar System," 28 Jan 1953 [HRF]; Ltr, BOMARC WSPO to WADC, "Monthly Report," 2 Mar 1953 and 25 Mar 1953 [HRF]; Hist of WADC, Jan-Jun 1953, Vol II, p. 254.

32. Ltr, Boeing to WADC, "Results of Firing 621-2,"

These test failures raised serious doubts that the existing development program could be carried out. Although Boeing insisted that "there was no reason to believe that present problems were associated with false fundamental theory or concept of operation," AMC was convinced, after a series of conferences with ARDC and Boeing representatives in October and November 1953, that experimental work on the BOMARC should be extended for an additional year. This meant that the initial delivery of tactical missiles would be delayed from March 1956 to January 1957. AMC was convinced, in December 1953, that missile testing could not be resumed until at least February 1954.[33]

Boeing suffered a similar setback in the summer of 1953 when it was decided that BOMARC would be controlled by the Lincoln Transition System (later designated SAGE) being

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[Cont'd] 13 Mar 1953 [HRF]; Msg, AFMTC to WADC, 12 Jun 1953 [HRF]; Ltr, Boeing to WADC, "Preliminary Report on 623-2 Firing," 23 Sep 1953 [HRF]; USAF Annual Guided Missiles Report, ARDC, 1 Oct 1953 [HRF].

33. Msg MCPPDF 9130, AMC to AFPR, Boeing, 24 Sep 1953 [DOC 26]; Msg WCSM 2337, WADC to ARDC, 25 Sep 1953 [DOC 27]; Msg MCPPDF 9236, AMC to AFPR, Boeing, 28 Sep 1953 [DOC 28]; Ltr, Boeing to AMC, "F-99 Program," 14 Nov 1953 [DOC 29]; Ltr, WADC to Boeing, "Bomarc Program Guidance," 18 Nov 1953 [DOC 30]; Ltr, AMC to USAF, "F-99 (BOMARC) Defense System, Status of Development and Production," 10 Dec 1953 [DOC 31]; Chart, "Demonstration of BOMARC I Program Slippage, 1950-1954," prepared by BOMARC WSPO, 26 Oct 1955 [DOC 32].

developed by the Lincoln Laboratories of the Massachusetts Institute of Technology rather than by the G-20 Ground Control System being developed by Boeing. The missile contractor admitted the Lincoln System showed promise, but contended that "it would appear exceedingly imprudent to cease work on equipment which is reasonably certain of fulfilling requirements (G-20) in favor of an attractive substitute (Lincoln), before it is clear that the substitute can perform the task, and in sufficient time."[34] Nevertheless, SAGE was given the job of controlling BOMARC, although development of the G-20 continued until it evolved into the GPA-35 that controlled BOMARC until the SAGE system became operational.

Meanwhile, ADC, which was only indirectly concerned with development of the missile, had increased its requirements for BOMARC. While a 1952 requirement statement had called for 30 squadrons of 100 missiles per squadron, a 1953 statement requested 53 squadrons of BOMARC. What such a network of BOMARC squadrons would mean in terms of funds was spelled out in a Boeing estimate of costs compiled in July 1953. If 10 missiles were produced, Boeing figured, the 10th missile would cost $623,000. If 100 were produced, the 100th would

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34. Ltr, Boeing to WADC, "Project MX-1599 Ground Control Equipment," 7 Jul 1953 [DOC 33].

be priced at $256,000. In a 1000-missile production run, the thousandth item would cost $142,000. On the basis of these figures, it would cost $739 millions to provide the 5,300 missiles ADC had requested, exclusive of the cost of missile shelters and support facilities.[35]

BOMARC testing did not resume in February 1954 as suggested in the AMC summary of the situation in December 1953. In fact, 1954 was another year of doubt and frustration in which very little seemed to go right with regard to BOMARC development and the date of operational deployment slid further and further into the future. In April 1954, with the sixth experimental missile still not launched, memoranda suggesting that BOMARC might well be junked on the grounds of cost and developmental difficulty were being circulated in AMC. At the very least, one such inter-office communication recommended, a high-level committee should evaluate the BOMARC situation and determine whether or not continuation of development was justified. The Wright Air Development Center (WADC) of ARDC, however, was not quite this dismayed. While admitting, in May 1954, that the BOMARC development program was in deep trouble, WADC felt the

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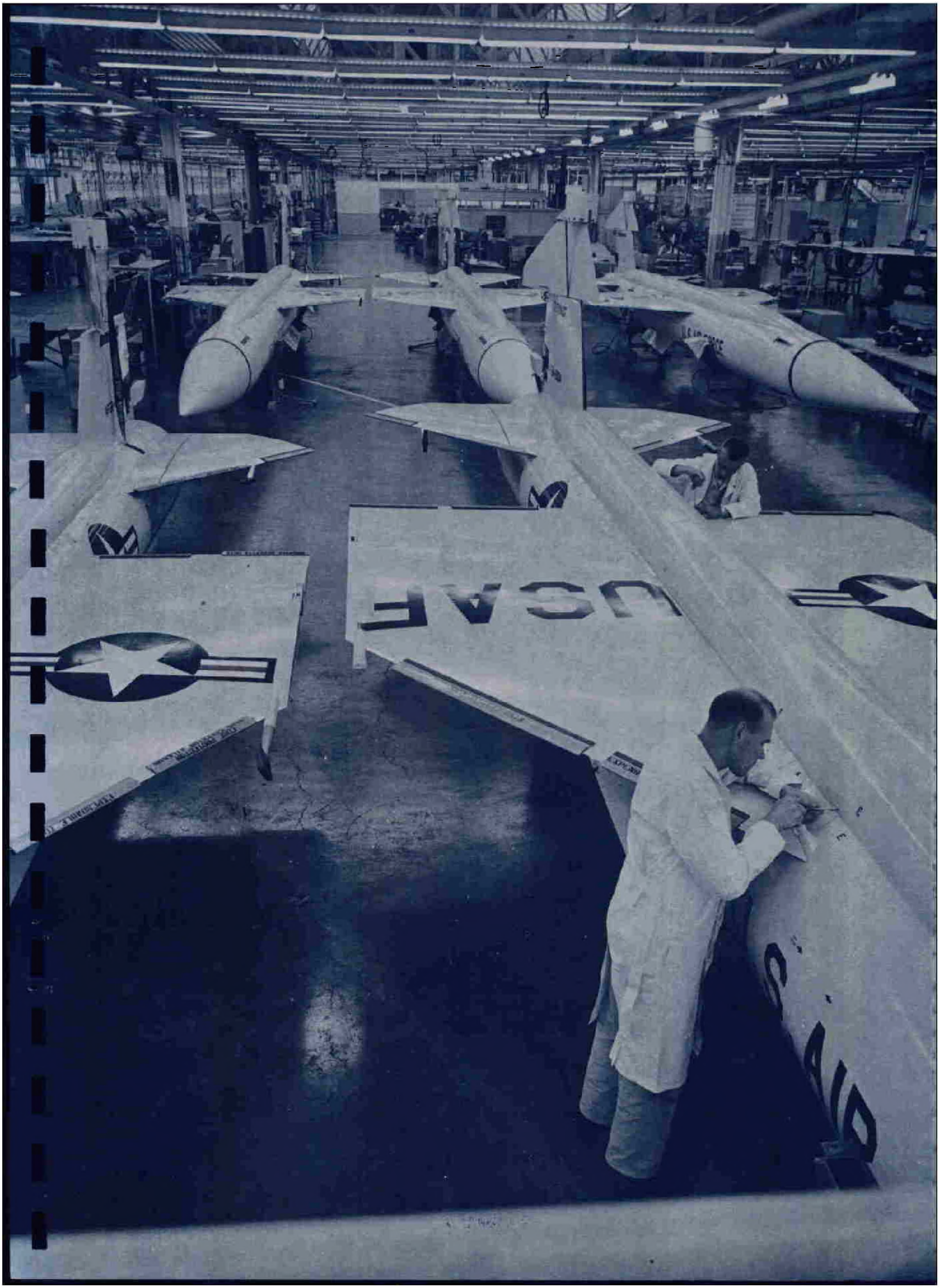
35. Air Defense Requirements for 1954-60, 1 Jun 1953 [HRF]; Ltr, Boeing to AMC, "Bomarc Production Program Missile Unit Prices," 1 Jul 1953 [DOC 34].

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problems could be solved and an advanced interceptor missile eventually produced. Taking a first-things-first attitude, WADC believed the shortcomings of the booster and ramjet should have first call on development effort. Problems with the target seeker, fuze and warhead could be attacked later, if they developed. The two major problems requiring immediate solution, in the WADC view, were the instability of the boost rocket and the possibility that the noise and vibration of the ramjets were causing malfunctions in electronic components of the missile. WADC felt that current development activity would provide answers to these problems and that the flight test program could soon be resumed. It was recommended that the next three test missiles be flown without ramjets in order to concentrate on booster operations. The following four missiles, according to WADC, should then include both booster and ramjets to make sure the two components worked together correctly. The seventh in this series (the 12th test missile launched), then, would be the tactical prototype. WADC was hopeful that the flight test program could be completed by January 1957, with the first tactical BOMARC squadron operational in January 1959.[36]

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36. Memo, MCPPAF-8, AMC for MCPPA, AMC, "Proposed Evaluation of F-99 (BOMARC) Program," 21 Aug 1954 [DOC 35];

[redacted]

Flight testing was finally resumed in August 1954, nearly a year after the suspension of September 1953. This missile got off the pad successfully, but flew only 15 seconds before the elevator control malfunctioned and caused violent maneuvers which tore the missile apart. Then, as WADC had recommended, two other flight tests of 1954 did not involve ramjets and tended to inspire confidence that a satisfactory booster had been provided by Aerojet. The BOMARC launched 25 October 1954 rose to an altitude of 44,000 feet, reached a speed of Mach 2.45 and covered 34 miles in eight minutes of flight. On 24 November a similar test missile reached an altitude of 44,000 feet, a speed of Mach 2.2 and covered 48 miles in nine minutes of flight. This pair of successful booster tests ended the Reaction Motors threat to Aerojet in the booster field. None of the Reaction Motors boosters tested during the first half of 1954 had operated successfully and Aerojet had made enough progress in solving earlier problems that in July ARDC authorized use of Aerojet boosters in the test launches of August, October and November 1954.[37]

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37. Dir/Weapons Systems Operations Reports, WADC, 6 Apr, 1 Jun, 10 Aug, 26 Oct, 30 Nov and 7 Dec 1954 [HRF]; ARDC Form 111, Project 3042, WADC, 15 Sep 1954 [HRF]; ARDC Weekly Activity Report, 1 Nov and 6 Dec 1954 [HRF]: AMC Daily Staff Digest, 6 Dec 1954 [HRF].

Meanwhile, the possibility of providing an atomic warhead for BOMARC improved to the point of probability. In 1952-53 it was the general consensus among experts in atomic warheads that an atomic device would be too large and heavy to carry in a missile the size of BOMARC. Plans were therefore made for four different types of high explosive BOMARC warheads. During the spring and summer of 1954, however, research by Boeing, WADC and the Atomic Energy Commission had borne sufficient fruit that in October 1954 WADC directed Boeing to design the BOMARC to carry either an atomic or conventional warhead.[38]

At the end of 1954, having only reached the point in development where it appeared that the booster might be satisfactory, it was evident that development of BOMARC was going to be a long and difficult process. For this reason, development was broken down into two phases. First would come BOMARC I with a range of 125 miles, altitude capability between 10,000 and 60,000 feet and speed of Mach 2.5. ARDC was hopeful this weapon would reach operational status by

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38. Ltr, ADC to USAF, "Atomic Weapons in Air Defense," 8 Jan 1954 [Doc 2 in ADC Hist Study No. 21, "BOMARC and Nuclear Armament, 1951-1963"]; Ltr, AMC to Boeing, "Contract AF33 (038)-19589; F-99 System Warhead-Fuze Developments," 9 Mar 1954 [DOC 37]; Msg WCSM 31613, WADC to AFPR (Boeing), 12 Oct 1954 [DOC 38].

January 1959. Then would come BOMARC II, with range of 250 miles, altitude capability between ground level and 80,000 feet and speed of Mach 2.7. Nobody wanted to guess when BOMARC II would become operational, although AMC was beginning to surmise that development of BOMARC II would take long enough that a solid propellant booster ought to be considered for it. Solid boosters had not shown much promise as of late 1954, but there was hope that solid propellant technology might improve rapidly. A solid booster would be much easier to handle than the tricky and dangerous acids used in the liquid booster. ADC continued to plan the deployment of 53 BOMARC squadrons.[39]

The third of the non-ramjet test missiles, launched 19 January 1955, was even more successful, going higher, further and faster than any previous test missile. It reached an altitude of 74,000 feet, flew 54 miles and attained a speed of Mach 3.2. Since there was now solid evidence that the booster was satisfactory, ramjets were again brought into the test program. Ramjets were aboard when the 10th BOMARC test missile was launched 24 February

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39. R&D Quarterly Review, USAF, 31 Dec 1954 [HRF]; ARDC System Development Directive No. 200A, 22 Sep 1954 [DOC 39]; Memo, MCPHFG, AMC for MCPH, AMC, "Solid Propellant Data (XF-99)," 28 Sep 1954 [DOC 40].

1955. The ramjets ignited as planned and the missile reached an altitude of 72,000 feet, a speed of Mach 2.4 and flew 106 miles. This was the first successful flight in which ramjets were used.[40]

There was a deviation from the WADC test plan 3 March 1955 when another non-ramjet missile was launched for the purpose of determining whether or not the airframe could withstand violent flight maneuvers. It could, on this occasion. After a series of roll and pitch acrobatics, the missile was still in one piece when it hit the water 24 miles from the launching pad. This series of successful flights, which extended back to October 1954, was deceiving, however. The test missile launched 5 May 1955 included ramjets, but elevator flutter ruptured a hydraulic line in the control system and the flight ended in 40 seconds. This malfunction, of course, precluded a check of booster-ramjet interaction.[41]

Boeing's temporary preoccupation with the flutter problem necessitated another change in the WADC test plan. Also, flight testing was delayed for nearly three months while an engineering solution was sought. It was not until

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40. BOMARC Flight Test Summary, n.d., pp. 8-9 [HRF].

41. Ibid., pp. 10-11.

27 July 1955 that Boeing was ready to test the redesigned airframe. This time another non-ramjet missile was launched, but not much was learned because rudder oscillation ended the flight after 34 seconds. No further test missiles were spent, at this time, on structural problems, however, and the regular test program was resumed with the missile launched 25 August 1955. This launching was partially successful. The booster raised the missile to the proper altitude and the ramjets ignited properly. The mission ended prematurely, however, when the control beacon failed after 137 seconds of flight. The missile achieved an altitude of 69,000 feet and speed of Mach 2.8 and flew 79 miles.[42]

While testing tended to fall further and further behind schedule, various plans were being made to produce the tactical missile and provide it to operational units of ADC. It was becoming very evident that BOMARC was going to cost a lot more than had been previously thought. In July 1955, the Missiles Branch of AMC estimated that the provision of eight operational squadrons (130 missiles per squadron) by January 1961 would require the expenditure of nearly two billion dollars, exclusive of brick-and-mortar costs (launchers, shelters and control and support facilities). There were

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42. Ibid., pp. 12-13.

hints, even at this relatively early date, that cost alone might be disastrous for BOMARC.[43]

The Air Materiel Command saw the BOMARC effort as three sub-tasks, each covered by a contract with Boeing. First was the development contract, already written and being performed. Then would come preparations for production (up to 100 missiles a month), covered by another contract that had already been written and under which performance had begun to a minor degree. Finally there would be a production contract, probably to be written in late 1956 so that production could begin in January 1957. In this connection, USAF had decided that BOMARC production should be undertaken at Boeing's Wichita (Kansas) plant. Establishment of a new Boeing plant at Denver or expansion of the Seattle plant were also considered.[44]

There was also another move to cut down the scope of the Boeing job in connection with BOMARC. Previously, Boeing had been relieved of the responsibility for providing

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43. Memo, MCPHMI, AMC for MCPHD, AMC, "IM-99A BOMARC," 20 Jul 1955 [DOC 41].

44. Ltr, AMC to AFPR (Boeing), "BOMARC Program Planning," 19 Oct 1955 [DOC 42]; Memo, DCS/M, USAF for Sec/AF, "Bomarc Facilities," 21 Nov 1955 [DOC 43]; Ltr, Boeing to AMC, "Boeing Proposals for Pilotless Aircraft Facility," 10 Dec 1955 [DOC 44].

a ground control network for the missile. In the autumn of 1955, AMC proposed to further restrict Boeing's responsibility by putting Marquardt under direct government supervision. Ramjets would be provided to Boeing as government-furnished equipment (GFE). Boeing, as might have been expected, objected to the transfer, since BOMARC was being developed under cost-plus-fixed-fee (CPFF) contracts under which the size of the fee was determined by the extent of management responsibility exercised by the contractor. The lighter the responsibility, the lower the fee.[45]

As to atomic warheads, WADC resisted a recommendation of the Air Force Special Weapons Center (AFSWC) to drop the high explosive warhead from consideration and thereby relax the degree of terminal guidance accuracy required of the missile. This relaxation, AFSWC believed, would make it much easier to develop a missile of improved reliability. This suggestion was based on the assumption that the atomic warhead would provide a much larger area of lethality than a high explosive warhead, hence the lower requirement for terminal guidance of pinpoint accuracy. WADC argued that no matter what warhead was used, it was necessary that the terminal guidance system in the missile be sufficiently accurate to kill not

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45. Ltr, Boeing to AMC, "Contract AF 33 (038)-19589, Project MX-1599, Procurement of Ramjet Engine Development and Supply," 4 Oct 1955 [DOC 45].

only the bomb carrier, but also the bomb. As of the end of 1955, therefore, both atomic and conventional warheads were still being developed for BOMARC.[46]

ADC was still thinking in terms of 53 BOMARC squadrons at the end of 1954. In light of the cost estimates of 1955, however, and in view of the fact that planning was beginning to give way to somewhat more precise programming, USAF began thinking in terms of 40 BOMARC squadrons of 120 missiles per squadron. This programming figure was accepted by ADC without quibble.[47]

Finally, there was an aura of achievement over the BOMARC test program at the end of 1955, when the last three missiles launched during the year were unqualified successes. The missile launched 29 September 1955 covered 94 miles and reached an altitude of 62,000 feet and a speed of Mach 2.7. Test launchings of 17 and 30 November were similarly successful Thus, after slightly more than three years of development and 17 test launches, Boeing claimed, and ARDC agreed, that the

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46. Ltr, WADC to ARDC, "System 200A (IM-99); Atomic Armament Capability," 3 Mar 1955 [DOC 46].

47. ADC Daily Diary, 17 Jun 1955 [HRF]; Memo P&R, ADC for DCS/O, ADC, "Interceptor Missile Program and Its Effect Upon Tactical Employment, Installations and Training," 5 Jul 1955 [Doc 275 in Hist of ADC, Jan-Jun 1955].

airframe, propulsion system and guidance system had proved suitable when tested individually. The next step in the test procedure was to determine whether or not the complete missile could intercept a target.[48]

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48. BOMARC Flight Test Summary, n.d., pp. 14-16 [HRF]; DCS/O Project Reports, ADC, 1 Jan 1956 [HRF].

## CHAPTER THREE

## PLANNING, TESTING AND OPERATIONAL READINESS 1956 - 1959

By February of 1956, USAF was ready to specify where and when it wanted the first eight squadrons of BOMARC. It was anticipated at this time that a squadron would consist of four detachments of 28 launchers each, with the squadron to control a total of 120 missiles (8 missiles being held in reserve). This plan also anticipated that three detachments would be deployed at some distance from the squadron headquarters and the first detachment. For example, the first

BOMARC squadron to be activated would have its headquarters and one detachment of 28 missiles at McGuire AFB, New Jersey. Other detachments were to be located at Suffolk County AFB, New York; Chincoteague Naval Air Station, Virginia; and Otis AFB, Massachusetts. According to the February plan the first eight BOMARC squadrons were to be located and become operationally ready as follows:

| Location | Readiness Date |
|---|---|
| McGuire AFB, New Jersey | June 1959 |
| Portsmouth AFB, New Hampshire | September 1959 |
| North Bay, Canada | December 1959 |
| Paine AFB, Washington | March 1960 |
| Fort Ord, California | June 1960 |
| Suffolk County AFB, New York | August 1960 |
| Plattsburg AFB, New York | October 1960 |
| Cut Bank AFS, Montana | December 1960 |

This plan also noted that the Air Force Council had approved the activation of 32 additional BOMARC squadrons at the rate of eight squadrons per year in 1961, 1962, 1963 and 1964.[49]

As part of this programming exercise, AMC was asked to determine the cost of support equipment for the BOMARC units. This, AMC figured, would come to about $21 millions per squadron, or roughly $850 millions for the full complement of 40 squadrons.[50]

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49. Ltr, USAF to AMC, "Target Dates for IM-99 (Bomarc Units)," 13 Feb 1956 [DOC 47].

50. 1st Ind (USAF to AMC, "Target Dates for IM-99

Programming in ADC was not proceeding in quite the same direction as that in USAF, however. While thinking in terms of 40 BOMARC squadrons, ADC anticipated that each squadron (112 shelters, 120 missiles) would be concentrated in one location, rather than dispersed in four detachments as outlined in the USAF program. The ADC program, embracing all 40 squadrons, was as follows:[51]

| ~~Location~~ | Operational Date ~~(Qtr/FY)~~ |
|---|---|
| 1. McGuire AFB, New Jersey | 1/60 |
| 2. Suffolk County AFB, New York | 2/60 |
| 3. Otis AFB, Massachusetts | 3/60 |
| 4. Dow AFB, Maine | 4/60 |
| 5. Niagara Falls, New York | 1/61 |
| 6. Plattsburg AFB, New York | 1/61 |
| 7. Kinross AFB, Michigan | 2/61 |
| 8. K.I. Sawyer AFB, Michigan | 2/61 |
| 9. Langley AFB, Virginia | 2/61 |
| 10. Truax Field, Wisconsin | 3/61 |
| 11. Paine AFB, Washington | 3/61 |
| 12. Portland Airport, Oregon | 3/61 |
| 13. Hamilton AFB, California | 4/61 |
| 14. Oxnard AFB, California | 4/61 |
| 15. San Diego NAS, California | 4/61 |
| 16. Fort Ord, California | 1/62 |
| 17. Bunker Hill AFB, Indiana | 1/62 |
| 18. Greater Pittsburgh Airport, Pennsylvania | 1/62 |
| 19. Duluth Airport, Minnesota | 2/62 |
| 20. Sioux City Airport, Iowa | 2/62 |
| 21. Grand Forks AFB, North Dakota | 2/62 |

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[Cont'd] (Bomarc Units)," 13 Feb 1956), AMC to USAF, 26 Mar 1956 [DOC 47].

51. ADC Historical Study No. 14, "History of Air Defense Weapons, 1946-1962," pp. 176-77 (hereafter cited as "ADC Study No. 14").

| Location | Operational Date (Qtr/FY) |
|---|---|
| 22. Cut Bank, Montana | 3/62 |
| 23. Opheim, North Dakota | 3/62 |
| 24. Minot AFB, North Dakota | 3/62 |
| 25. Klamath Falls, Oregon | 4/62 |
| 26. Geiger Field, Washington | 4/62 |
| 27. McConnell AFB, Kansas | 4/62 |
| 28. Ardmore, Oklahoma | 1/63 |
| 29. Amarillo AFB, Texas | 1/63 |
| 30. Reese AFB, Texas | 1/63 |
| 31. Biggs AFB, Texas | 2/63 |
| 32. Laughlin AFB, Texas | 2/63 |
| 33. Williams AFB, Arizona | 2/63 |
| 34. Ellington AFB, Texas | 3/63 |
| 35. New Orleans, Louisiana | 3/63 |
| 36. Fort Campbell, Kentucky | 3/63 |
| 37. Pinecastle AFB, Florida | 4/63 |
| 38. Tyndall AFB, Florida | 4/63 |
| 39. Charleston AFB, South Carolina | 4/63 |
| 40. Seymour Johnson AFB, North Carolina | 1/64 |

In light of Air Force Council approval of the full complement of 40 BOMARC squadrons, ADC, in the late spring of 1956, wanted to establish definite sites for the first 24 squadrons. USAF felt that this action was somewhat premature, however, because no funds for BOMARC construction were included in the Military Construction Program for Fiscal 1957.[52]

52. Msg ADOCE-C 1071, ADC to Defense Forces, 18 May 1956 [Doc 297 in Hist of ADC, Jan-Jun 1956]; Msg ADRSI 1207, ADC to USAF, 5 Jun 1956 [Doc 298 in Hist of ADC, Jan-Jun 1956]; Msg AFOOP-OC-F/2 52314, USAF to ADC, 16 Jun 1956 [Doc 299 in Hist of ADC, Jan-Jun 1956].

While the discussion of siting was in progress, ADC re-cast its BOMARC deployment plan to call for initial placement of two flights (half a squadron) at each of the 40 sites. Later each site would be expanded to a full complement of 112 launchers. USAF took no immediate action on this alternative plan, but when a similar plan (40 half-squadrons) was re-submitted in September 1956, USAF flatly rejected the ultimate plan of 40 complete squadrons as far too costly. Neither would USAF accept the plan for 40 half-squadrons (80 flights) at the locations previously specified by ADC. Instead, USAF offered an alternative plan proposing deployment of 22 squadrons with a total of 70 flights, distributed as follows:[53]

| Location | Number of Flights |
|---|---|
| 1. Langley AFB, Virginia | 4 |
| 2. McGuire AFB, New Jersey | 4 |
| 3. Otis AFB, Massachusetts | 4 |
| 4. Dow AFB, Maine | 4 |
| 5. Plattsburg AFB, New York | 4 |
| 6. Niagara Falls, New York | 4 |
| 7. Kinross AFB, Michigan | 4 |
| 8. Duluth Airport, Minnesota | 4 |
| 9. Paine AFB, Washington | 4 |

53. Msg ADRSI 1288, ADC to USAF, 19 Jun 1956 [Doc 300 in Hist of ADC, Jan-Jun 1956]; Ltr, ADC to USAF, "BOMARC Development - January 1965," 10 Sep 1956 [Doc 181 in Hist of ADC, Jul-Dec 1956]; Msg AFOOP-OC-F/2 56120, USAF to ADC, 13 Sep 1956 [Doc 182 in Hist of ADC, Jul-Dec 1956].

| Location | Number of Flights |
|---|---|
| 10. Portland Airport, Oregon | 4 |
| 11. Hamilton AFB, California | 4 |
| 12. Santa Maria Airport, California | 4 |
| 13. San Diego NAS, California | 4 |
| 14. Cut Bank, Montana | 2 |
| 15. Minot AFB, North Dakota | 2 |
| 16. Klamath Falls, Oregon | 2 |
| 17. Davis-Monthan AFB, Arizona | 2 |
| 18. Biggs AFB, Texas | 2 |
| 19. Lackland AFB, Texas | 2 |
| 20. New Orleans, Louisiana | 2 |
| 21. Orlando AFB, Florida | 2 |
| 22. Seymour Johnson AFB, North Carolina | 2 |

ADC made vigorous rebuttal to the USAF proposal, pointing out that even the 40 BOMARC squadrons contained in the ADC plan would provide only minimum defense coverage so far as ADC was concerned. Any reduction, therefore, was fraught with risks ADC did not want to accept. After more inconclusive discussion in late 1956, the matter of BOMARC deployment was taken out of ADC's hands. In December, USAF asked that the ADC plan be submitted to CONAD for approval and subsequent submission to the Joint Chiefs of Staff.[54]

Since everybody was convinced, by the end of 1955, that the missile would fly, the next step in testing was to

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54. Msg ADRPI 2013, ADC to USAF, 19 Sep 1956 [Doc 183 in Hist of ADC, Jul-Dec 1956]; Msg AFOOP-OC-F/2 59322, USAF to ADC, 30 Nov 1956 [Doc 184 in Hist of ADC, Jul-Dec 1956]; Msg ADRSI-D (no number), ADC to USAF, 10 Dec 1956 [Doc 185 in Hist of ADC, Jul-Dec 1956]; Ltr, ADC to CONAD, "BOMARC Deployment-1965," 12 Dec 1956 [Doc 186 in Hist of ADC, Jul-Dec 1956].

determine whether or not it would hit a target. Six test missiles were launched to that purpose between March and July 1956. The target, a 185-knot QB-17 drone, was virtually a sitting duck, to be sure, but test operations against a moving target had to begin somewhere. On three occasions the BOMARC made successful interceptions of the QB-17 at altitudes of 28,000 feet and at ranges between 55 and 63 miles. One interception involved a tail-chase approach to the target. The other two were head-on approaches. The three failures were of a random nature. An April launching fell short of expectations because of a power failure within the missile after 50 seconds of flight. The following month a test missile exploded shortly after launching. A June launching was unsuccessful because of a malfunction within the target seeker. Despite the qualified success of this test series, Boeing was satisfied that it had adequately demonstrated the ability of the BOMARC to intercept a target. Boeing was also confident, as of August 1956, that it could provide operationally ready missiles of 125-mile range (BOMARC I or IM-99A) in 1959.[55]

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55. BOMARC Flight Test Summary, ADC, n.d., pp. 17-23 [HRF]; Memo, DCS/P&R, ADC for Cmdr, ADC, "Report of Conference," 9 Aug 1956 [Doc 296 in Hist of ADC, Jan-Jun 1956].

[redacted]

At the end of 1955 it appeared to have been definitely decided that regular BOMARC production, as opposed to experimental production at Seattle, would be conducted in the Boeing plant at Wichita. In the 1955 discussions, Boeing appeared to express no particular preference with regard to a production site. But after the decision had been made in favor of Wichita, Boeing began to attempt to overturn it. As late as August 1956, AMC still officially favored Wichita, although within the AMC staff there was a minority group that favored acceptance of the Boeing proposal to concentrate all BOMARC production at Seattle. Eventually, the pro-Seattle group (which included the Air Force Plant Representative assigned to Boeing contracts) won and Wichita was written off as the site of quantity BOMARC production.[56]

It was also getting to be time, from the Boeing standpoint, to write some solid contract provisions concerning development of the advanced BOMARC, IM-99B, which would have a range of 250 miles, could cope with targets between sea

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56. Ltr, AFPR (Boeing) to AMC, "Contract AF 33 (038)-19589, Production Pilot Line Philosophy," 24 Feb 1956 [DOC 48]; Ltr, Boeing to AMC, "Production Facilities-Model IM-99A," 4 Jun 1956 [DOC 49]; Draft Ltr, AMC to USAF, "Proposed Bomarc Production Facility," 25 Aug 1956 [DOC 50]; Memo, Comment 2, MCPHM, AMC for MCPRMR, AMC, "Minority Position in Support of Boeing Proposal for a Separate Bomarc Facility," 4 Sep 1956 [DOC 51].

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level and 80,000 feet, would react more quickly and be more reliable than the earlier model. The basic contract for BOMARC development had been amended in March 1955 to limit Boeing to development of the IM-99A. Boeing, in May 1956, asked to be "unleashed" to proceed with the IM-99B. The contractor figured initial development work, which did not involve fabrication of any hardware, would cost about $19 millions. The Boeing proposal, essentially as originally written, was later made a part of the basic BOMARC contract.[57]

And, speaking of contracts, another move was afoot to further restrict Boeing authority over the development and production of major BOMARC components. Earlier, AMC had written a prime contract with Marquardt for production of ramjet engines. These were furnished to Boeing as government-furnished equipment. In the summer of 1956, AMC proposed to take the same action with Aerojet and BOMARC booster rockets. Boeing, as in the case of the ramjets, vigorously protested this action.[58]

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57. Ltr, Boeing to AMC, "Contract AF 33 (038)-19589, Advanced IM-99 Development Program," 1 May 1956 [DOC 52].

58. Memo, Comment 2, MCPHMI, AMC for MCPRP-P, AMC, "Procurement of Engines for BOMARC," 3 Feb 1956 [DOC 53]; Ltr, Boeing to AMC, "Contract AF 33 (038)-19589, Project MX-1599, Procurement of Boost Rocket," 31 Aug 1956 [DOC 54].

As has been mentioned above, USAF bluntly rejected ADC's plan for the deployment of 40 BOMARC squadrons (4,800 missiles) in the autumn of 1956 on the basis of cost. It had never been really apparent, to that point, what the planned BOMARC program was actually going to cost, although the estimates of September 1955 had given cause for concern. At that time it was estimated that BOMARC costs, through Fiscal 1964, would come to $1.93 billions. This was a sufficiently serious figure to give the planners pause, but when the estimates of August 1956 gave a total cost of $3.42 billions, it was completely obvious that BOMARC, as originally planned, could not be financed. Hence the revisions of late 1956.[59]

After several years of discussion, the matter of the warhead was finally settled in late 1956. Early planning had called for a high explosive warhead, which meant that the target seeker had to be capable of a high degree of accuracy. When it became evident that an atomic warhead small enough for inclusion in the BOMARC could be developed, plans were changed to call for interchangeable atomic and

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59. Ltr, USAF to AMC, "Cost Increase in the Bomarc Program," 31 Aug 1956 [DOC 55]; Ltr, Boeing to USAF, "Contracts AF 33 (038)-19589, AF 33 (600)-24748, AF 33 (600)-32832; Budget Quotation on FY 1958 Procurement of Weapon Support Equipment," 29 Nov 1956 [DOC 56].

high explosive warheads. Still later, when considerable difficulty was encountered in developing a target seeker sufficiently sophisticated for use with the high explosive warhead, sentiment for exclusive use of an atomic warhead increased. The decision to dispense with the high explosive warhead was taken 8 November 1956, on which date USAF approved an ADC request.[60]

While a concerted effort was being made to make sure that BOMARC would be compatible with SAGE when the new system took control of the ground environment, a more pressing requirement was that it be determined whether or not the missile was compatible with the GPA-35, the control system to be used with BOMARC until SAGE was ready. Therefore, six test missiles were set aside for this purpose and the GPA-35 test program began in October 1956. The first missile in this series, launched 12 October 1956, was a qualified success. A tail-chase interception of a QB-17 resulted in a miss distance of 1,000 feet at an altitude of 28,000 feet. and a range of 75 miles. Whether or not a missile passing this distance from a target would produce a kill was an open

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60. Ltr, Boeing to AMC, "Contract AF 33 (038)-19589, Revised Armament Program," 25 May 1956 [DOC 57]; Ltr, APGC to Det 1, ARDC, "BOMARC Missile, Warhead and Equipment Requirements for E&ST," 29 Aug 1956 [DOC 58]; Msg MCPHMI 5110, AMC to USAF, 6 Dec 1956 [DOC 59].

question. The second missile, launched 29 November 1956, did much better. It passed within 9 feet of the QB-17 at similar range and altitude.[61]

A number of milestones were passed in the BOMARC development program during 1956 -- the first interception of an airborne target and the decision to use only atomic warheads, for example -- but the interceptor missile was far from being operationally ready. The plans of 1950 had called for operational readiness in 1956. The plans of 1950, hindsight proved, were highly optimistic.

The four remaining missiles used to test the GPA-35 were launched between January and April 1957. While the GPA-35 performed perfectly, all four missions had to be counted as failures. In two instances the target seeker malfunctioned. In another, one ramjet failed. In the fourth case the missile exploded after 37 seconds of flight because of the loss of the ceramic liner from the throat of the rocket. In any event, the QB-17 target got away every time.[62]

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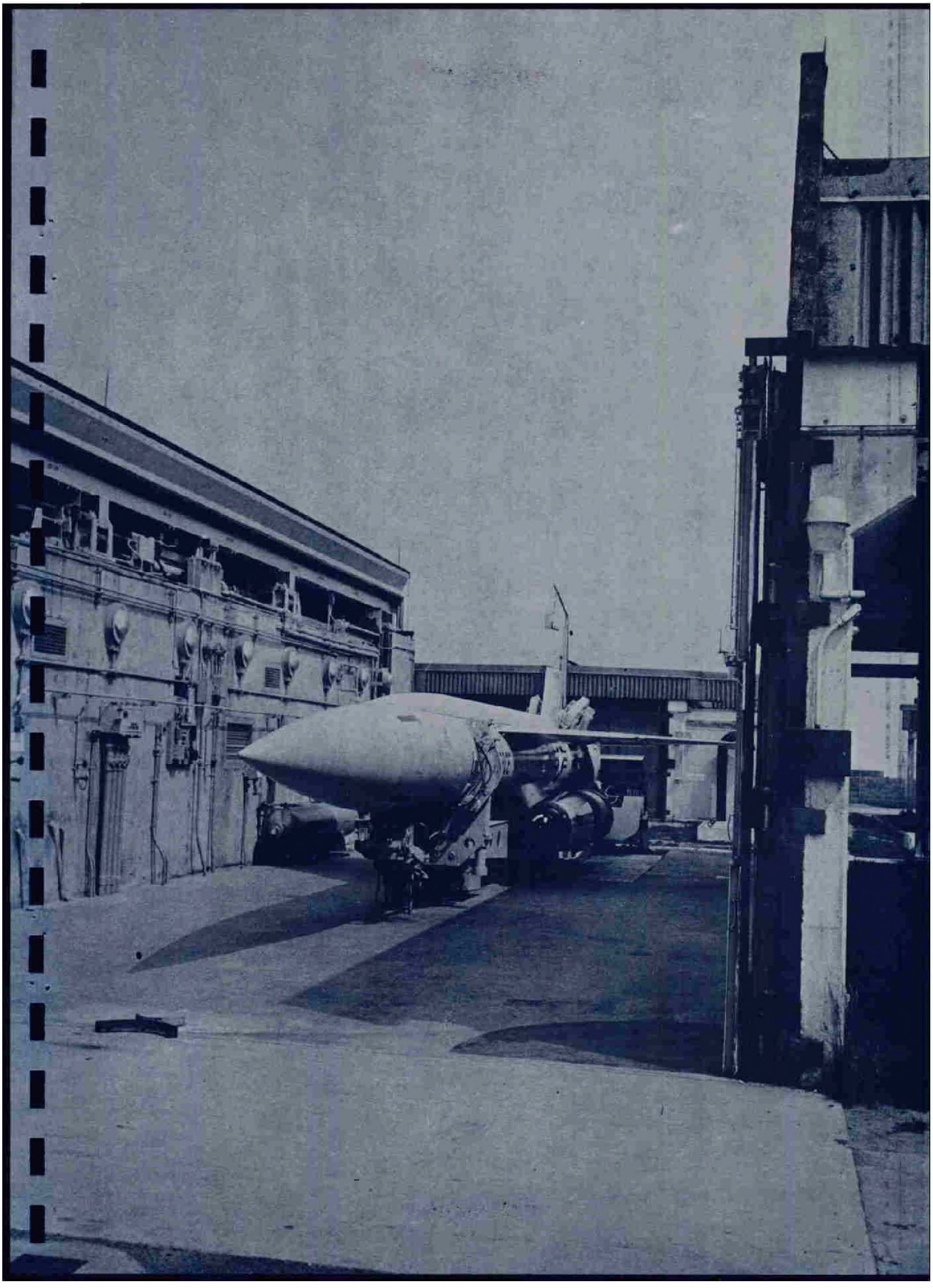
61. Ltr, USAF to ARDC, "IM-99-SAGE Integration," 19 Dec 1956 [DOC 60]; BOMARC Flight Test Summary, ADC, n.d., pp. 25-26 [HRF].

62. BOMARC Flight Test Summary, ADC, n.d., pp. 27-30 [HRF].



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In the planning area, CONAD answered the late 1956 request for an opinion on BOMARC deployment by recommending, in January 1957, that 40 squadrons be deployed, but that each include only two flights of missiles for a total of 80 flights. This compromise solution, which fell somewhere between the ADC and USAF positions, was accepted, at least temporarily, by both USAF and ADC. Meanwhile, site surveys for the first 14 BOMARC installations were underway. Siting was temporarily halted in April until USAF could be assured that all BOMARC units would be located on existing bases and would not require the purchase of additional land. Also, launchers were re-designed to permit more "austere" construction.[63]

The Congress, still reasonably friendly to BOMARC, appropriated $43 millions for the construction of four BOMARC

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63. Ltr, ADC to USAF, "BOMARC Deployment," 4 Feb 1957 [Doc 296 in Hist of ADC, Jan-Jun 1957]; Msg ADRSI-C 778, ADC to ADES Project Office, 20 Mar 1957 [Doc 297 in Hist of ADC, Jan-Jul 1957]; Msg ADRSI-D (no number), ADC to USAF, 8 Jan 1957 [Doc 306 in Hist of ADC, Jan-Jun 1957]; Msg AFCIE-C 51856, USAF to ARDC, 4 Feb 1957 [Doc 308 in Hist of ADC, Jan-Jun 1957]; Msg ADRSI-D 148, ADC to ARDC, 16 Jan 1957 [Doc 307 in Hist of ADC, Jan-Jun 1957]; Ltr, ADC to CONAD, "BOMARC Re-launch Capability," 12 Mar 1957 [Doc 304 in Hist of ADC, Jan-Jun 1957]; Msg AFCIE-P 52523, USAF to ADC, 19 Feb 1957 [Doc 309 in Hist of ADC, Jan-Jun 1957]; Msg AFCIR-P 54987, USAF to ADC, 17 Apr 1957 [Doc 310 in Hist of ADC, Jan-Jun 1957]; Msg USAFIR NER 720/ENG-1, USAFIR, NE Region, Corps of Engineers to ARDC, 26 Jun 1957 [Doc 312 in Hist of ADC, Jan-Jun 1957].

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bases in the Military Construction Program (MCP) for Fiscal 1958. It was understood that these funds would be used to build half-squadrons (56 missiles) at McGuire, Suffolk, Otis and Dow. Most initial effort was devoted to McGuire, since it was scheduled to become the first operational BOMARC base on 1 September 1959. From the beginning it was evident that the $43 millions in the MCP for Fiscal 1958 were not going to be sufficient to build four bases. Preliminary engineering estimates placed the cost of McGuire and Suffolk alone at $38.5 millions. There was also unexpected delay at McGuire when it required intervention by the Secretary of Defense to obtain Army permission (McGuire AFB is located on Fort Dix, an Army installation) for construction of BOMARC launchers. And more problems developed when construction actually began. In August 1957 the Corps of Engineers caused considerable consternation in ARDC by announcing that the Beneficial Occupancy Date (BOD) at Suffolk would be 31 October 1959, while that for McGuire would be 30 November 1959. ARDC immediately asked for help from USAF, since it was imperative that the McGuire site be ready for occupancy by 1 May 1959 if the planned operational readiness date of 1 September 1959 was to be met. This situation was complicated still further in September 1957 when Boeing demanded that it be allowed 10 months instead of the previously

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requested 6 months to install and calibrate the support equipment required at each BOMARC base. The Engineers offered to re-study their construction plans in an attempt to improve the promised dates of occupancy.[64]

A different kind of financial crisis also swirled around BOMARC in 1957. In August, USAF asked that every effort be made to reduce expenditures in the BOMARC weapon support area to $75 millions in Fiscal 1958. This was something of a blow to AMC, which had planned to spend $124.5 millions in this area. This situation was resolved by deferring the procurement of training equipment for both ADC and the Air Training Command (ATC) and by delaying the time when AMC could assume logistic support of BOMARC by one year. Despite these efforts, the ultimate cost of the total system continued to climb. In August 1956 it had been estimated that the complete cost of BOMARC through Fiscal 1964 would amount to $3.42 billions. A similar estimate of October 1957, including costs only through Fiscal

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64. Msg RDXSMB 31206, Det 1, ARDC to USAF, 14 Aug 1957 [DOC 61]; Msg ADORQ 217, ADC to USAF, 17 Sep 1957 [Doc 196 in Hist of ADC, Jul-Dec 1957]; Msg MCPHMI 2774, AMC to USAF, 9 Sep 1957 [DOC 62]; Msg ADORQ-C 243, ADC to USAF, 30 Sep 1957 [Doc 197 in Hist of ADC, Jul-Dec 1957]; Msg AFOOP-OP-U 51793, USAF to ADC, 25 Oct 1957 [Doc 198 in Hist of ADC, Jul-Dec 1957]; Msg ADORQ-C 131, ADC to ARDC, 3 Feb 1958 [Doc 199 in Hist of ADC, Jul-Dec 1957]; Msg ADORQ-C 51, ADC to USAF, 10 Jan 1958 [Doc 201 in Hist of ADC, Jul-Dec 1957].

1962, came to $3.984 billions. As an ironic footnote to this matter of money, Boeing, in May 1957, produced a production schedule that showed how 40 BOMARC bases would be equipped by the end of 1966 and how the production of tactical missiles would rise to the point of 68 missiles per month in January 1962 and would continue at that rate until a total of 5,535 missiles had been produced by January 1967.[65] Nobody attempted to place a price on this effort.

As to the logistic support of the BOMARC weapons system, Boeing was perfectly willing, for a price, to step into the breach and provide a maintenance and supply capability. This Boeing proposal, made in May 1957, was not seriously considered until later in the year when it was determined that AMC would receive only $75 millions of a requested $124.5 millions for BOMARC logistic support in Fiscal 1958. Although this amount was later raised to $87.5 millions, USAF recommended that Boeing continue, under existing (and financed) contracts, to provide depot capability for BOMARC for at least another year, or until AMC could be

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65. Msg MCPHMI (no number), AMC to USAF, 14 Aug 1957 [DOC 63]; Msg AFMPP-WS-2 59316, USAF to Det 1, ARDC, 16 Aug 1957 [DOC 64]; Ltr, AMC to USAF, "Shift of Executive Management Responsibility of the IM-99A Missile," 4 Oct 1957 [DOC 65]; Ltr, Boeing to AMC, "Bomarc Production Schedules," 7 May 1957 [DOC 66].

provided with the funds necessary to establish an Air Force maintenance and supply capability. Therefore, although AMC had not planned it that way, the Boeing proposal, at least temporarily, was accepted.[66]

A new series of missile tests, designed to demonstrate the effectiveness of the fuze-warhead combination, began in July 1957. Nine missiles were launched, the last in January 1958. Success was far from common during this series, since only three of the missiles launched were considered to have completed the prescribed mission. Oddly enough, the first success of this series was gained, 16 September 1957, at the expense of a 350-knot QF-80 drone, the first attempt at intercepting a target faster than the 185-knot QB-17. The other eight missions in this series involved the QB-17. The BOMARC also intercepted targets during the course of missions of 11 October and 23 October.

The six failures, again, were of a random nature. The initial launching in this series, 22 July 1957, failed when random radar pulses forced the missile to destroy itself after only 64 seconds of flight. The missile was just 12 miles

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66. Pers Ltr, William M. Allen, Pres., Boeing, to Gen. E.W. Rawlings, Cmdr, AMC, no subj., 14 May 1957 [DOC 67]; Msg AFMDC 52420, USAF to AMC, 18 Sep 1957 [DOC 68].

from the launch pad at Cape Canaveral. The mission of 15 August failed when the target seeker achieved lock-on 10 seconds late. The missile was then unable to execute the sharp turn necessary to maintain lock-on and the interception was not completed. The first missile containing a live high-explosive warhead was launched 27 September 1957, but a ramjet failure prevented the mission from being a success. The following month, however, the second missile with a live warhead made a direct hit on a QB-17 at the longest range -- 108 miles -- achieved to that time. Other failures were the result of faulty mid-course guidance from the GPA-35 and malfunctioning command systems within the missile.[67]

Planning for the IM-99B went forward during 1957 and even an interceptor missile beyond the IM-99B (IM-X) was considered. By August 1957 it had been decided that Boeing would design and produce the IM-99B. But since increasing difficulty was being experienced in obtaining funds for BOMARC, AMC urged Boeing to design, with all possible urgency a missile which would be much more enonomical and reliable than the IM-99A and which could be delivered, without fail, by January 1961. It was also decided in 1957, despite some

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67. BOMARC Flight Test Summary, ADC, n.d., pp. 30-39 [HRF].

minority objections within AMC, that the IM-99B would be equipped with a solid booster in order to obviate the continued handling of the dangerous and tricky acids required by the liquid booster of the IM-99A.[68]

As to the IM-X, a vastly improved interceptor missile, the prognosis was not favorable. Boeing, Convair, Martin and North American were asked to study such a missile and the general conclusion was that the existing state of the art was inadequate to support the prompt and economical development of an IM-X. For example, electronic components currently being produced could withstand a maximum temperature of 700 degrees. Components of the IM-X would have to operate in temperatures as high as 1,200 degrees. Because major advances in the state of the art would be required, it was estimated (March 1957) that 13 years would be needed for development of the missile and establishment of 24 bases. And estimated costs were ridiculous, although they varied widely. Martin suggested a program of 26 bases and 17,302 missiles at a cost of $7.9 billions. Convair, on the other

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68. Ltr, AMC to Boeing, "Contract AF 33 (600)-35030, Model Improvement of the IM-99A (Bomarc) Weapon System," 13 Aug 1957 [DOC 69]; Memo, RDZSMB, Det 1, ARDC for MCPHMI, AMC, "XIM-99 () Solid Propellant Booster," 3 Jan 1957 [DOC 70]; Msg MCPHMI 3228, AMC to Boeing, 21 Oct 1957 [DOC 71].

hand, foresaw a defense complex of 24 bases and 6,200 missiles at a cost of $43.8 billions. The evaluation committee concluded that the matter needed considerably more study before a definite IM-X development program was organized.[69]

Although there were many disappointments during the year, progress was made during 1957 toward the goal of an operational BOMARC weapon system. It was demonstrated that the missile could intercept a target (QF-80) faster than the 185-knot QB-17 and would fly more than 100 miles. Construction began on the BOMARC bases at McGuire and Suffolk and a definite operational date of 1 September 1959 was established. Boeing was given a contract for development of the advanced IM-99B. Despite this progress, however, there was continuing failure to demonstrate that the IM-99A was a reliable mechanism. Many more test missions failed, for various reasons, than were successful.

Hints of things to come in 1958 were given in December 1957 when USAF, mindful of the tremendous cost of the full BOMARC program, wondered if the increased range of the IM-99B (hopefully better than 400 miles) might not make it possible to reduce the number of BOMARC sites. No specific reduction was recommended. ADC could not agree that any reduction was

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69. Staff Summery Sheet, AMC, "Evaluation of Interceptor Missile (IM-X)," 17 Apr 1957 [DOC 72].

feasible, however, on the theory that the improved range of the IM-99B would merely offer improved air defense coverage where it was vitally needed. ADC countered this proposal by recommending that BOMARC deployment be expedited rather than reduced. It was suggested that USAF seek a supplemental Fiscal 1958 appropriation to permit the construction of nine BOMARC bases, rather than the four presumably financed in the regular 1958 MCP. In addition, ADC recommended that each of these nine bases be equipped with 112 launchers instead of the 56 launchers authorized for the first four bases -- a recommendation which ran counter to the CONAD-USAF-ADC compromise reached early in 1957. Looking ahead, ADC also asked for funds to construction of 11 BOMARC sites in the Fiscal 1959 MCP. If this request was approved, a total of 20 BOMARC bases would be provided by 1958-59 Military Construction Programs.[70]

The ADC request (subsequently supported by NORAD, created 12 September 1957 when a Canadian element was added to CONAD) hung fire through the spring of 1958, but eventually came to naught. Not only was the request for acceleration

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70. Msg ADORQ-C 462, ADC to USAF, 12 Dec 1957 [Doc 97 in Hist of ADC, Jul-Dec 1957]; Msg ADORQ-C 476, ADC to USAF, 18 Dec 1957 [Doc 96 in Hist of ADC, Jul-Dec 1957].

denied, but the BOMARC program for Fiscal 1959 was also cut. It was becoming painfully obvious that ADC was not going to get the 40 squadrons of BOMARC (112 launchers and 120 missiles to a base) as planned in 1955. It was also becoming evident that the 40 half-squadron compromise reached in early 1957 was a dead letter. In June 1958, USAF let it be known that it was prepared to ask Congress for only 31 BOMARC bases. Two of these were to have 56 launchers and the remainder 28 launchers, which added up to a total program of 924 launchers. Construction of 10 additional bases was authorized for Fiscal 1959, for a total of 14.[71]

As a result of the USAF action, the ADC plan for the deployment of BOMARC underwent considerable change. At the

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71. Msg ADORQ-C 112, ADC to USAF, 29 Jan 1958 [Doc 232 in Hist of ADC, 1958]; Msg AFOOP-OC-F/2 56198, USAF to ADC, 5 Feb 1958 [Doc 233 in Hist of ADC, 1958]; Msg ADORQ-C 296, ADC to USAF, 22 Apr 1958 [Doc 234 in Hist of ADC, 1958]; Ltr, ADC to USAF, "FY 59 Funding," 6 May 1958 [Doc 142A in Hist of ADC, 1958]; Ltr, USAF to ADC, "FY 59 Funding," 29 May 1958 [Doc 143 in Hist of ADC, 1958]; Msg AFOOP 51849, USAF to ADC, 9 Jun 1958 [Doc 225 in Hist of ADC, 1958]; Msg ADLSI-C 401, ADC to USAF, 10 Jul 1958 [Doc 235 in Hist of ADC, 1958]; Msg ADCMA 2100, ADC to USAF, 10 Jul 1958 [Doc 236 in Hist of ADC, 1958]; Msg AFORQ 319, ADC to USAF, 2 May 1958 [Doc 237 in Hist of ADC, 1958]; Msg ADCMA 2099, ADC to USAF, 10 Jul 1958 [Doc 238 in Hist of ADC, 1958].

end of 1958. ADC planned to construct BOMARC sites in the following order (excluding the two squadrons programmed for Canada):[72]

1. McGuire AFB, NJ
2. Suffolk County AFB, NY
3. Otis AFB, Mass
4. Dow AFB, Me
5. Langley AFB, Va
6. Truax Field, Wisc
7. Kinross AFB, Mich
8. Duluth Airport, Minn
9. Ethan Allen AFB, Vt
10. Niagara Falls Airport, NY
11. Paine AFB, Wash
12. Adair AFS, Ore
13. Travis AFB, Calif
14. Vandenberg AFB, Calif
15. San Diego NAS, Calif
16. Malmstrom AFB, Mont
17. Grand Forks AFB, ND
18. Minot AFB, ND
19. Youngstown AFB, Ohio
20. Seymour Johnson AFB, NC
21. Bunker Hill AFB, Ind
22. Sioux Falls Airport, SD
23. Charleston AFB, SC
24. McConnell AFB, Kan
25. Holloman AFB, NM
26. McCoy AFB, Fla
27. Amarillo AFB, Tex
28. Barksdale AFB, La
29. Williams AFB, Ariz

By the time the new BOMARC deployment program had been written it was time to think about the budget for Fiscal 1960 and the BOMARC construction it would buy. NORAD/ADC asked that 15 additional bases be built with 1960 money, thereby bringing the 1958/59/60 total to 29 bases and completing BOMARC construction as currently programmed. The preliminary USAF reaction, as stated in November 1958, was that no more than 12 bases could be worked into the construction budget.[73]

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72. Msg ADLPR C58-99, ADC to USAF, 2 Dec 1958 [Doc 256 in Hist of ADC, 1958].

73. Weekly Activities Report, ADC, ADLSI, 16 Jul and 5-6 Aug 1958 [HRF]; Msg AFOIE-WD 51053, USAF to ADC, 19 Nov 1958 [Doc 260 in Hist of ADC, 1958].

Late 1958 was also the time for settling the problem of which bases should have the early-model IM-99A and which should have the fully developed IM-99B. Discussions of this matter in 1956 found ARDC holding the position that the first 12 bases should have IM-99A, the remainder IM-99B. ADC wanted the change made after the 10th base. As missile development proceeded and the years rolled by, the number of bases to receive the IM-99A grew smaller, because base construction was slower than missile development. In June 1958, USAF reduced the number of IM-99A bases to eight. The following September, NORAD asked that the IM-99A bases be reduced to six and JCS and USAF concurred. Then in December 1958 a reduction to five IM-99A bases was directed by USAF. Under this plan, three of the IM-99A bases were to be supplemented with IM-99B missiles. Only the bases at McGuire and Suffolk were to be limited to the IM-99A model.[74]

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Msg ADORQ-C 193, ADC to USAF, 20 Feb 1958 [Doc 241 in Hist of ADC, 1958]; Msg AFOOP-OC-F/2 57061, USAF to ADC, 27 Feb 1958 [Doc 242 in Hist of ADC, 1958]; Msg AFOIE-CS 52572, USAF to ADC, 26 Jun 1958 [Doc 245 in Hist of ADC, 1958]; Msg AFCAD 57216, USAF to AMC, 15 Sep 1958 [Doc 246 in Hist of ADC, 1958]; Msg AFOIE-C 59232, USAF to AFIR, North Atlantic Region, 8 Oct 1958 [Doc 247 in Hist of ADC, 1958]; Msg AFCAD 51731, USAF to ADC, 5 Dec 1958 [Doc 248 in Hist of ADC, 1958]; Msg AFOOP-DC 52233, USAF to ADC, 19 Dec 1958 [Doc 249 in Hist of ADC, 1958]; Msg ADLSI-C 472, ADC to ARDC, 10 Sep 1958 [Doc 250 in Hist of ADC, 1958]; Msg AFOIE-WD 59903, USAF to ADC, 21 Oct 1958 [Doc 251 in Hist of ADC, 1958].

While the 1957 series of tests involving the fuze-warhead combination was far from successful, BOMARC had already been under development seven years and there was no time to backtrack. Therefore, a test series intended to determine whether or not the IM-99A could consistently intercept a target at ranges in excess of 100 miles was inaugurated in March 1958. At this time the IM-99A was designed for a maximum range of 125 miles. One of the test group of eight missiles, incidentally, was intended to check the theoretical minimum range of 43 miles.

Again the degree of failure was high, only four of the eight launches being considered successful. At the same time, however, two of the failures provided information that considerably revised pre-conceived notions as to the capability of the missile. Despite a theoretical maximum range of 125 miles, the missiles launched 2 April and 1 May 1958 flew 187 and 197 miles, respectively. Partly because of these test results, the design goals for the two types of interceptor missiles were subsequently raised to 230 miles for the IM-99A and 440 miles for the IM-99B. Nevertheless, the long-range flight of 2 April had to be counted a failure because the target seeker failed to function. That of 1 May was also figured to be unsuccessful, because the GPA-35

failed to control the missile beyond 130 miles. The other two failures resulted from ramjet malfunctions, flaws in the flight control system and fuze difficulties.

The three successful long-range sorties against the QB-17 occurred, oddly enough, in June 1958, and involved interceptions at 103,111 and 115 miles. The minimum-range test was the only one in which the faster QF-80 was used as a target. In this instance, 20 May 1958, the IM-99A improved on the theoretical minimum range of 43 miles by intercepting the QF-80 at 41.9 miles.[75]

Although the testing of experimental missiles had not been highly reassuring as to the reliability of BOMARC, testing of the production prototype began in August 1958. At the same time, the compatibility of SAGE and BOMARC was to be determined. Ten missiles were expended in this program by the end of 1958.

The first attempt at SAGE control of BOMARC occurred 7 August 1958. The SAGE computer involved was the experimental model at Kingston, New York, approximately 1500 miles from the BOMARC launch site at Cape Canaveral. This initial attempt was unsuccessful. Because of split radar returns, SAGE was not able to give the missile the proper commands

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75. BOMARC Flight Test Summary, ADC, n.d., pp. 39-47 [HRF].

and 153 seconds after launching the GPA-35 took control. The command system within the missile malfunctioned, however, and the missile refused to accept commands. As a result, the missile remained at cruise altitude (65,500 feet) until its fuel was exhausted and it dropped into the Atlantic Ocean about 180 miles from the launch site. The second attempt at SAGE control, however, was a complete success. On 15 August, SAGE maintained total control of the missile until the terminal phase of the interception, when guidance equipment within the missile took over and made a direct hit on the QB-17 target at a range of 78 miles and an altitude of 30,000 feet.[76]

Another milestone in BOMARC development was reached 21 October 1958 when two missiles under SAGE control were almost simultaneously launched against two QB-17 targets spaced far enough apart to present two distinct radar images. Surprisingly enough, in view of earlier experience, the dual mission was almost a complete success. SAGE took complete control of both missiles and put them in proper position for interception. Only the fact that the fuze in the first missile did not operate properly was a double interception prevented. The first missile passed within four feet of the

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76. Ibid., pp. 49-50.

drone at a range of 100 miles. The second missile, launched 12 seconds after the first, made a direct hit on the drone at a range of 159 miles.[77]

The initial attempt at BOMARC interception of a supersonic target, made 24 September 1958, ended in failure. The target was an X-10 drone flying directly toward the launch site at a speed of Mach 1.57 and an altitude of 53,000 feet. The early phases of the mission went exactly according to plan, but during the last 72 seconds of the midcourse phase the SAGE computer received no information about the target. Therefore the missile was positioned so far to the right of the target that, because of the rapid closing rate between missile and target, there was not enough time to steer the missile back on the correct course. The missile as a consequence, missed the target by 12,000 feet.[78]

Although the August-December 1958 test series provided the welcome information that SAGE and BOMARC were indeed compatible, it did nothing to increase faith in the reliability of the missile. Of the 10 missiles launched during this period, only two were regarded as unqualified successes.

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77. Ibid., pp. 54-55; Msg RDZSDB-31347, Det 1, ARDC to USAF Requirements Interchange Officer (Ottawa), 24 Oct 1958 [Doc 626 in Hist of ADC, 1958].

78. BOMARC Flight Test Summary, ADC, n.d., p. 53 [HRF].

Various things went wrong with the other eight. On four occasions the fuze failed to operate properly. The other four failures were credited to command system and target seeker malfunctions. Fifty-seven IM-99A test missiles had been launched from Cape Canaveral by the end of 1958. IM-99A testing shifted to Santa Rosa Island in Northwest Florida, across the peninsula from Cape Canaveral, in 1959.[79]

The matter of targets for the BOMARC test program began to cause concern in 1958. If the BOMARC was to be tested realistically, it had to be sent against something at least resembling a possible enemy. Early testing made use of the QB-17, but this freight-train-slow World War II bomber was useful only in indicating that the BOMARC could intercept a target -- any kind of target. This done, it was necessary to send the missile against a target offering much improved performance. USAF first suggested use of the QF-80, but although a few of the 350-knot targets were used, ADC argued that the obsolete fighter was entirely inadequate. The X-10 (Navaho surface-to-surface guided missile) was acceptable, but only three were available. One was used during a BOMARC test mission in September 1958. The Q-4 was a specially designed supersonic Ryan drone that appeared

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79. Ibid., pp. 48-59.

to offer promise as a target for BOMARC, but engine troubles made it unlikely that the Q-4 would be available before July 1960, if at all. The SNARK strategic missile (SM-73) was also considered, but rejected because of excessive cost. This left the obsolete QB-17 for immediate use, although there might be some improvement later when the QB-47 became available. Also, ARDC was debating the possibility of converting the F-104 to drone use.[80]

While Congress had been restive over mounting BOMARC costs in 1958, it nearly revolted in 1959 over the question of whether the BOMARC or the Army's NIKE antiaircraft missile was the best air defense weapon. Actually, the question was hardly valid, because the two weapons were complementary, not competing. NIKE was a short-range point defense weapon, while BOMARC was designed for long-range air defense. Nevertheless, Congress saw NIKE and BOMARC as duplicate means of

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80. Msg RDXSMB 30002, Det 1, ARDC to USAF, 2 Jan 1958 [Doc 674 in Hist of ADC, 1958]; Msg ADORQ-C 37, ADC to USAF, 9 Jan 1958 [Doc 675 in Hist of ADC, 1958]; Msg AFDRQ-AD 56579, USAF to ADC, 13 Feb 1958 [Doc 676 in Hist of ADC, 1958]; Msg ADORQ-C 269, ADC to USAF, 3 Apr 1958 [Doc 679 in Hist of ADC, 1958]; Msg RDZSD 31382, Det 1, ARDC to USAF, 31 Oct 1958 [Doc 680 in Hist of ADC, 1958]; Msg ADLSI-B 560, ADC to Det 1, ARDC, 1 Dec 1958 [Doc 681 in Hist of ADC, 1958]; Msg AFMPP-EQ-3 52224, USAF to ARDC, 19 Dec 1958 [Doc 682 in Hist of ADC, 1958].

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doing the same job and balked at providing funds for both. Furthermore, the Department of Defense abdicated its responsibility to provide guidance in this matter. Testifying before the Senate Armed Services Committee in the spring of 1959, Secretary of Defense Neil McElroy admitted that his organization had not been able to reach a decision as to how available funds should be distributed between NIKE and BOMARC. Furthermore, the Secretary of Defense suggested that Congress "hold our feet to the fire" in this matter. In other words, McElroy wanted Congress to make the decision.[81]

This unique abdication of an executive function led to a grotesque legislative situation in which the Armed Services Committees of both chambers of Congress examined the same set of facts and came to exactly opposite conclusions. The Senate committee recommended that no further funds be spent on NIKE. The House group recommended the same treatment for BOMARC. To light the way out of this impasse, the Senate committee directed the Department of Defense to prepare a master air defense plan which would provide some basis for Congressional action. The Department of Defense, therefore, was still required to do its constitutional duty.[82]

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81. House Committee on Government Operations, Report No. 11, "Organization and Management of Missile Programs," 2 Sep 1959, p. 123.

82. ~~Ibid~~.

The result was the publication, in June 1959, of a Master Air Defense (MAD) Plan in which the Department of Defense proposed to keep both NIKE and BOMARC, but on a reduced scale. The BOMARC program was reduced from 31 to 18 sites (including two in Canada), each site to have 56 launchers and 60 missiles for a total of 1,080 missiles. The revised deployment of BOMARC was as follows:[83]

| Priority Number | Site | Activation Date | Operational Date |
|---|---|---|---|
| 1 | McGuire | Jan 1959 | Sep 1959 |
| 2 | Suffolk | Feb 1959 | Dec 1959 |
| 3 | Otis | Mar 1959 | Mar 1960 |
| 4 | Dow | Jun 1959 | Jun 1960 |
| 5 | Langley | Sep 1959 | Sep 1960 |
| 6 | Kinross | Mar 1960 | Mar 1961 |
| 7 | Duluth | Apr 1960 | Apr 1961 |
| 8 | Niagara Falls | May 1960 | May 1961 |
| 9 | Paine | Jul 1960 | Jul 1961 |
| 10 | Adair | Aug 1960 | Aug 1961 |
| 11 | Travis | Sep 1960 | Sep 1961 |

83. Msg NOCPR 45, NORAD to JCS, 1 Dec 1958 [Doc 297 in Hist of ADC, Jan-Jun 1959]; Msg SIGPI 2-100, ADSID to USAF, 2 Feb 1959 [Doc 298 in Hist of ADC, Jan-Jun 1959]; Msg AFOIE-WD 56789, USAF to ADSID, 19 Feb 1959 [Doc 299 in Hist of ADC, Jan-Jun 1959]; Msg SIAM 3-174, ADSID to ADC, 18 Mar 1959 [Doc 300 in Hist of ADC, Jan-Jun 1959]; Msg ADLAN-S 46, ADC to USAF, 7 Apr 1959 [Doc 301 in Hist of ADC, Jan-Jun 1959]; Msg AFODC 58959, USAF to ADC, 15 Apr 1959 [Doc 302 in Hist of ADC, Jan-Jun 1959]; Msg ADLPR C59-54, ADC to ADSID, 21 Apr 1959 [Doc 303 in Hist of ADC, Jan-Jun 1959]; Msg AFODC 50523, USAF to ADC, 2 May 1959 [Doc 304 in Hist of ADC, Jan-Jun 1959]; Msg AFOOP-DE 53141, USAF to ADC, 10 Jul 1959 [Doc 305 in Hist of ADC, Jan-Jun 1959]; Change B to ADCM 27-2, 3 Aug 1959 [HRF].

| Priority Number | Site | Activation Date | Operational Date |
|---|---|---|---|
| 12 | Vandenberg | Oct 1960 | Oct 1961 |
| 13 | Malmstrom | Jan 1961 | Jan 1962 |
| 14 | Glasgow | Apr 1961 | Apr 1962 |
| 15 | Minot | May 1961 | May 1962 |
| 16 | Charleston | Jul 1962 | Jul 1963 |
| 17 | La Macaza (Canada) | Feb 1961 | Feb 1962 |
| 18 | North Bay (Canada) | Mar 1961 | Mar 1962 |

Although no funds were provided for additional BOMARC construction in the budget for Fiscal 1960, money for 14 sites had been provided in the 1958 and 1959 budgets, so there was no immediate shortage of construction funds. Since the Ethan Allen and Truax sites had been removed from the program, however, construction at these locations was halted.

A new era in BOMARC testing began 15 January 1959 when the first test missile was launched from the Air Force Missile Employment Facility at Hurlburt Field, Florida (officially designated Eglin Auxiliary Field No. 9). Launchers were emplaced on a narrow strip of sand known as Santa Rosa Island and missiles were launched over the Gulf of Mexico. The beginning at Santa Rosa was auspicious, since the missile made a direct hit on a maneuvering QF-80 drone at an altitude of 25,000 feet and a range of 79 miles. The initial launching was not made without difficulty, however. Earlier plans called for the first launching from the AFMEF

in November 1958, but a number of malfunctions in missile testing equipment, notably the Mobile Inspection Equipment (MIE) vans, caused delays. Finally, a group of Boeing engineers was sent from Cape Canaveral to Hurlburt on 30 December 1958 and by using makeshift testing methods was able to provide the successful launching of 15 January 1959.[84]

The initial Santa Rosa launching was the beginning of Category II testing of the IM-99A. Category II was the test phase wherein ARDC attempted to demonstrate to the using command that it was receiving a combat-ready weapon. While test operations were beginning at Santa Rosa, Category I testing (in which the contractor demonstrates the reliability of the weapon) was being completed at Cape Canaveral. The remaining six Category I missiles had been launched by April 1959. Reliability was little, if any, better than had been experienced in earlier test series. Three launches were counted successes. The other three failed because of fuze and warhead problems and control difficulties.[85]

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84. BOMARC Flight Test Summary, ADC, n.d., p. 60 [HRF]; Msg 73CP-SS X2A, 73 AD to ADC, 7 Jan 1959 [Doc 503 in Hist of ADC, Jan-Jun 1959]; Msg 73CP X5A, 73 AD to ADC, 13 Jan 1959 [Doc 504 in Hist of ADC, Jan-Jun 1959]; Msg ADCST-O 8000, ADC to USAF, 21 Jan 1959 [Doc 505 in Hist of ADC, Jan-Jun 1959].

85. BOMARC Flight Test Summary, ADC, n.d., pp. 61-68 [HRF].

Eleven Category II test missiles were launched from Santa Rosa between January and April 1959. Following the success of 15 January, a "double shoot" about two weeks later, involving two missiles against a single QF-80 drone, was a qualified success. The missiles came near the target at ranges of 103 and 46 miles, but the fuze of the second missile failed to fire in the vicinity of the target. Success was not contagious, however, and the launchings of 27 February and 6 March 1959 were failures because in one instance the target seeker had locked-on several things other than the target and in the other the GPA-35 gave the missile the wrong pre-launch commands.[86]

At this point in the test program a brief halt was called in an attempt to remedy the eminently unsatisfactory MIE van, the same problem that had delayed the commencement of testing at Santa Rosa for two months. Although the van, in theory, was supposed to thoroughly check all missile systems in four hours, 10 to 14 days were being required to process a missile. And then the processing was incomplete.

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86. Msg PGYU 6CR, APGC to Det 1, ARDC, 5 Feb 1959 [Doc 510 in Hist of ADC, Jan-Jun 1959]; Msg PGG 107C, APGC to Det 1, ARDC, 4 Mar 1959 [Doc 515 in Hist of ADC, Jan-Jun 1959]; Msg 73DO-OTM X259C, 73 AD to ADC, 10 Mar 1959 [Doc 517 in Hist of ADC, Jan-Jun 1959].

Only once had the processing procedure gone as far as step 104, and then only because several troublesome steps had been skipped. Attempts to calibrate the van met with indifferent success, so the BOMARC Weapons System Project Officer (WSPO), an ARDC official, gave permission to launch 12 missiles without benefit of MIE processing by 24 April. This deadline was necessary, because it was planned to spend the three weeks beginning 24 April in maintenance work on the GPA-35 and its associated FPS-20 radar. By the time this work was accomplished, in early May, it was hoped that the MIE van would be improved to the point where it would be possible to resume IM-99A testing with a minimum of improvization.[87]

Because of this special dispensation, the test organization at AFMEF attempted to launch eight missiles between 13 and 24 April 1959. Six were actually launched, which was a fine testimonial to the test crew, although the results did not say much for the IM-99A and its control system. Only one

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87. Msg 73DO-OTM X283C, 73 AD to ADC, 17 Mar 1959 [Doc 519 in Hist of ADC, Jan-Jun 1959]; Msg 73DO-OTM 316C, 73 AD to ADC, 24 Mar 1959 [Doc 520 in Hist of ADC, Jan-Jun 1959]; Msg 73DO-OTM X352C, 73 AD to ADC, 31 Mar 1959 [Doc 521 in Hist of ADC, Jan-Jun 1959]; Msg 73DO-OTM X404D, 73 AD to ADC, 7 Apr 1959 [Doc 523 in Hist of ADC, Jan-Jun 1959]; Msg 73DO-OTM X403D, 73 AD to ADC, 7 Apr 1959 [Doc 524 in Hist of ADC, Jan-Jun 1959]; Msg ADMLP-CD 491, ADC to APGC, 7 Apr 1959 [Doc 525 in Hist of ADC, Jan-Jun 1959].

of the six missiles intercepted the QF-80 target. Of the two missiles launched 13 April, the two failures resulted from a faulty target seeker and the inability of the GPA-35 to control the missile after 100 seconds of flight. On 24 April it was planned that two of the four missiles launched (a new record for one day) would be controlled by SAGE, two by the GPA-35. The first SAGE-controlled launching was nearly disastrous. The missile rose only eight feet, then settled back into the launcher, causing extensive damage to both launcher and shelter. The second SAGE-controlled missile did little better. The IM-99A began its terminal dive far too early and was destroyed at a point 50 miles from the launcher, apparently because it was given erroneous commands by SAGE. The first of the missiles controlled by the GPA-35 also behaved poorly, since the target seeker never saw the target. Finally, the last of the four missiles launched on 24 April succeeded in intercepting a QF-80 at a range of 73 miles.[88]

Although nearly seven years of BOMARC testing had failed to produce a missile that inspired confidence, the

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88. Msg PGYU 13 CR, APGC to USAF, 13 Apr 1959 [Doc 526 in Hist of ADC, Jan-Jun 1959]; Msg PGYU 15 CR, APGC to USAF, 25 Apr 1959 [Doc 529 in Hist of ADC, Jan-Jun 1959].

test organization, in June 1959, pushed ahead doggedly to the next item on the test agenda -- the SAGE/BOMARC evaluation. This step was taken in the full knowledge that many people of greater authority were beginning to have serious doubts about the performance and reliability of BOMARC. For example, the Air Force Chief of Staff, on 3 June 1959, "expressed strong personal interest in the earliest possible launching of a BOMARC at a supersonic target."[89] Apparently nobody had thought to remind the Chief of Staff that the IM-99A had been launched at the supersonic Navaho (X-10) missile on 24 September 1958, possibly because the interception had been unsuccessful as a result of the failure of SAGE to properly control the interceptor missile.

At any rate, the desire of the Chief of Staff could not be immediately gratified because, with the destruction of the last X-10 at Cape Canaveral in early 1959, there were no supersonic drones in the Air Force inventory. It was hoped, however, that some supersonic Regulus missiles could be obtained from the Navy for target use in the near future. Meanwhile, the SAGE/BOMARC evaluation proceeded, and the early results were encouraging. SAGE performed faultlessly

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89. Msg AFDRD-AD 51637, USAF to Dir of Sys Mgt, ARDC, 3 Jun 1959 [Doc 539 in Hist of ADC, Jan-Jun 1959].

during the initial launch of 4 June 1959. The missile was guided to a direct hit on a QF-80 at a range of 100 miles. On 24 June, two test missiles, launched 30 seconds apart, were sent after two QF-80 drones spaced 18 miles apart. Both missiles passed within lethal distance of the targets, at ranges of about 100 miles, although there was some doubt that fuzes and arming devices had operated properly.[90]

The wish of the USAF Chief of Staff to have BOMARC launched at a supersonic target was fulfilled in September 1959. On the third day of that month an IM-99A destroyed a supersonic Regulus II at a range of 125 miles. To prove that this mission was not an isolated fluke, another Regulus II was knocked down on 17 September, this time at a range of 140 miles. It was apparent that the IM-99A, when all subsystems were operating in accord with specifications, was capable of dealing with a supersonic target.[91]

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90. Msg MOODC 632, MOADS to 32 AD, 5 Jun 1959 [Doc 536 in Hist of ADC, Jan-Jun 1959]; Msg MOODC 709, MOADS to 32 AD, 24 Jun 1959 [Doc 537 in Hist of ADC, Jan-Jun 1959]; Msg RDXSDB 30524, Dir of Sys Mgt, ARDC to USAF, 29 Apr 1959 [Doc 540 in Hist of ADC, Jan-Jun 1959]; Msg ADCMA 2261, ADC to USAF, 19 May 1959 [Doc 111 in Hist of ADC, Jan-Jun 1959]; Msg ADOOP-S 18-F-38, ADC to USAF, 11 Jun 1959 [Doc 542 in Hist of ADC, Jan-Jun 1959]; Msg PGYU 257C, APGC to ADC, 24 Jun 1959 [Doc 543 in Hist of ADC, Jan-Jun 1959].

91. Ltr, 4751 ADW to Joint BOMARC/SAGE Test Staff, "Status Report as of 10 September 1959," 14 Sep 1959 [Doc 220 in Hist of ADC, Jul-Dec 1959]; Msg PGYU 31CR, APGC to USAF,

Despite the successes of June and September, the IM-99A test record during the summer and early fall of 1959 was an almost unrelieved catalogue of failure. To indicate the magnitude of the test debacle during the period 1 July-9 October, only six of the missiles it was planned to launch were actually launched and of this number only two, the two directed at the supersonic Regulus II, completed interceptions. Probably the most unnerving event of this period occurred 29 July when two of the three missiles of a planned "triple shoot" erected when the count-down was still six seconds short of launch time. The mission was immediately cancelled and an investigation organized because of the implications as regards missile safety. It was later discovered the premature "fire-up" command had resulted from test channel noise produced by a faulty rectifier at the Chipley (Florida) microwave relay station. This problem, fortunately, had a simple solution. It was merely necessary to replace the faulty rectifier. Following a test failure of 9 October

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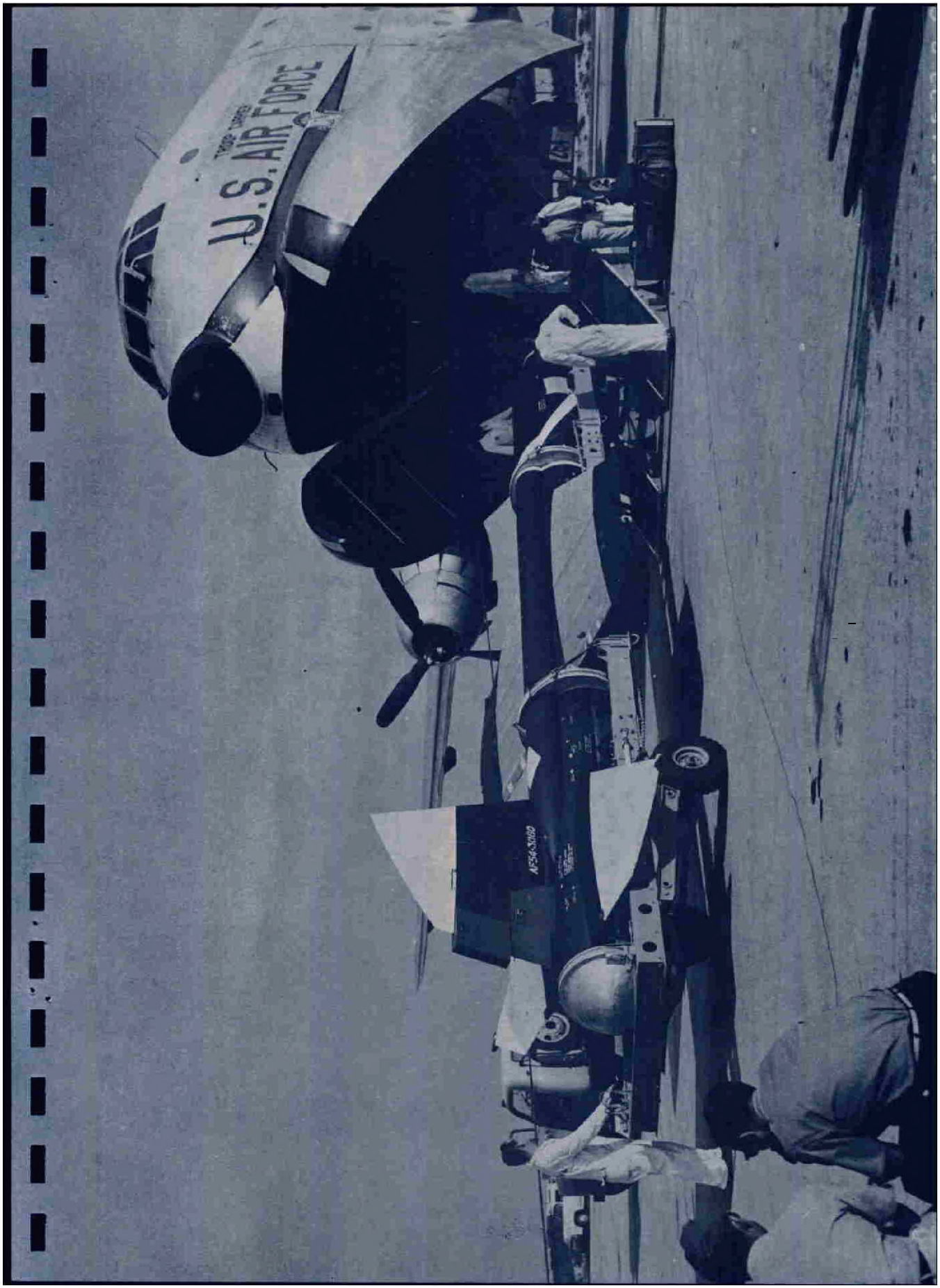
[Cont'd] 11 Sep 1959 [Doc 221 in Hist of ADC, Jul-Dec 1959]; Ltr, 4751 ADW to Joint BOMARC/SAGE Test Staff, "Status Report as of 24 September 1959," 25 Sep 1959 [Doc 222 in Hist of ADC, Jul-Dec 1959]; Msg PGYU 32CR, APGC to USAF, 17 Sep 1959 [Doc 223 in Hist of ADC, Jul-Dec 1959].



the 1959 IM-99A test season at Santa Rosa came to an end, because it was necessary to prepare the test site and the range for IM-99B testing.[92]

As of late 1959, the reliability rate of the IM-99A was unacceptably low. Boeing had predicted that 40 per cent of the missiles in ready storage would fire and that 40 per cent of the missiles fired would accomplish interception. The Boeing forecast offered, therefore, a system effectiveness of a very modest 16 per cent when missiles in the ready storage condition were considered. Experience gained during the launching of 20 IM-99A missiles from Santa Rosa between 15 January and 9 October 1959, however, indicated that Boeing was optimistic. While 43.5 per cent of the ready missiles were launched, only 23.5 per cent found the target, for a composite effectiveness rate of 10.7 per cent. It had also been expected that reliability would improve as test equipment more nearly approached a uniform tactical

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92. Ltr, 4751 ADW to Joint BOMARC/SAGE Test Staff, "Status Report as of 24 July 1959," 4 Aug 1959 [Doc 214 in Hist of ADC, Jul-Dec 1959]; Ltr, 4751 ADW to Joint BOMARC/SAGE Test Staff, "Status Report (1 through 13 August 1959)," 17 Aug 1959 [Doc 215 in Hist of ADC Jul-Dec 1959]; Ltr, 4751 ADW to Joint BOMARC/SAGE Joint Test Staff, "Status Report as of 31 August 1959," 31 Aug 1959 [Doc 219 in Hist of ADC, Jul-Dec 1959]; Msg MOODC 2009, MOADS to 32 AD, 25 Sep 1959 [Doc 224 in Hist of ADC, Jul-Dec 1959]; Msg PGYU 415C, APGC to USAF, 9 Oct 1959 [Doc 225 in Hist of ADC, Jul-Dec 1959].

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configuration. But this had not proven true. The situation had rapidly become worse instead of better. ADC hoped to achieve an in-commission rate of 83 per cent at the tactical sites, but on the basis of test operations at Santa Rosa it appeared likely that the in-commission rate was likely to be closer to 10 per cent.[93]

USAF already sensed that all was far from well with the BOMARC program and on 29 October 1959 requested an ARDC briefing on the matter, since "the recent unsuccessful IM-99A firings and attempted firings [had] caused considerable concern to the Air Staff."[94] ADC responded, although not charged with responsibility for the briefing, with another long list of BOMARC deficiencies. USAF thereupon appointed a General Officers' BOMARC Review Board to study BOMARC problems and decide what was to be done to improve matters. The first meeting of the Board was held at Wright-Patterson on 18 December 1959.[95]

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93. Msg ADAMA 2316, ADC to USAF, 28 Oct 1959 [Doc 120 in Hist of ADC, Jul-Dec 1959].

94. Msg AFMDC 86956, USAF to ARDC, 29 Oct 1959 [Doc 226 in Hist of ADC, Jul-Dec 1959].

95. Weekly Activities Reports, ADC, ADLSI-C, 18 Nov, 23 Nov, 24 Nov and 3 Dec 1959 and ADLPG-I, 18 Dec 1959 [HRF].

Meanwhile, by severely straining the concept of operational readiness, it was possible to declare the BOMARC squadron at McGuire operationally ready on 1 September 1959, according to plan. On that date, Brig. Gen. Arthur C. Agan, Jr., commander of New York Air Defense Sector, announced that he had "reasonable confidence one BOMARC at McGuire [could] be fired and guided by New York Air Defense Sector to destroy targets."[96]

This was the shakiest sort of operational readiness, however, because there was much to be done before McGuire could be considered really ready. As late as mid-December 1959 only one missile was in ready storage at McGuire. Following the initial declaration of operational readiness, ADC worked feverishly to improve the degree of readiness at McGuire. Engineers of the 46th Air Defense Missile Squadron (ADMS) and Boeing were formed into an integrated team, under Boeing direction, to process missiles to operationally ready status. Between 1 September and 22 October 1959, the team was engaged in getting the MIE, functional check-out gear (FCO) and the propulsion and hydraulic testing equipment in sufficiently operable condition to permit processing of a

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96. Msg CMD 59S-1656, NYADS to ADC, 1 Sep 1959 [Doc 247 in Hist of ADC, Jul-Dec 1959].

second missile. Testing of a second missile began 22 October. Four days were spent on FCO operations and two days on fueling. Ten days were devoted to repeated MIE tests. With completion of these procedures, operational readiness testing of this second missile began 13 November. But the missile was not ready. After 21 successive failures, the missile was returned to the MIE sequence on 16 November. By this time there were indications that missile components had been worn out by excessive testing. These failures were adequate proof that the FCO and MIE test equipment was inadequate and Boeing was put to re-engineering both sets. Despite the difficulties at McGuire, the second IM-99A site was declared operational at Suffolk on 1 December 1959, primarily because ADC was adamant in insisting that programmed dates for operational readiness be met.[97]

The same day that the IM-99A site at McGuire was declared operationally ready, 1 September 1959, testing of the IM-99B began at Cape Canaveral. Early test experience

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97. Msg ADAMA-P 80, ADC to USAF, 24 Nov 1959 [Doc 248 in Hist of ADC, Jul-Dec 1959]; Msg LMDN 2755, Aeronautical Systems Center, AMC to ADC, 30 Nov 1959 [Doc 249 in Hist of ADC, Jul-Dec 1959]; Msg ADLSI-C 1, ADC to 26 AD, 2 Nov 1959 [Doc 252 in Hist of ADC, Jul-Dec 1959]; Msg ADOOP-ES 313, ADC to ADES Proj Off (NY), 18 Dec 1959 [Doc 253 in Hist of ADC, Jul-Dec 1959]; Weekly Activities Reports, ADC, ADLSI-C, 11-14 Nov and 8 Dec 1959 [HRF].

was not conducive to optimism, since the five IM-99B missiles launched by the end of 1959 were all counted failures because of malfunctions in the ramjet engines. Despite nine years of experience with BOMARC, no means of building a satisfactory degree of reliability into the missile had yet been discovered.[98]

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98. Msg ADCVC 1418, ADC to 32 AD, 12 May 1960 [Doc 375 in Hist of ADC, Jan-Jun 1960.

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CHAPTER FOUR

REDUCTION OF THE BOMARC MISSION
1960 - 1964

Many congressmen experience long tenure in office and most have long memories. It had not been forgotten, when the new Secretary of Defense, Thomas S. Gates, Jr., faced the House Appropriations Committee on 13 January 1960, that the House had voted to withhold all funds from BOMARC the previous year. This House group well remembered that it had been forced to compromise its best judgement in order to obtain agreement with the Senate. It was a hostile audience and it



[redacted]

came as a surprise to nobody when House members returned to the attack on BOMARC. On the second day of the hearings, 14 January, George A. Mahon of Texas, once an avid supporter of strong air defense in general, quoted the 1959 committee report to the effect that 30 billion dollars had been spent on air defense in 10 years and that there were plans in existence that would run this figure to 50 billions. In the next breath he asked if it was true that both the BOMARC and NIKE HERCULES programs were being continued.

Secretary Gates, quoting the MAD Plan of June 1959, vouched for the truth of the statement. If this was so, asked Mahon, did the Secretary think the air defense program was in proper focus? With the air of sweet reasonableness that characterized all Department of Defense witnesses at this time, Gates responded that he thought the air defense program was "in good shape," but immediately qualified this statement by adding that it, "like other programs, ought to be under continuous review."[99]

At this point, General Nathan F. Twining, Chairman of the Joint Chiefs of Staff, testified that he concurred with Secretary Gates, but revealed that there was not unanimous

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99. House Hearings on Department of Defense Appropriations for Fiscal 1961, Part 1, 14 Jan 1960, p. 54.

agreement within the Department of Defense on this point. "General Kuter (Laurence S., NORAD commander)," said General Twining, "feels very strongly we are not devoting enough of our time and effort to air defense." Nevertheless, he continued, "I feel -- and the other chiefs go along with me -- this is a pretty good balance we have now." But General Twining also added a note of qualification. "Maybe the Russians will eliminate their air threat entirely. We do not know. We certainly ought to keep watching this and not spend money on air defense unnecessarily."[100]

The committee would not let the matter rest with this exchange of general statements, however. George W. Andrews of Alabama touched a sore nerve when he asked for a progress report on the testing of BOMARC B. General Twining professed not to know the details, but insisted that "we have had pretty good luck." Dr. Herbert F. York, Director of Defense Research and Engineering, concurred that "where we stand so far is encouraging. It is not discouraging."[101] But Andrews was not satisfied with general impressions and demanded the specific results of every test launching of the

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100. ~~Ibid~~.

101. ~~Ibid~~., p. 113.

IM-99B. The simple and unfortunate truth was that every IM-99B test launching to that date had been a failure because of malfunctions in the ramjets.[102]

Despite this attempt to put the best possible face on the BOMARC situation, there was a discernible lack of conviction among the Department of Defense witnesses. Again, as in earlier testimony, Secretary Gates emphasized the need for continuing scrutiny of the BOMARC program. "It might be well," he said later, "before this budget is spent or committed further -- I mean in the course of fiscal year 1961 -- that we have another re-appraisal. Such a re-appraisal might change the emphasis on certain factors."[103]

This lack of conviction came into the open shortly after initial testimony on the Fiscal Year 1961 appropriation had been completed, when Air Force leadership asked the House to consider revisions in the budget. Although this was an unusual request, it was granted by Mahon, chairman of the Defense Appropriations Subcommittee of the House Appropriations Committee. Therefore, General Thomas D. White, Air Force Chief of Staff, and several of his subordinates appeared before the subcommittee on 24 March 1960 to explain the

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102. Ibid.

103. Ibid.

changes. The most drastic involved BOMARC. General White now recommended that BOMARC be limited to 10 sites (including two in Canada) instead of the 18 sites for which funds had been requested in January. The estimated cost of BOMARC in Fiscal 1961 was reduced from $421 millions to $40 millions.[104]

Mahon asked the obvious question. "If this is such a wonderful idea which you present today," he asked, "why did you not come to the Capitol in January and present us with this money-saving, defense-improving, eye-catching, more attractive program?" The reasons for curtailment of BOMARC were many and spread over many pages of subsequent testimony. Increasing Soviet emphasis on intercontinental ballistic missiles, against which the SAGE/BOMARC system was impotent, was mentioned. The technical difficulties which had delayed the operational readiness of BOMARC were listed as factors. And seven test launchings of the IM-99B to that date had been failures. The need for diverting BOMARC production funds to projects of higher priority (such as ATLAS, TITAN and MINUTEMAN) was underscored. As to why what was so evident in March could not be seen in January, the only answer was that it had taken a long time to absorb the true meaning

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104. House Hearings on Department of Defense Appropriations for Fiscal 1961,"Revisions in 1960 and 1961 Air Defense Programs," 24 Mar 1960, pp. 3 and 19-22.

of the MAD Plan of June 1959. Nobody bothered to mention that the MAD Plan had specified the deployment of BOMARC at 16 locations in the United States and two in Canada.[105]

Understandably, both NORAD and ADC objected violently to the proposed reductions. When queried as to the substitution of aircraft for BOMARC missile, ADC insisted that the only possible substitution was one-for-one. In fiscal terms, since the F-106 cost $4.4 million per aircraft and the BOMARC cost $3.2 million per missile, such a substitution was simply not feasible. The Air Force witnesses admitted lack of agreement on the part of NORAD and ADC, but argued that the consideration of fiscal realities and defense priorities had made it impossible to fulfill NORAD/ADC requirements.[106]

The House, however, could not be convinced that BOMARC was a bargain at any price and again, as in 1959, decided to withhold all funds for BOMARC. At the same time, reflecting the thinking of the influential Mahon that a mobile manned interceptor aircraft was vastly superior to a fixed interceptor missile of dubious capability, the House authorized the expenditure of $215 millions for additional F-106 aircraft. The Department of Defense had not requested these funds.

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105. Ibid., pp. 25-37.

106. Ibid., pp. 26-27 and 34; Msg ADLDC-S 931, ADC to USAF, 23 Mar 1960 [Doc 147 in Hist of ADC, Jan-Jun 1960].

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But all was not lost as regards BOMARC. The Senate still had to take action on the appropriation bill for Fiscal 1961. The argument in favor of the missile was helped 13 April 1960 when the test organization managed the first successful interception mission (in eight tries) with the IM-99B. One successful launching was not likely to assure the Senate that all the technical problems of the BOMARC had been overcome, however. In early May, therefore, Dr. Joseph V. Charyk, Undersecretary of the Air Force, "inquired as to the possibility of getting some successful BOMARC B firings before the end of May."[107] The Senate Appropriations Committee had scheduled hearings for the last week in May. Fortunately, the next test launching of an IM-99B, 17 May 1960, was also successful. It was therefore possible for General White to go before the Senate group and ask for restoration of BOMARC funds with a greater air of confidence than he might otherwise have shown.[108]

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107. Msg ADCVC 1418, ADC to 32 AD, 12 May 1960 [Doc 375 in Hist of ADC, Jan-Jun 1960].

108. Aviation Week, 4 Apr 1960; Msg WWSDBE-B 14-4-29, IM-99 Field Test Sec to USAF, 14 Apr 1960 [Doc 372 in Hist of ADC, Jan-Jun 1960]; Msg WWSDBE 18-5-48, IM-99 Field Test Sec to USAF, 18 May 1960 [Doc 377 in Hist of ADC, Jan-Jun 1960]; Air Force Times, 1 Jun 1960.

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Repeating the pattern of 1959, the Senate expressed more faith in BOMARC than did the House and not only restored the funds to equip 10 sites in the northeast (including two in Canada), but added, in reporting the bill on 8 June 1960, $75 millions for two sites in the Pacific northwest. The Senate did not adopt the House proposal to spend $215 for additional F-106 aircraft. The conference committee which met in mid-July agreed that BOMARC should survive in 10-site form.[109]

After the legislative battles of 1959 and 1960, which reduced BOMARC to the position of a limited adjunct to the air defense of the northeastern United States, everything else that happened to BOMARC was anticlimactic. All eight sites within the United States were operational by the end of 1962. Three -- McGuire, Otis and Langley -- had both IM-99A and IM-99B missiles. Two sites -- Suffolk and Dow -- offered only the IM-99A and three others -- Niagara, Kincheloe and Duluth -- were equipped solely with the IM-99B. The sites in Canada -- North Bay and La Macaza -- were not operationally ready because of the continuing reluctance of

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109. Washington Post, 9 Jun 1960; Aviation Daily, 20 Jul 1960.

[redacted]

the Canadian government to permit the storage of nuclear warheads in Canada.[110]

Testing continued and intensified in 1960, as unceasing efforts were made to increase the reliability of the missile. There was a heartening upsurge of successful IM-99A testing in May 1960 as the result of energetic action on the part of the USAF General Officers' BOMARC Review Board, ARDC and ADC and thousands of engineering manhours on the part of Boeing. Suddenly, in the last 20 days of May, two reasonably successful "triple shoots" were accomplished, including interception of Regulus supersonic targets. During the first four months of 1960, the test group had attempted the launching of eight missiles. Only two became airborne and these missed interceptions because of target seeker and yaw rate gyro malfunctions. Then the sudden rush of success that gave, at least temporarily, some indication that the IM-99A was becoming a reliable missile.[111]

This confidence was shaken, however, when, on 7 June 1960, the rupture of the helium tank of an IM-99A in "ready

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110. RCS: 3AF-V14, ADC, 31 Aug 1962 [HRF]; ADCM 27-2, Vol II, 15 Mar 1962 [HRF].

111. Msg ADLPG-IM 1259, ADC to WADD, 27 Apr 1960 [Doc 295 in Hist of ADC, Jan-Jun 1960]; Msg WWSDBE-FA 12-5-30, IM-99 Field Test Sec to USAF, 12 May 1960 [Doc 296 in Hist of ADC, Jan-Jun 1960]; Msg WWXDBE-A 18-5-49, IM-99 Field

storage" at McGuire caused a fire that involved the TNT detonator and destroyed the missile and the nuclear warhead. There was no atomic explosion and damage was confined to the immediate vicinity of the missile shelter. Although uninformed rumor created considerable anxiety among the civilian population in the McGuire area, the accident was in reality a minor one. When the cause of the McGuire accident (burst helium tank) became known in late June, the helium pressure of all IM-99A missiles was reduced from the tactical pressure of 4,300 pounds per square inch (psi) to atmospheric pressure. This meant that ADC had a questionable combat capability with the IM-99A missile until the scope of the helium tank problem was outlined and the necessary improvements were made. This procedure required more than a year. Study of the problem forced the conclusion that it was impractical to maintain a constant helium pressure of 4,300 psi within combat-ready missiles. The solution accepted was to maintain a helium pressure of 3,000 psi, while adding to each launch shelter a cumbersome "top-off" tank containing 10 cubic feet of helium at a pressure of 7,000 psi. In the last 30 seconds before launching, helium

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[Cont'd] Test Sec to USAF, 19 May 1960 [Doc 302 in Hist of ADC, Jan-Jun 1960].

from the "top-off" tank was introduced into the missile until the required pressure of 4,300 psi was reached. The first test launching of a missile so pressurized occurred 29 June 1961. The "top-off" tank was subsequently added to all IM-99A shelters and combat capability was regained.[112]

Meanwhile, the IM-99A test program continued. In late May 1960 a new series of tests designed to determine the ability of the control system (and the missile) to switch from one target to another and discriminate between two targets in the same area was begun. Four attempts at missions of this type during May and June resulted in two successes and two failures. At the least, it was discovered that such missions could be accomplished if both SAGE and the missile worked according to specifications.[113]

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112. SECRET/RESTRICTED DATA, Msg NYCRR 2473 60S, NYADS to USAF, 8 Jun 1960 [Doc 191 in Hist of ADC, Jan-Jun 1960]; ~~New York Times~~, 9 Jun 1960; Msg NYCVC 2799, NYADS to Dep IG for Nuclear Safety Research, USAF, Norton AFB, 24 Jun 1960 [Doc 192 in Hist of ADC, Jan-Jun 1960]; Msg 26CIG 18, 26 AD to ADC, 22 Jun 1960 [Doc 199 in Hist of ADC, Jan-Jun 1960]; Current Status Report, USAF, Air Defense Mission Area, Jun 1961, pp. 3-13 [HRF].

113. Msg WWSDBE-A 27-5-82, IM-99 Field Test Sec to ADC, 27 May 1960 [Doc 306 in Hist of ADC, Jan-Jun 1960]; Msg WWZDBE-A 5-6, IM-99 Field Test Sec to ADC, 3 Jun 1960 [Doc 309 in Hist of ADC, Jan-Jun 1960]; Msg WWXDBE-FA 9-6-26, IM-99 Field Test Sec to USAF, 9 Jun 1960 [Doc 310 in Hist of ADC, Jan-Jun 1960]; Msg WWXDBE-A 24-6-64, IM-99 Field Test Sec to ADC, 25 Jun 1960 [Doc 317 in Hist of ADC, Jan-Jun 1960].

During August, the last month of the IM-99A 1960 test year, a special test series was conducted to prove or disprove the efficiency of the proximity fuze provided by the Diamond Ordnance Fuze Laboratory. In the course of launching more than 100 test missiles, there had been frequent instances wherein it was suspected that the fuze had not operated properly. Diamond insisted that the fuze had been designed to cope with a target the size of a B-47 and could not be expected to work efficiently against small targets like the F-80 and Regulus. Therefore, a QB-47 drone was obtained for fuze test purposes. Three missiles launched on 5 and 11 August successfully intercepted the target, but only secondary fuze action was observed. A fourth test missile was launched 18 August, but in this case the missile, if such a situation can be imagined, was too efficient, since the missile made a direct hit on the QB-47 target. This was the only QB-47 target available, so fuze testing ended abruptly and on an inconclusive note. Following an unsuccessful high-altitude mission of 19 August 1960, Category II testing of the IM-99A was declared ended. Because of the need to change computer programs at the Montgomery (Alabama) SAGE site, no further IM-99A testing was undertaken in 1960.

The end of Category II testing left a number of Category II projects incomplete. The capability and reliability of the fuze had not been verified. The ability of the IM-99A to operate as planned in an electronic countermeasures (ECM) environment had not been established. The ability of the missile to operate in all types of weather had not been proven. Its reliability after tactical maintenance recycles and extended periods of ready storage had not been checked. It was necessary to move these test items over into the Category III phase of testing, although Category III was primarily intended as a demonstration of the tactical capability of the IM-99A in a normal squadron environment.[114]

Following the successful IM-99B launchings of 13 April and 17 May 1960 and the subsequent Congressional decision to proceed with the procurement of a limited number of IM-99B missiles, 13 test missions were conducted at Santa Rosa during the last half of 1960. Although only five of the 13 missiles completed interceptions, certain milestones

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114. Weekly Activities Report, ADC, ADLPG-I, 24 Aug 1960 [HRF]; Joint Air Force-Boeing Weekly Status Report No. 35, 24-30 Aug 1960 [Doc 479 in Hist of ADC, Jul-Dec 1960]; Msg WWZDB 29-8-435, WADD to ARDC, 29 Aug 1960 [Doc 480 in Hist of ADC, Jul-Dec 1960]; Msg MOY 29-9-43, APGC to ADC, 30 Sep 1960 [Doc 481 in Hist of ADC, Jul-Dec 1960].

were passed. On 8 July, an IM-99B missile intercepted a supersonic Regulus target at an altitude of 35,000 feet and a range of 148 miles. This was the first time the IM-99B had been sent against a target and the first time an active target seeker and fuze had been used. The interception of a supersonic target was not repeated in 1960, although success was experienced against subsonic QB-47 drones in December.[115]

Category III testing of the IM-99A, involving the launching of 27 missiles, was nearly completed during 1961. Twenty-five were launched in 1961, mostly against high-level and low-level maneuvering targets, both subsonic and supersonic. Fifteen of the 25 launches experienced some degree of success, a greater percentage of successes than had been realized during earlier periods of testing.

Despite the greater degree of test success during 1961, there were still serious doubts about the liquid-fuel boost system of the IM-99A as the official test program drew toward a close. Throughout the program there had been periodic

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115. Msg WWXDBE-B 11-7-25, IM-99 Field Test Sec to USAF, 11 Jul 1960 [Doc 494 in Hist of ADC, Jul-Dec 1960]; IM-99B Weekly Reports No. 45, 18 Nov-2 Dec 1960; No. 46, 2-9 Dec 1960; No. 47, 9-16 Dec 1960 and No. 48, 16-30 Dec 1960 [Docs 544, 550, 551 and 554 in Hist of ADC, Jul-Dec 1960].

failures, including the fire at McGuire in June 1960, traceable to the boost system. These failures persisted through 1961. On 16 February it was necessary to destroy a missile only 200 feet from the launcher when the boost system failed only a few seconds after the launch process began. Similar failures occurred on 3 March and 21 March. On the latter occasion the missile caught fire and hit the water only a half-mile from the launcher. Investigation of this accident revealed that a faulty shock absorbing crush cone had brought about helium starvation within the missile and had resulted in the fire and failure of the mission. A metallurgical test of all crush cones -- test or tactical -- was directed and it was believed that this problem had been solved.[116]

The completion of several successful interceptions after the crush cone inspection of late March 1961 created a cautious optimism over the boost system. This optimism was not severely shaken when a missile launched on 8 September fell back into the shelter and the shelter was extensively damaged in the resulting fire, because there was a completely

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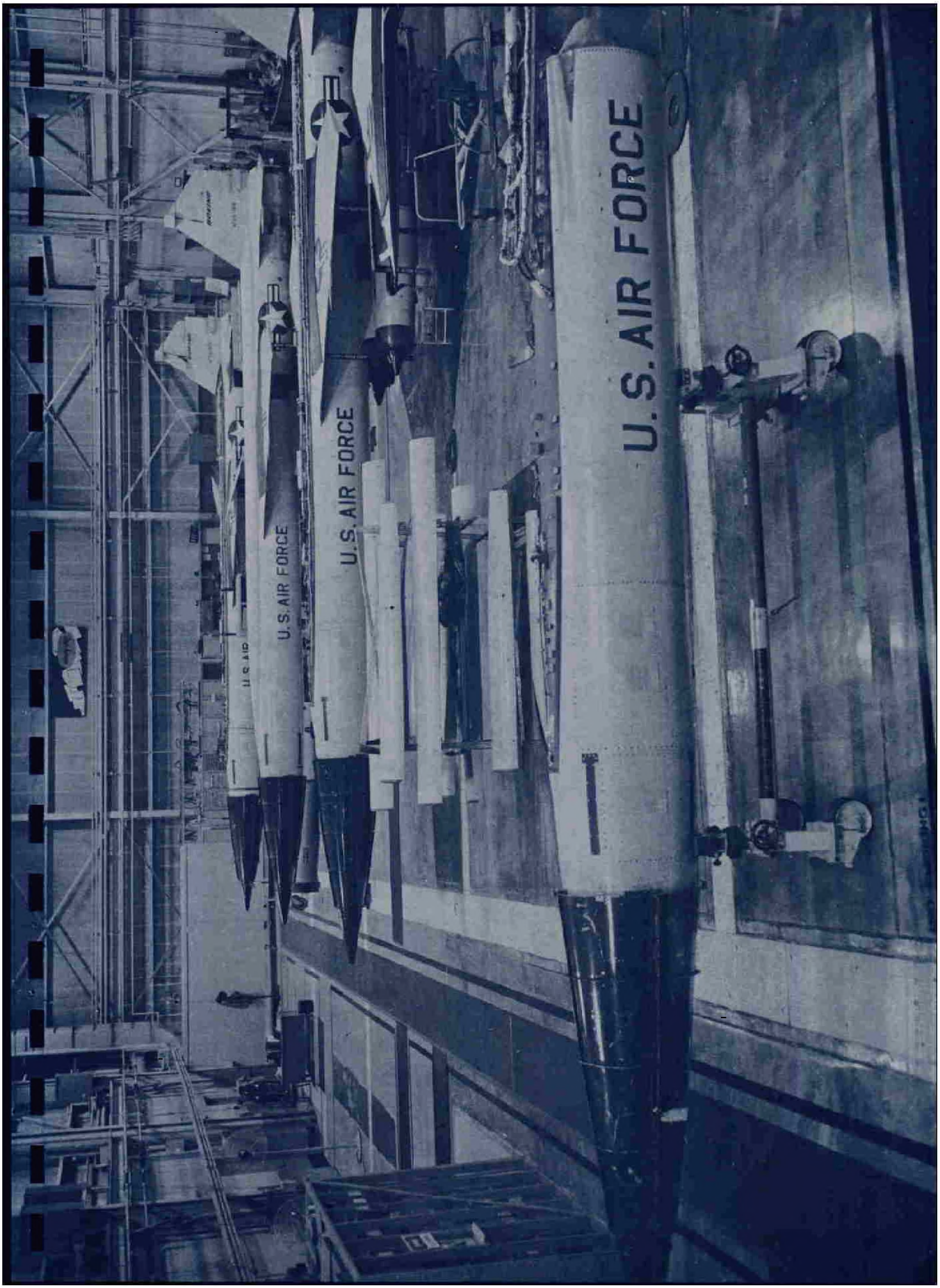
116. Msg MOY 20-1-3, APGC to USAF, 21 Jan 1961 [Doc 579 in Hist of ADC, Jan-Jun 1961]; Msg MOY 14-2-14, APGC to USAF, 15 Feb 1961 [Doc 580 in Hist of ADC, Jan-Jun 1961]; Msg MOY 21-2-18, APGC to USAF, 22 Feb 1961 [Doc 582 in Hist of ADC, Jan-Jun 1961]; Msg MOY 6-3-22, APGC to USAF, 7 Mar



logical explanation for the accident. The cause was determined to be a defective diaphragm in the helium control valve. The grooves in this part had been cut to only a depth of .068 inches instead of the specified .094 inches. This malfunction was not likely to be repeated if the diaphragms were correctly machined. Therefore, since none of the remaining Category III missiles contained helium control valves with diaphragms from the defective lot, another test missile was launched on 26 September 1961. This missile, equipped with special instrumentation to measure helium pressure at various points, performed perfectly, making a direct hit on an inbound supersonic Regulus target at a range of 125 miles and an altitude of 20,000 feet.[117]

Nevertheless, the USAF Deputy Inspector General for Safety recommended, 29 September 1961, that further testing

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[Cont'd] 1961 [Doc 583 in Hist of ADC, Jan-Jun 1961]; Msg MOY 9-3-26, APGC to USAF, 10 Mar 1961 [Doc 584 in Hist of ADC, Jan-Jun 1961]; Msg MOY 17-3-21, APGC to USAF, 18 Mar 1961 [Doc 586 in Hist of ADC, Jan-Jun 1961]; Msg MOY 24-3-38, APGC to USAF, 26 Mar 1961 [Doc 587 in Hist of ADC, Jan-Jun 1961]; Msg MOYU-AM 17-4-20, Eglin Test Br (WADD) to ADC, 19 Apr 1961 [Doc 588 in Hist of ADC, Jan-Jun 1961].

117. Msg PGYI 13-9-68, APGC to USAF, 14 Sep 1961 [Doc 526 in Hist of ADC, Jul-Dec 1961]; NOFORN EX CANADA, Msg 4751 CCR 10013, APGC to USAF, 3 Oct 1961 [Doc 527 in Hist of ADC, Jul-Dec 1961].

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of the IM-99A be halted until there was reasonable assurance that the main helium release valve was safe. The successful launching of 26 September was not regarded as reasonable assurance. The test organization protested that the burst diaphragm was an isolated incident that had occurred only once in 66 launchings from Santa Rosa and was unlikely to happen again. Because of this fact, and since the IM-99A test program was so close to completion, permission to continue was requested. The USAF Inspector General replied that his comment on the situation constituted a recommendation, not a prohibition, and that ADC was free to continue with testing if it was convinced that further testing was safe.[118]

Armed with this somewhat ambiguous clearance from the USAF Inspector General, the test organization attempted another launching on 17 October 1961. Unfortunately, the experience of 8 September was repeated. The missile accepted the boost fire signal and the launch sequence appeared normal until ignition of the boost motor. At this point a large

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118. Msg AFIMS 1-9-19, Dep IG for Safety (USAF) to ADC, 29 Sep 1961 [Doc 528 in Hist of ADC, Jul-Dec 1961]; Msg 4751 CCR 90-387, 4751 AD Wg to Dep IG for Safety (USAF), 29 Sep 1961 [Doc 529 in Hist of ADC, Jul-Dec 1961]; Msg AFIMS 1-10-3, Dep IG for Safety (USAF) to 4751 AD Wg, 3 Oct 1961

cloud of acid fumes was observed and the missile was enveloped in flames. It did not leave the launcher. Investigation revealed that an abnormal amount of helium pressure had been present in the missile and was the cause of the fire and the failure to launch. This incident, coming so soon after the 8 September accident, convinced everybody concerned that there was still something seriously wrong with the boost system of the IM-99A. The test organization noted that this forced the IM-99A tactical units (of which five were operational) to live with a serious problem of unknown proportions. In this connection, it was also noted that a large proportion of the Emergency Unsatisfactory Reports submitted by tactical units involved components of the propulsion system.[119]

While this combination of serious propulsion failures caused ADC to direct a temporary cessation of IM-99A test activities, ADC also asked the Aeronautical Systems Division (ASD) of AFSC for authority to proceed with the launching

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[Cont'd] [Doc 530 in Hist of ADC, Jul-Dec 1961]; Msg ADOOP-WM 2213, ADC to OOAMA, 10 Oct 1961 [Doc 531 in Hist of ADC, Jul-Dec 1961].

119. Ltr, 4751 AD Wg to ADC, "Status of the BOMARC Test Program as of 31 October 1961," 8 Nov 1961 [Doc 532 in Hist of ADC, Jul-Dec 1961].

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of the five missiles remaining in the Category III test inventory on the grounds that suspension of tests for several months for a thorough probe of the boost system would seriously disrupt ADC test plans. ASD agreed to continuation of testing, taking the position that nothing had happened during September or October to prove that there was a design deficiency in the boost system. ASD was convinced that the problems could be traced to the lack of quality control in the manufacture of components. Therefore, Category III testing was resumed 17 November 1961, with the 27th, and last, Category III missile being launched 10 May 1962. One IM-99A test missile was retained for a demonstration of BOMARC capability against the GAM-77 (Hound Dog) missile carried by the B-52 bomber. This demonstration was discussed as early as the autumn of 1961, but, for one reason and another, was delayed for several months. It finally took place on 27 June 1962, but proved nothing, because the IM-99A experienced a power failure during the mid-course portion of the flight and had to be destroyed before the point of interception was reached.[120]

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120. Msg ADOOP-WM 2540, ADC to ASD, 14 Nov 1961 [Doc 533 in Hist of ADC, Jul-Dec 1961]; Msg ASZDBE 15-11-56, ASD to ADC, 15 Nov 1961 [Doc 534 in Hist of ADC, Jul-Dec 1961]; Ltr, 4751 AD Wg to ADC, "Status of the BOMARC Test Program as of 31 May 1962," 11 Jun 1962 [Doc 9 in ADC Historical Study

One-hundred-thirty-four missiles and nearly 10 years were expended in testing the IM-99A. Even so, the IM-99A was not a fully proven weapon, although it had demonstrated the ability to destroy a supersonic target when all sub-systems worked according to specifications.

It took well into 1963 to complete the testing of the IM-99B, however. Only 22 test missiles had been launched by the end of 1960 and at that time there were such misgivings over the percentage of test failures charged to the target seeker, that it was felt necessary to re-design this component. The new target seeker, which was given the complicated name of Low Velocity Target Capability Modified Target Seeker, but was familiarly known as LVT, became available in March 1961 and was first used in a missile launched 30 March. Everything worked well and a subsonic QB-47 was intercepted at 35,000 feet and a range of 205 miles. Satisfaction over the LVT was intensified in May 1961 when five successful missions were accomplished in five tries. Four of the missiles were equipped with LVT. Also, on 23 May, the test

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[Cont'd] No. 18, "Interceptor Missiles, 1962-63," hereafter cited as "ADC Study No. 18"]; Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 30 June 1962," 11 Jul 1962 [Doc 10 in ADC Historical Study No. 18].

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organization managed the first completely successful triple launching in BOMARC history.[121]

Hardly had the concern about the target seeker been dispelled when, in June 1961, an analysis of low altitude missions indicated the possibility of structural failure in the vertical stabilizer of the IM-99B. A campaign to reduce the weight of the IM-99B had resulted in the removal of eight pounds of metal from the rudder and this was suspected as the cause of the sudden rash of structural failures, though Boeing insisted that company tests proved the effect on missile performance was negligible. In view of this conflicting information, ASD directed, 22 June 1961, that missions below 18,000 feet be postponed until the true cause of structural failure could be determined. Six missiles and two months of testing time were devoted to this test within a test. ASD later concluded that the solution to the problem lay in the addition of a mass balance weight

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121. NOFORN EX CANADA, Msg WWXDBE-B 31-3-36, Eglin Test Br (WADD) to USAF, 1 Apr 1961 [Doc 622 in Hist of ADC, Jan-Jun 1961]; IM-99B Status Report No. 55, 17-31 Mar 1961 [Doc 618 in Hist of ADC, Jan-Jun 1961]; NOFORN EX CANADA, Msg WWXDBE-B 26-5-51, Eglin Test Br (WADD) to USAF, 27 May 1961 [Doc 644 in Hist of ADC, Jan-Jun 1961]; IM-99B Status Reports No. 58, 28 Apr-12 May 1961 and No. 59, 12-26 May 1961 [Docs 634 and 635 in Hist of ADC, Jan-Jun 1961].

to the rudder. A test launching of 7 September seemed to indicate the rightness of this modification when a modified missile not only intercepted a QB-47 at an on-the-deck altitude of 1,500 feet and minimum range of 42 miles, but also retained its structural integrity until it hit the water. Action was subsequently taken to modify all IM-99B missiles with the necessary mass balance weights.[122]

Although the target seeker and structural weakness problems were apparently solved, 1961 was not a particularly satisfying year for IM-99B testing. Of 36 missiles launched only 17 had intercepted the target, a success rate of somewhat less than 50 per cent. Category I testing was finished in September 1961 and, although it had been planned that Category II testing would also be finished in 1961, five Category II test missiles remained to be launched at the end of the year.

BOMARC planning in 1950 foresaw the end of missile testing in 1956. The plans of early 1962 were somewhat less optimistic, anticipating the end of the IM-99B test series

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122. Msg ASZDBT 22-6-132, ASD to AFSC, 22 Jun 1961 [Doc 648 in Hist of ADC, Jan-Jun 1961]; Msg ASZDBT 27-6-146, ASD to AFSC, 27 Jun 1961 [Doc 649 in Hist of ADC, Jan-Jun 1961]; Msg ASZDB 4-8-43, ASD to AFSC, 7 Aug 1961 [Doc 547 in Hist of ADC, Jul-Dec 1961]; NOFORN EX CANADA, Msg ASXDBF 3-8-9-9, Eglin Test Br (ASD) to USAF, 9 Sep 1961 [Doc 551 in Hist of ADC, Jul-Dec 1961].

in November 1962, approximately the date when the eight-base BOMARC complex in the United States would become completely operational. The test program which unfolded in 1962 did not follow the pre-conceived plan, however. In the first place, the 1961 program had ended on a note of frustration, because three of the last four test missiles launched in 1961 had failed to complete the mission by reason of a perplexing series of control system malfunctions.

The test organization attacked the problem of flight control anomalies by requiring more stringent pre-launch inspection of test missiles. And in the face of three successful test launches (all Category II) during the first three months of 1962, it appeared that this approach had been appropriate. But the launches of 23 March and 8 April were unsuccessful, because the target seeker and fuze system apparently called for so much electricity that, in both cases. the power system failed. Since both failures followed a similar pattern, testing was ordered halted 11 April 1962 to permit Boeing to look into the situation. The contractor devised a group of 17 tests it conducted on a ground test missile in Seattle, but concluded that no particular subsystem or combination of subsystems was at fault. Boeing

merely recommended that testing be resumed, with more attention being given to missile handling techniques.[123]

Therefore, the 20th, and last, IM-99B Category II test missile was launched 16 May 1962. Whether or not the electrical system would have acted properly was not determined, because the control system put the missile into such a steep climb that the ramjet engines "blew out" only 34 miles from the launch site.[124]

Four more test missiles were launched in June, but only one reached the target. The failures only served to emphasize the fact that something was radically wrong with the electrical system of the IM-99B, especially as it affected the target seeker. The month of July 1962 was spent in a concentrated effort to hunt down the source of the trouble. All target seekers were recycled through the Westinghouse plant in Baltimore to make sure they met specifications.

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123. Msg ASZDBF-ME 24-3-24, Eglin Test Br (ASD) to USAF, 26 Mar 1962 [Doc 18 in ADC Study No. 18]; Msg ASXDBR-ME 30-3-27, Eglin Test Br (ASD) to ADC, 31 Mar 1962 [Doc 19 in ADC Study No. 18]; Ltr, 4751 AD Wg to ADC, "Status of the BOMARC Test Program as of 30 April 1962," 10 May 1962 [Doc 8 in ADC Study No. 18].

124. NOFORN EX CANADA, Msg ASXDBF-ME 18-5-23, Eglin Test Br (ASD) to USAF, 20 May 1962 [Doc 20 in ADC Study No. 18].

The Mobile Inspection Units (MIU) were carefully examined in an attempt to determine why missiles could pass the ground tests and fail in flight. After all this effort, it was particularly disappointing when the launching of 10 August also had to be counted a failure. In this instance the control system directed the missile to a position so far to the right of the QF-104 target that it was not possible to make corrections rapidly enough to give the target seeker a really good chance to acquire the target.[125]

At this point, ADC took direct control of the test program in an effort to bring it to a conclusion by 1 November 1962. ADC directed that test missions be made simpler and that greater effort be made to shorten the time required to process missiles for launching. A progressive testing program was outlined in which the IM-99B would begin with missions against a head-on QB-47 at 35,000 feet, then, when

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125. Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 30 Jun 1962," 10 Jul 1962 [Doc 10 in ADC Study No. 18]; Msg ASZDB 6-7-14, ASD to AFPRO Boeing (Seattle), 6 Jul 1962 [Doc 27 in ADC Study No. 18]; Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 31 July 1962," 10 Aug 1962 [Doc 31 in ADC Study No. 18]; NOFORN EX CANADA, Msg MOBE 14811, Eglin Test Br (ASD) to ADC, 15 Aug 1962 [Doc 34 in ADC Study No. 18].

successful, move to missions against a turning QB-47 target. The third step would be to send the missile against a QF-104 target, augmented with a nine-inch Luneberg lens, head-on at 35,000 feet. The final step would be missions against an unaugmented QF-104, flying head-on at 48,000 feet. The interim program prescribed by ADC was generally accomplished in five test missions flown between 31 August and 17 October 1962.[126]

Testing halted abruptly on the latter date when the Cuban crisis erupted and the SAGE center at Montgomery was needed for active air defense. The crisis ended in December 1962, but testing was not resumed until January 1963. Seven Category III missiles remained to be launched.[127]

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126. Msg ADODC 2231, ADC to MOADS, 23 Aug 1962 [Doc 35 in ADC Study No. 18]; Msg ADODC 2329, ADC to ASD, 31 Aug 1962 [Doc 36 in ADC Study No. 18]; Msg SCSE 28-8-119, AFSC to ASD, 28 Aug 1962 [Doc 37 in ADC Study No. 18]; Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 31 August 1962," 14 Sep 1962 [Doc 40 in ADC Study No. 18]; Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 30 September 1962," 12 Oct 1962 [Doc 44 in ADC Study No. 18]; Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 31 October 1962," 14 Nov 1962 [Doc 47 in ADC Study No. 18].

127. Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 31 December 1962," 9 Jan 1963 [Doc 49 in ADC Study No. 18].

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The emergence of a new problem, however, made it necessary to consume nearly eight months in the launching of seven missiles. The outlines of this latter-day difficulty did not become immediately apparent, however. The launching of 2 January 1963 was the first in the long-delayed BOMARC/ALRI test series. ALRI (Airborne Long Range Input) was an airborne radar platform expected, among other things, to make possible the use of the IM-99B at extremely low altitudes. The ALRI modification had been completed on selected RC-121 aircraft of the Airborne Early Warning and Control (AEW&C) fleet and the time had come to see whether or not the ALRI equipment could actually direct an IM-99B missile in an attack against a low-flying target. From the ALRI standpoint, the first mission was highly successful. The airborne radar acquired the target without difficulty and provided missile position information to the SAGE computer, permitting the interception of a QB-47 flying only 500 feet over the Gulf. The general satisfaction over the performance of ALRI tended to obscure the fact that the target seeker had acted in response to reflections from the water
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as well as reflections from the target.

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128. NOFORN EX CANADA, Msg MOBE 3-1-1, Eglin Test Br (ASD) to USAF, 4 Jan 1963 [Doc 52 in ADC Study No. 18].

Low-altitude testing was then postponed while the IM-99B was tested against a QF-104 that cruised at subsonic speed at 35,000 feet until the missile was launched, then zoomed to an altitude of 55,000 feet and a speed of 1.6 Mach. The first mission of this type failed because of incompatibility between the SAGE control system and the control system of the missile. There was then a delay of nearly a month before compatibility was restored. A high-altitude mission of 13 February 1963 was successful, making it possible to return to low-altitude BOMARC/ALRI testing the following day. The pattern of the 2 January launching was repeated, except that the missile missed the target by a much wider margin. Now, however, the test organization raised the possibility that the target seeker was incapable of low-altitude work. A design deficiency was indicated. On 21 February 1963, therefore, ADC concurred with a MOADS recommendation that Category III launchings of the IM-99B be suspended until the low-altitude deficiency of the target seeker could be thoroughly analyzed. Only two missiles remained in the Category III test inventory and it was thought wise to hold these for use in testing an improved

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target seeker should the development agencies decide that a redesigned target seeker was required.[129]

Early March optimism concerning prompt improvement of the target seeker faded before April concern that the proposed changes might degrade the total capability of the target seeker and May disclosure that conflicting data had been developed by Boeing and Westinghouse. Finally, after four-and-one-half months were consumed in an attempt to provide a target seeker that would be adequate at low altitudes, the next-to-last IM-99B test missile was launched 27 June 1963. Again the target was a QB-47 flying at 500 feet above the surface of the Gulf at a speed of 325 knots. Whether or not the mission was a success became a matter of debate. While SAGE and ALRI cooperated efficiently in positioning the missile, the operation of the modified target seeker was the subject of some differences of opinion. The missile was 1850 feet from the target when the fuze fired and would have theoretically killed the target. Therefore, Boeing concluded that the modified target seeker had solved the problem. The Eglin Test Branch, on the other hand,

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129. Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 28 February 1962," 12 Mar 1963 [Doc 63 in ADC Study No. 18]; Msg ADODC 558, ADC to MOADS, 21 Feb 1963 [Doc 68 in ADC Study No. 18].

contended that not much had changed. While admitting that the modified target seeker was an improvement over the earlier version, the Test Branch was of the opinion that the image problem still remained. During the final phase of the interception the target seeker first locked-on the target's reflection on the water, then on the target, then back to the reflection, making the transfer several times before the missile finally hit the Gulf.[130]

BOMARC testing ended 19 August 1963 when the last IM-99B Category III test missile was launched against a QB-47 flying at 500 feet. As before, SAGE and ALRI performed satisfactorily. The missile apparently hit the water near the planned point of interception. The performance of the improved target seeker (designated as Engineering Change Proposal -- ECP -- 2237) was good enough to gain the approval of the AFSC Configuration Control Board on 29 August 1963. Whenever funds became available, the ECP 2237 target seeker was to be installed in all tactical IM-99B missiles.[131]

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130. NOFORN, Msg PGYI 27-6-19, APGC to USAF, 27 Jun 1963 [Doc 79 in ADC Study No. 18]; NOFORN EX CANADA, Msg MOBE 28-6-10, Eglin Test Br (ASD) to USAF, 28 Jun 1963 [Doc 80 in ADC Study No. 18]; Msg MOB 5-7-2, Eglin Test Br (ASD) to MOADS, 5 Jul 1963 [Doc 81 in ADC Study No. 18]; Msg ADOOP-WM 2642, ADC to Joint BOMARC Test Org, 9 Jul 1963 [Doc 82 in ADC Study No. 18].

131. NOFORN, Msg PGYI 19-8-29, APGC to USAF, 19 Aug 1963 [Doc 84 in ADC Study No. 18]; Msg ADODC 5829, ADC to USAF, 6 Dec 1963 [DOC 73].

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In 11 years of testing -- September 1952 to August 1963 -- the test organization sent aloft 215 test missiles (134 IM-99A and 81 IM-99B).

Another BOMARC milestone was reached in August 1963 when, on the 17th, the Canadian government signed an agreement that permitted the use of nuclear warheads by the IM-99B units at North Bay and La Macaza. This agreement followed a long period of soul-searching in Canada that included the fall of the sitting government. Although Canada had agreed, in 1959, to accept the interceptor missiles, the government of John Diefenbaker in 1962 declined to permit storage of the necessary warheads in Canada although the launch shelters had been built and the missiles delivered. Lester Pearson, leader of the opposition Liberal Party and once opposed to acceptance of nuclear warheads, changed his position and in January 1963 urged acceptance. The political battle was thereby joined and reached a climax at the end of that month when the U.S. State Department charged the Diefenbaker government with welshing on the 1959 agreement. The Diefenbaker government collapsed in February. The subsequent election of 8 April brought the Liberals to power and the

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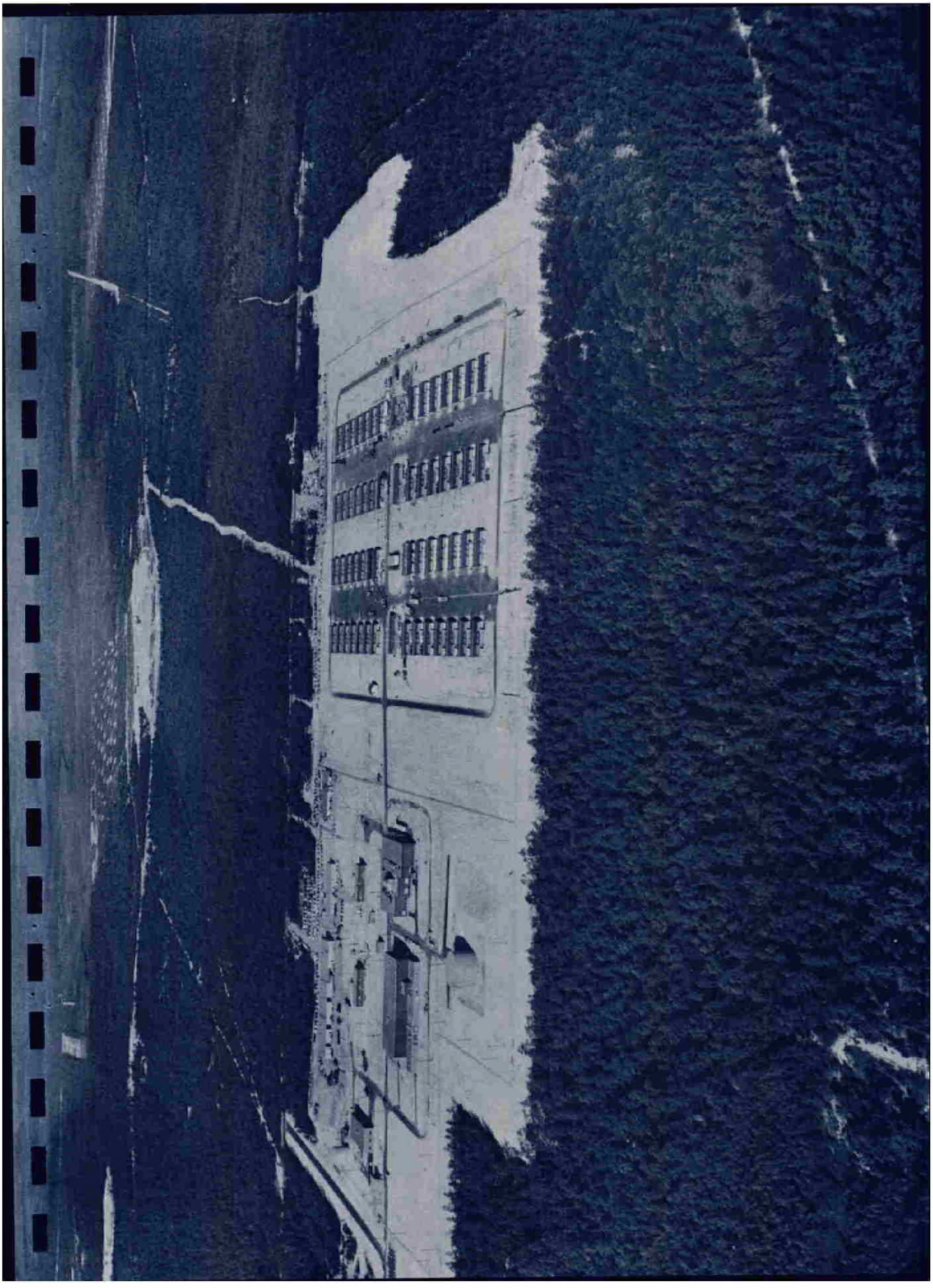

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new agreement was signed 17 August. The Canadian BOMARC squadrons were operationally ready early in 1964.[132]

Yet another historic landmark was reached 21 August 1963 when USAF informed ADC that the Secretary of the Air Force had forwarded to the Department of Defense on 8 July a recommendation that the IM-99A be phased out of the USAF missile inventory during Fiscal 1965. USAF added, on the strength of expected DOD approval, that valuable operating funds could be saved by commencing phase-out actions during Fiscal 1964. The Department of Defense approved the recommended action before the end of August.[133]

ADC did not protest this directive and by mid-September 1963 had prepared a phase-out plan that called for removal of IM-99A missiles from three locations in July-September 1964 and from the two remaining sites before the end of that year. By early November 1963, ADC had prepared a more

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132. Denver Post, 12 Mar 1963; Toronto Globe and Mail, 28 Jun and 18 Aug 1963; Msg ADOOP-WM 5027, ADC to USAF, 18 Sep 1963 [DOC 74]; New York Times, 15 Dec 1963; New York Post, 6 Jan 1964.

133. Msg AFXOPN 88661, USAF to ADC, 21 Aug 1963 [Doc 2 in ADC Study No. 18]; Msg AFOOP-WM 3012, ADC to CONAD, 23 Aug 1963 [Doc 3 in ADC Study No. 18]; Msg AFOAPD 90654, USAF to ADC, 29 Aug 1963 [Doc 4 in ADC Study No. 18].

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detailed plan which foresaw the last operational missiles being removed from their shelters in October 1964. In March 1964, ADC had come around to the position that the sooner the last IM-99A was removed the better. USAF was asked for permission to dispose of the last IM-99A missiles in July. Permission was refused and ADC was instructed to adhere to the earlier schedule which ended IM-99A operations in October. ADC replied, in early April, with a strong reclama that pointed out the savings in money and manpower that would accrue from accelerated disposal of the missile. This proposal was eventually approved by USAF, but not until June 1964, when it was almost too late to get the disposal job completed in July. Nevertheless, the last IM-99A missile was removed from operational status by the 30th Air Defense Missile Squadron at Suffolk County AFB (New York) on 23 July 1964. The first missile had become operational 1 September 1959 at McGuire, giving the IM-99A an operational life of slightly less than five years.[134]

As a footnote to the story of the IM-99A, the General Accounting Office, in a report released in May 1964, alleged

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134. Msg ADODC 5010, ADC to 26 and 30 AD, 17 Sep 1963 [DOC 75]; NOFORN EX CANADA, Msg ADCCS 5493, ADC to USAF, 4 Nov 1964 [DOC 76]; Msg ADOOP 1072, ADC to USAF, 26 Mar 1964 [DOC 77]; NOFORN EX CANADA, Msg ADOOP-WM 1170, ADC to NORAD, 3 Apr 1964 [DOC 78]; NOFORN EX CANADA, Msg ADCVC 1193, ADC to USAF, 6 Apr

that Boeing had overcharged the government $23 millions in connection with the design, development and procurement of the missile through the device of overstating initial target cost estimates. Boeing vigorously denied the GAO allegations, but the GAO report added that the Air Force intended to seek "substantial downward adjustments" when the Boeing contracts were audited.[135]

All launching of BOMARC missiles did not halt when the official test program was completed. In late 1962, when it was apparent that the test program was drawing to a close, ADC decided that the time was appropriate for a decision as to the future status of the Santa Rosa test facility. Three possibilities were considered. The test equipment could be "pickled" and re-opened every 18 months for test launches designed to proof-test missile/SAGE modifications and provide confidence in the tactical BOMARC system as deployed around the northeastern United States. Conversion of Santa Rosa to tactical configuration, thus providing a ninth tactical site within the United States, was also possible. Finally,

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[Cont'd] 1964 [DOC 79]; Msg AFXOPNW 88713, USAF to ADC, 18 Jun 1964 [DOC 80]; Msg ADMDC 2056, ADC to 26 AD, 19 Jun 1964 [DOC 81]; NOFORN EX CANADA, Msg ADODC 2346, ADC to 26 AD, 21 Jul 1964 [DOC 82].

135. ~~Missile/Space Daily~~, 28 May and 1 Jun 1964.

[redacted]

it was possible to retain Santa Rosa in its current status, but on a much reduced scale, to launch perhaps one missile a month. Continuing proof and confidence testing could be conducted in this manner and tactical units could be brought to the Gulf Test Range approximately once a year to maintain their proficiency through actual launch of a missile.[136]

The "pickling" proposal would save money, since it was determined that 174 people would be required to maintain the test facility on a "one-launch-a-month" basis. Also, there was logic in the conversion of Santa Rosa to tactical configuration in view of the threat posed by Cuba, only 90 miles off the Florida coast. In the final analysis, however, it was decided in December 1962 that most would be gained by retaining the test complex as a continuing entity, with tactical BOMARC squadrons alternating in the launching of one missile a month beginning in April 1963. A schedule for the first 15 months of such proof and proficiency testing was drawn up.[137]

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136. Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 31 October 1962," 14 Nov 1962 [Doc 47 in ADC Study No. 18].

137. NOFORN EX CANADA, Msg ADCCS 3405, ADC to APGC, 8 Dec 1962 [Doc 85 in ADC Study No. 18]; Msg ADODC 3557, ADC to USAF, 28 Dec 1962 [Doc 86 in ADC Study No. 18]; Ltr, Det 1, MOADS to ADC, "Status of the BOMARC Test Program as of 31 December 1962," 9 Jan 1963 [Doc 49 in ADC Study No. 18].

The extension of IM-99B Category III testing to August 1963 and the announcement, in the same month, that the IM-99A would be phased out, however, made it impossible to carry out the program outlined in December 1962. A new CEL program for the IM-99B, issued in October 1963, anticipated that each of the six IM-99B squadrons would undertake one CEL mission a year, beginning in November 1963. Two IM-99B missiles had been launched under the terms of the earlier plan, one on 26 July 1963, the other on 19 August. These two missiles were jointly processed by the Joint BOMARC Test Organization and crews from operational squadrons. They were designated as Category III missiles and were used to validate the ECP 2237 target seeker modification. If Canada accepted an invitation to join CEL, both Canadian squadrons would also launch one missile a year, making a total of eight IM-99B launches from Santa Rosa each year.[138]

Crews from operational squadrons, with the assistance of the 4751 Air Defense Squadron (Missile), attempted to launch nine CIM-10B (formerly IM-99B) missiles between November 1963 and the end of 1964. In six instances the missile actually left the launcher. In five the interception

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138. NOFORN EX CANADA, Msg ADCCS 5103, ADC to 73 AD, 26 Sep 1963 [DOC 83]; NOFORN EX CANADA, Msg ADCCS 5171, ADC to USAF, 3 Oct 1963 [DOC 84].

[redacted]

was completed. All targets, whether QF-104, QB-47 or BQM-34A (Ryan Firebee), included augmented radar reflectivity to provide a larger target for the missile target seeker.[139]

This proof and proficiency testing was not accomplished without some attrition among the tactical missiles assigned to ADC. The last of the spare missiles was launched 17 March 1964. In February 1964, ADC asked USAF for permission to remove missiles from tactical sites in order that the CEL program might continue. Blanket approval was not immediately given, although ADC was permitted to move two missiles from Niagara Falls in April in order to meet a June launch date. General approval did not come until June 1964 when USAF informed ADC that the Secretary of Defense had approved the ADC proposal. At the time of this judgement, five of the U.S. squadrons had 28 missiles each. Niagara Falls had 46. The Secretary of Defense directed that the Niagara Falls unit provide the six missiles for CEL purposes in Fiscal Years 1965, 1966 and 1967. This would bring Niagara Falls down to the 28-missile status of the other five sites at the

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139. Msg 4751OOP 30091, 4751 AD Sq to ADC, 30 Sep 1964 [DOC 85]; Msg ADOOP-WM 3167, ADC to USAF, 7 Oct 1964 [DOC 86]; Msg ADOOP-WM 3434, ADC to USAF, 4 Nov 1964 [DOC 87]; Msg 4751OOP 8123, 4751 AD Sq to ADC, 8 Dec 1964 [DOC 88]; Msg 4751OOP 10001, 4751 AD Sq to ADC, 11 Dec 1964 [DOC 89]; Msg ADCCS 4044, ADC to USAF, 21 Dec 1964 [DOC 90]; NOFORN EX CANADA, Msg 4731OOP 10002, 23 Dec 1964 [DOC 91].

end of Fiscal 1967. Then all six BOMARC bases would alternate at providing two missiles at a time until each squadron was reduced to 26 missiles at the end of Fiscal 1969. The Canadian squadrons were expected to furnish their own CEL missiles. Thus, at mid-1964 it appeared that the CEL program would continue indefinitely, although it would impose a considerable loss of tactical capability over the long haul. Under this directive the force structure as it applied to the CIM-10B would decline from 186 at the end of Fiscal 1964 to 132 at the end of Fiscal 1972.[140]

Although the CIM-10A was no longer required in active air defense, there was no thought of selling the early-model BOMARC for junk. By the end of October 1963, about two months after the announcement of the phase-out of BOMARC A, ADC was studying the possibility of using the missile as a target for manned interceptors. It was later decided that 45 CIM-10A's could be used in this manner. Installation of a scoring system and radar augmentation would be necessary, however, to make the CIM-10A an adequate target. In November

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140. NOFORN EX CANADA, Msg ADODC 742, ADC to USAF, 24 Feb 1964 [DOC 92]; Msg ADODC 1376, ADC to USAF, 22 Apr 1964 [DOC 93]; Msg AFXOPNW 88713, USAF to ADC, 18 Jun 1964 [DOC 80]; Msg ADOOP-WM 2610, ADC to 26 and 30 AD, 19 Aug 1964 [DOC 94].

[redacted]

1963, ADC asked USAF to have OOAMA make a feasibility study on this matter, a request that USAF approved the following month.[141]

The Navy reached similar conclusions about the soon-to-be-deactivated CIM-10A, indicating a possible requirement for as many as 160 of the missiles for use as drones. ADC subsequently decided that a BOMARC drone might also be useful in testing an Improved Manned Interceptor and in March 1964 increased its requirement from 45 to 117 of the high-altitude, high-speed targets. USAF approval of the modification of the CIM-10A to drone configuration was also granted in March. It was hoped that the first BOMARC drone would be launched in September 1964, but considerable difficulty was encountered in augmenting the missile to the point where it would present a target 40 square meters in size so that the September date for initial launch could not be met. As of early 1965 it was anticipated that the initial launching of the BOMARC drone would occur 21 January.[142]

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141. Msg ADCCS 5415, ADC to USAF, 28 Oct 1963 [DOC 95]; Msg ADODC 5766, ADC to AFLC, 2 Dec 1963 [DOC 96]; Weekly Activities Report, ADC, ADLPW-A, 30 Oct and 12 Dec 1963 [HRF].

142. Msg ADMSS-OF 9, ADC to USAF, 2 Jan 1964 [DOC 97]; Msg ADLPW 189, ADC to USAF, 17 Jan 1964 [DOC 98]; Msg ADLDC 969, ADC to USAF, 14 Mar 1964 [DOC 99]; Msg ADLPW 1335, ADC to AFLC, 17 Apr 1964 [DOC 100]; Msg ADLPW 2052, ADC to USAF,

The high hopes for BOMARC, expressed in the early fifties, were never realized. Instead of 4,800 missiles deployed at 40 sites, the final BOMARC configuration involved only 10 sites (including two in Canada) and less than 500 missiles. Design and development proved to be much more difficult than anticipated in 1950 and the first missile did not reach operational readiness until September 1959. Because of development difficulties, testing did not end in 1956, as estimated early in the program, but stretched into August 1963. And even after the expenditure of 215 missiles in a test period that lasted nearly 11 years, the BOMARC was still not a highly reliable weapon. It would perform according to specifications if all components operated properly, but was so complex that the all-components-working situation could not be expected more than about half the time. At the end of 1964, the BOMARC A had been retired from the tactical inventory and was about to begin a new half-life as a target drone. Roughly 240 BOMARC B missiles were standing alert at eight sites (including two in Canada) strung around the

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[Cont'd] 19 Jun 1964 [DOC 101]; Msg ADOOP-WM 3324, ADC to OOAMA, 22 Oct 1964 [DOC 102]; Msg ADODC 202, USAF to 73 AD, 20 Jan 1965 [DOC 103]; Weekly Activities Reports, ADC, ADLPW-A, 2 Mar, 27 May and 19 Jun 1964 [HRF].

northeastern United States from Norfolk, Virginia (Langley AFB) to Duluth, Minnesota. Interceptor missiles had not, as once predicted, replaced the manned interceptor. They ended by complementing the manned interceptor force in one corner of the country.

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APPENDIX A

TEST LAUNCHINGS -- IM-99A

(Cape Canaveral)

1. 10 Sep 1952 -- Missile rose 500 feet before gimbaling controls failed. It performed several loops and "other unorthodox gyrations" before it crashed and exploded.
2. 23 Jan 1953 -- Booster failed after only 1.5 seconds of flight. Missile rose 8 feet, then settled back to the ground and exploded.
3. 10 Jun 1953 -- Booster performed satisfactorily and ram-jets ignited, but after 23 seconds of flight a low-order explosion (apparently in the rocket chamber) abruptly ended the flight at 16,000 feet and Mach 1.6.
4. 27 Jul 1953 -- Followed pattern of Test 3. Disintegration after about 20 seconds of flight, at altitude of about 10,000 feet and speed of about Mach 1.5.



[redacted]

5. 4 Sep 1953 -- Followed pattern of Tests 3 and 4. Testing suspended to determine cause of nearly identical failures.

6. 5 Aug 1954 -- Missile flew only 15 seconds before the elevator control malfunctioned and caused violent flight maneuvers that tore the missile apart.

7. 25 Oct 1954 -- Test program changed to exclude ramjets. Only rocket motor and guidance components were being tested. Whether coincidence or not, this was the first successful flight. BOMARC rose to 44,000 feet, reached a speed of Mach 2.45 and covered 34 miles in 8 minutes of flight.

8. 24 Nov 1954 -- Similar test missile also reached an altitude of 44,000 feet, speed of Mach 2.2 and covered 48 miles in 9 minutes of flight.

9. 19 Jan 1955 -- A third non-ramjet missile rose to 74,000 feet, reached a speed of Mach 3.2 and covered 54 miles.

10. 24 Feb 1955 -- Ramjets returned to the test program. This missile flew 106 miles, reached an altitude of 72,000 feet and a speed of Mach 2.4. First successful flight using ramjets.

11. 3 Mar 1955 -- No ramjets. Another success, however. Reached 38,000 feet, Mach 2.4 and distance of 24 miles.

12. 5 May 1955 -- Ramjets used again. Elevator flutter caused rupture of hydraulic line in control system. Loss of control ended flight after 40 seconds. Distance 7 miles. Altitude 37,000 feet and speed Mach 2.3.

13. 27 Jul 1955 -- No ramjets. Oscillation of rudder ended flight after 34 seconds. Distance 8 miles, altitude 32,000 feet, speed Mach 2.6.

14. 25 Aug 1955 -- Ramjets used. Partially successful, even though loss of control beacon ended flight at 137 seconds. Distance 79 miles, altitude 69,000 feet, speed Mach 2.8.

15. 29 Sep 1955 -- Ramjets used in this and all subsequent flights. Completely successful, with all components working well. Distance 94 miles, altitude 62,000 feet, speed Mach 2.7.

16. 17 Nov 1955 -- Another complete success. Distance 68 miles, altitude 62,000 feet, speed Mach 2.8.

[redacted]

[redacted]

17. 30 Nov 1955 -- Third consecutive success. Distance 77 miles, altitude 53,000 feet, speed Mach 2.6. This ended Phase I of the Boeing test program. There was general agreement that the workability of individual components had been proven. The time had come to determine whether or not BOMARC could intercept a target.

18. 14 Feb 1956 -- First attempt to intercept a target -- QB-17 at 28,000 feet and 185 knots. Unexplained loss of 250-volt power after 50 seconds caused destruction of missile and failure of mission.

19. 15 Mar 1956 -- Similar mission, but successful. Near miss at 62 miles and 28,000 feet.

20. 14 Apr 1956 -- Similar mission, but head-on attack on QB-17. Other two were tail chases. Miss distance of 90 feet at 55 miles and 28,000 feet.

21. 21 May 1956 -- Failure when explosion in rocket chamber of missile ended flight after 29 seconds. Altitude 17,000 feet.

[redacted]

22. 19 Jun 1956 -- Failure of similar mission against QB-17 when target seeker failed, sending missile away from target. Missile destroyed after 211 seconds of flight.

23. 13 Jul 1956 -- Successful. Missile passed within 25 feet of QB-17 at 59 miles and 28,000 feet. Boeing was now convinced that it had proved the BOMARC could hit a moving target.

24. 12 Oct 1956 -- This was the first of a series of tests to determine whether GPA-35 (ground control equipment to be used with BOMARC until SAGE was ready) could control BOMARC interceptions. Target was the 185-knot QB-17 at 25,000 feet. Tail-chase interception resulted in miss distance of 1,000 feet at 75 miles and 28,000 feet.

25. 29 Nov 1956 -- First successful 90-degree crossing course (right to left) interception. Missile passed within 9 feet of QB-17 at 75 miles and 26,000 feet.

26. 3 Jan 1957 -- Similar mission failed when a valve in a ramjet malfunctioned 2 seconds after the booster burned out. Missile destroyed after 28-mile flight.

[redacted]

27. 13 Feb 1957 -- This time the QB-17 maneuvered, but the mission failed when the target seeker malfunctioned at 198 seconds. Missile hit water after 3.8 minutes of flight. Distance unknown.

28. 28 Feb 1957 -- Similar mission failed because of another target seeker malfunction. Missile destroyed at 91 miles.

29. 17 Apr 1957 -- Another similar mission failed when missile exploded after 37 seconds of flight because of the loss of the ceramic liner from the throat of the rocket. This was the last of the GPA-35 tests. GPA-35 performed perfectly, but the BOMARC did not.

30. 22 Jul 1957 -- First of a series of tests to determine the reliability of fuze and warhead. Target was a maneuvering QB-17 at 20,000 feet. Mission failed when extraneous radar pulses caused missile to destroy itself only 13 miles from launch site.

31. 15 Aug 1957 -- Target was a maneuvering QB-17 at 28,000 feet. Target seeker malfunction caused missile to miss target by 4,000 feet. Missile destroyed at 85 miles.

32. 16 Sep 1957 -- First use of the QF-80 drone, flying at 350 knots and maneuvering. Most successful BOMARC flight to date. Missed target by 6 feet at 90 miles and 30,000 feet.

33. 27 Sep 1957 -- Tail-chase of a non-maneuvering QB-17 at 28,000 feet. First test of a live (high explosive) warhead. Mission failed because one ramjet failed. Missile destroyed at 84 miles.

34. 11 Oct 1957 -- Similar mission was successful when missile made a direct hit on the target at 105 miles and 28,000 feet. Longest range achieved to date.

35. 23 Oct 1957 -- Low altitude, close-in interception of a crossing-course QB-17. Direct hit at 45 miles and 12,000 feet.

36. 14 Nov 1957 -- Close-in, head-on mission against a QB-17. Missile would not accept mid-course commands from GPA-35 and drifted 13,000 feet off course. Destroyed at 66 miles.

37. 9 Dec 1957 -- Same mission failed again, because the GPA-35 computer was confused by radar noise and was guilty of a large error in estimating target and missile position. Missile hit water at 45 miles.

38. 14 Jan 1958 -- Same mission failed again. GPA-35 commanded dive at 124 seconds, but missile did not dive until 136 seconds. The drone was then outside the target envelope of the target seeker. Missile destroyed at 79 miles.

39. 20 Mar 1958 -- Long range (162 miles) mission against QB-17 failed when the ramjets flamed out at 92 miles.

40. 2 Apr 1958 -- Same mission, but even longer -- 180 miles. Failed because of target seeker malfunction. Missile destroyed at 186 miles. Longest flight to date.

41. 1 May 1958 -- Same mission failed because of battery failure. Missile destroyed at 197 miles. Longest flight to date.

42. 20 May 1958 -- Close-in, low altitude (11,000 feet) mission against 350-knot QF-80. Miss distance 400 feet.

43. 9 Jun 1958 -- Interception of a weaving, head-on QB-17 at medium range (114 miles). Miss distance 2 feet.

44. 20 Jun 1958 -- Similar mission, but the QB-17 followed a 90 degree crossing course 115 miles down-range. Miss distance 7 feet.

45. 26 Jun 1958 -- Similar mission, with QB-17 at 100-mile range. Completely successful, with miss distance of 4 feet.

46. 11 Jul 1958 -- Same mission failed because of failure of flight control system. Missile destroyed after 128 seconds of flight.

47. 7 Aug 1958 -- First test using SAGE. Target was a QB-17 at 80 miles and 30,000 feet. Head-on approach. Failed because of a malfunction in the missile command system. SAGE got split radar returns and had to turn ground control over to GPA-35. Missile lost to radars at 180 miles. This was first missile completely processed and readied for flight by Air Force personnel.

48. 15 Aug 1958 -- Similar mission. SAGE worked well and missile made a direct hit on QB-17 at 78 miles.

49. 21 Aug 1958 -- Mission against a QB-17 on a crossing course at 100 miles and 30,000 feet. Miss distance 2 feet, but primary fuze did not fire.

[redacted]

50. 3 Sep 1958 -- Long range (160 miles) mission against a QB-17. Failed because an anomalous signal told the missile to pitch down at the wrong time. Missile destroyed at 54 seconds.

51. 24 Sep 1958 -- Head-on interception of a supersonic X-10 drone at 48,000 feet. Failed because SAGE did not receive data for the last 72 seconds of the mid-course phase and directed the missile too far to the right of the target. First attempt to intercept a supersonic target.

52. 21 Oct 1958 -- First half of first "double shoot." First missile missed the QB-17 only 4 feet, but primary fuze did not fire.

53. 21 Oct 1958 -- Second missile made a direct hit on the QB-17 at 159 miles and 31,000 feet.

54. 21 Nov 1958 -- Crossing interception of a QF-80 at 100 miles and 20,000 feet. Miss distance 10 feet.

55. 13 Dec 1958 -- Similar mission against a QF-80 at 146 miles and 30,000 feet. Miss distance less than 200 feet, but the fuze did not fire and the high-explosive warhead did not detonate.

[redacted]

56. 19 Dec 1958 -- Missile sent against a QB-17, but switched at 162 seconds to a QF-80, requiring a 60 degree change in heading. Transfer was made successfully and missile missed the QF-80 by 10 feet, but the fuze did not fire.

57. 24 Dec 1958 -- Mission against a course-changing QF-80. Failed because of malfunction of missile command system. Missile began to roll excessively at 281 seconds and was subsequently destroyed.
(Santa Rosa Island)

58. 15 Jan 1959 -- First launching from Santa Rosa Island. Head-on interception of a QF-80 at 78 miles and 25,000 feet. Direct hit.
(Cape Canaveral)

59. 27 Jan 1959 -- Target was a maneuvering QF-80 at 108 miles and 30,000 feet. Failed because the target seeker did not acquire the target.

60. 27 Jan 1959 -- Head-on attack on a QF-80 at minimum range (45 miles) and minimum altitude (10,000 feet). Direct hit.

(Santa Rosa Island)

61. 28 Jan 1959 -- Head-on interception of a QB-80 at 100 miles and 30,000 feet. Believed a near miss, although telemetry was lost at 130 seconds.

62. 28 Jan 1959 -- Minimum range interception of a QF-80. Miss distance 11 feet, but primary fuze malfunctioned.
(Cape Canaveral)

63. 13 Feb 1959 -- Head-on interception of two QB-17's flying in formation 600 feet apart. Failed because missile got off course due to imbalance of the azimuth gyro about its precession axis.
(Santa Rosa Island)

64. 27 Feb 1959 -- Interception of a QF-80 turning so as to present a quartering head-on attack at 55 miles and 10,000 feet. Failed because the target seeker locked-on clouds above the drone.
(Cape Canaveral)

65. 4 Mar 1959 -- Crossing course interception of a QF-80 at 146 miles and 30,000 feet. Miss distance of 50 feet, but the fuze did not fire with

[redacted]

[Cont'd]
enough strength to detonate the warhead. Fuze looked at the rear aspect of the drone, which was not a large enough target to fire the fuze at full strength.
(Santa Rosa Island)

66. 6 Mar 1959 -- Crossing course interception of a QF-80 at 140 miles and 30,000 feet. Failed because of an error in the computer program used by the GPA-35. The missile was launched on a 173-degree course rather than the required 150-degree course.
(Cape Canaveral)

67. 31 Mar 1959 -- Two QB-17 targets with 400-foot separation. Missile passed within 100 feet of the slave drone, but the warhead did not detonate.
(Santa Rosa Island)

68. 13 Apr 1959 -- Two QF-80 drones were supposed to be countered by missiles launched 12 seconds apart. First missile malfunctioned on the ground and was not launched. Antenna on the second missile acted irrationally and produced a miss distance of two miles.

[redacted]

69. 13 Apr 1959 -- This was a second attempt at a "double shoot." Again the first missile failed to launch, but the second went aloft 12 seconds later. GPA-35 lost contact with the guidance beacon after 100 seconds and the results were uncertain.
(Cape Canaveral)

70. 21 Apr 1959 -- The target was a QB-17. Interception appeared successful, but radar plots did not give accurate range and altitude.
(Santa Rosa Island)

71. 24 Apr 1959 -- This was the first of four launchings scheduled for the same day. All four targets were QF-80's at 35,000 feet and ranges of 75 to 100 miles. This missile rose only 8 feet above the shelter before settling back, causing considerable damage.

72. 24 Apr 1959 -- Second missile got erroneous instructions from SAGE and dived early.

73. 24 Apr 1959 -- The target seeker of the third missile never achieved lock-on and was destroyed.

74. 24 Apr 1959 -- Fourth missile intercepted the QF-80 with a miss distance of less than 250 feet at a range of 73 miles.

[redacted]

75. 4 Jun 1959 -- First launching in the SAGE/BOMARC demonstration. Also first mixed operation involving manned and unmanned interceptors. Targets were QF-80 drones. The IM-99A made a direct hit at 100 miles. An F-101B made a successful interception of the second drone.

76. 24 Jun 1959 -- Second SAGE/BOMARC demonstration mission involved a double launch with QF-80 drones 18 miles apart and missiles launched 30 seconds apart. First missile made a near miss at 100 miles and 26,000 feet.

77. 24 Jun 1959 -- Second missile also achieved a near miss at 103 miles and 25,000 feet.

78. 3 Sep 1959 -- Target was a supersonic Regulus II. Interception made at 125 miles. First interception of a supersonic target.

79. 10 Sep 1959 -- Target was a Regulus II. Ramjets failed after only 110 seconds and the missile was destroyed 70 miles downrange.

80. 17 Sep 1959 -- Direct hit on a Regulus II at 140 miles. Second successful interception of a supersonic target.

[redacted]

81. 25 Sep 1959 -- The Regulus was again the target. SAGE operated well, but the interception was not made. No reason given.

82. 25 Sep 1959 -- Second part of a "double shoot." Missile was originally committed to a different target, but was recommitted in mid-course to a Regulus. SAGE operations were successful, but interception was not made. No reason given.

83. 9 Oct 1959 -- The missile was successfully launched, but was destroyed after only 15 seconds of flight because of extreme oscillation.

84. 11 Feb 1960 -- Target was a QF-80 at 100 miles. The missile was slightly erratic during the climb-out phase, then engaged in increasingly erratic maneuvers. Destroyed 50 miles from launcher. Cause was failure of yaw rate gyro.

85. 26 Feb 1960 -- Similar mission. Missile passed within 150 feet of the QF-80, but the fuze did not fire.

86. 12 May 1960 -- This was the first missile of the first successful "triple shoot" in BOMARC history. A Regulus was intercepted at 150 miles.

87. 12 May 1960 -- The second missile intercepted a QF-80 at 125 miles.

[redacted]

88. 12 May 1960 -- The third missile was launched at the same target, but was destroyed after a flight of 22 miles because the ramjets failed to light.

89. 18 May 1960 -- This was the first missile of another successful "triple shoot." A Regulus was intercepted at 150 miles and 43,000 feet.

90. 18 May 1960 -- The second missile was sent after the same Regulus target and made a second interception at 78 miles and 43,000 feet.

91. 18 May 1960 -- The third missile made a direct hit on a QF-80 at 102 miles and 30,000 feet.

92. 27 May 1960 -- The missile was originally launched against a QF-80 flying at 30,000 feet. When 75 miles out, an attempt was made to recommit the missile against a Regulus flying a course parallel to the QF-80, but at 19,000 feet. SAGE rejected the recommitment as impossible in view of existing missile-target geometry, so the missile completed the interception of the QF-80 at 125 miles.

93. 27 May 1960 -- Another missile was launched against a Regulus and made the interception at 75 miles and 19,000 feet.

94. 2 Jun 1960 -- Another recommitment mission. The missile was launched against a QF-80 at 30,000 feet. At 75 miles it was recommitted against a Regulus, this time flying at 43,000 feet. This was accomplished and the Regulus was intercepted at 121 miles.

95. 2 Jun 1960 -- A second missile was launched against the QF-80 of the earlier mission, but failed to make the interception because of a malfunction in the airborne command equipment.

96. 9 Jun 1960 -- Targets were two QF-80 drones stacked at 23,000 and 35,000 feet with a 12,000-foot horizontal distance between the two targets. The missile intercepted the lead drone at 115 miles and 23,000 feet. Discrimination was good.

97. 9 Jun 1960 -- Target was a QF-80 at 20,000 feet. The missile made the required 45-degree turn into the target and made a direct hit at 42 miles.

98. 16 Jun 1960 -- Target was an outbound QF-80 at 35,000 feet. Interception was made at 31 miles in a successful test of minimum range capability.

99. 24 Jun 1960 -- Intended as a test of the missile's ability to intercept a particular target in an area of many targets. But, because of a malfunction in the flight control system, the missile climbed almost vertically to 70,000 feet and the ramjets blew out after only 4 seconds. The missile was destroyed at 24 miles.

100. 24 Jun 1960 -- Intended to test missile capability against a descending low altitude target. A QF-80, inbound at 30,000 feet, was to descend 1,600 feet per minute, beginning six minutes before launch. The missile was within about 2,000 feet of the target when the missile was destroyed by means of low-altitude self destruction. This occurred at about 10,000/12,000 feet.

101. 28 Jul 1960 -- Minimum range, minimum altitude mission against a QF-80. The missile was launched 14 degrees left of the commanded azimuth and never managed interception.

102. 5 Aug 1960 -- An attempt to evaluate the T-3019 fuze against a specification-size (QB-47) target. Interception occurred at 35,000 feet and 150 miles, but only secondary fuze action was observed.

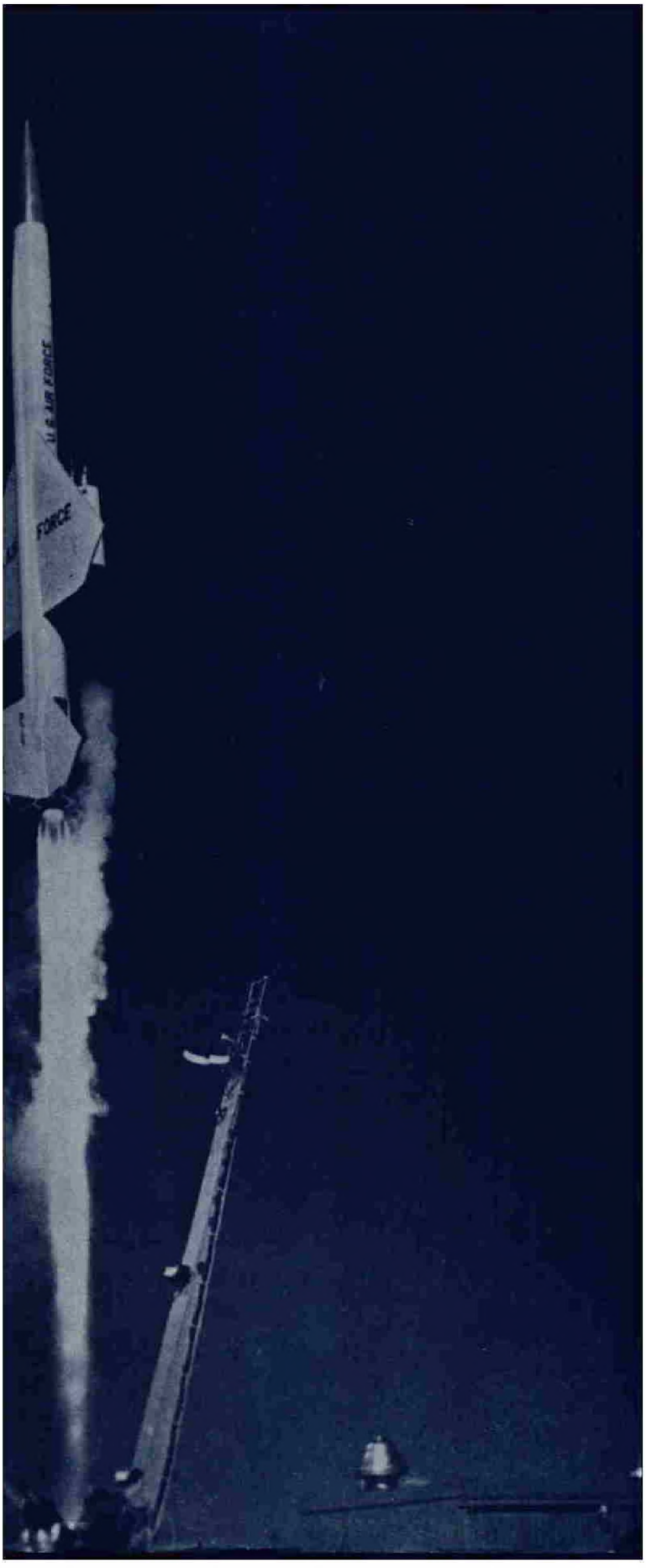
103. 11 Aug 1960 -- Similar mission, with similar results, except that primary fuze action was observed.

104. 11 Aug 1960 -- Similar mission with results duplicating those of the earlier mission of this date.

105. 18 Aug 1960 -- Target was a QB-47. The missile made a direct hit at 135 miles and 15,000 feet, but the ECM portion of the test was not conducted because of the malfunction of ECM equipment on the drone.

106. 19 Aug 1960 -- Target was a Regulus II at Mach 1.5 and 46,000 feet. The missile had been boosted to 67,000 feet when the guidance beacon failed. No interception.

107. 17 Jan 1961 -- First Category III launching. Another test of fuze against a specification (AB-47) target. Missile made a direct hit at 125 miles and 35,000 feet.

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108. 9 Feb 1961 -- Target was a QF-80 at 20,000 feet and 125 miles. SAGE successfully directed missile to target. Miss distance 75 feet.

109. 16 Feb 1961 -- First part of double shoot. Target was a QF-80 at 35,000 feet and 125 miles. Direct hit.

110. 16 Feb 1961 -- Second missile was directed at a Regulus, but was destroyed after 200 feet of flight when boost rocket controls failed.

111. 2 Mar 1961 -- Target was a QB-47 at 35,000 feet and 150 miles. Miss distance less than 50 feet. Guidance beacon failed, but missile was tracked perfectly by radar skin paint.

112. 3 Mar 1961 -- Target was Regulus, but interception failed because a malfunction in the rocket boost motor caused the ramjets to flame out. Missile destroyed at 75 miles.

113. 14 Mar 1961 -- Missile made a direct hit on a QF-80 at 35,000 feet and 125 miles. Direct hit was unfortunate in that it destroyed the last "C" band-equipped QF-80 available to the test organization.

114. 21 Mar 1961 -- Target was a QF-80 at 20,000 feet and 125 miles. Missile climbed slowly because of low rocket thrust. Then fire broke out in aft section and missile crashed about a half-mile from the launcher. Cause discovered to be helium starvation.

115. 28 Mar 1961 -- Direct hit on a Regulus II flying at Mach 1.08 at 35,000 feet and 125 miles.

116. 4 Apr 1961 -- First missile of a "triple shoot." Target was a QF-80 at 20,000 feet and 125 miles. The missile passed within 100 feet of target, but the primary fuze did not fire because of an arming programmer malfunction.

117. 4 Apr 1961 -- Second missile did not accept or act on any commands and failed to make an interception.

118. 4 Apr 1961 -- Third missile failed to act consistently in response to SAGE commands and altitude destruction package did not work. Missile missed interception and hit water 115 miles from launcher.

119. 20 Apr 1961 -- Direct hit on QF-80 at 35,000 feet and 125 miles.

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120. 4 May 1961 -- Target was a Regulus II, but interception was missed because SAGE gave the missile the wrong intercept points and missile dive time was delayed 11 seconds. Missile destroyed 122 miles downrange.

121. 23 May 1961 -- Another mission against a Regulus failed because control of the drone was lost just before the missile was launched.

122. 31 May 1961 -- Direct hit on QF-80 at 20,000 feet and 125 miles.

123. 13 Jun 1961 -- Target was a Regulus at Mach 1.08, 20,000 feet and 120 miles. Miss distance about 50 feet. Mission significant in that the drone was not augmented and offered a target of only 7.5 square meters, about 2.5 square meters below specifications. This indicated that the IM-99A should be able to kill an air-to-surface missile.

124. 22 Jun 1961 -- Target was a QF-80 at 35,000 feet and 125 miles. Missile passed within 250 feet of the target and the primary fuze fired.

125. 29 Jun 1961 -- Target was a Regulus at 660 knots, 35,000 feet and 125 miles. Missile passed within 50 feet of target, but primary fuze did not

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fire. This was a mixed mission with F-102A aircraft also in the area. An F-102A successfully intercepted a T-33 within 30 seconds of the IM-99A interception.

126. 1 Aug 1961 -- Target was a maneuvering Regulus at Mach 1.08, 20,000 feet and 120 miles. The missile passed within 75 feet of the target, but fuze action was not determined.

127. 29 Aug 1961 -- A Regulus was again the target, but the missile acted erratically and ramjets blew out. Missile destroyed 25 miles from the launcher.

128. 8 Sep 1961 -- The missile fell back into launcher immediately after launch and the resulting fire extensively damaged the shelter.

129. 26 Sep 1961 -- Target was a maneuvering Regulus, inbound at Mach 1.15, 20,000 feet and 125 miles. Direct hit.

130. 26 Sep 1961 -- Target was a QF-104 at Mach 1.15, 35,000 feet and 120 miles. Miss distance of 50 feet.

[redacted]

131. 22 Nov 1961 -- Similar target, but power within the missile failed after 20 seconds of flight and the missile was destroyed.

132. 1 Feb 1962 -- Similar mission, but against an unaugmented QF-104. Direct hit. This missile was processed by Air Force personnel from the BOMARC site at Langley AFB, Virginia.

133. 10 May 1962 -- Target was a QF-104 at Mach 1.08, 20,000 feet and 120 miles. Because of malfunctions in the flight control system, the missile missed the target by 1,700 feet, too far away for the proximity fuze to react.

134. 27 Jun 1962 -- This was the much-delayed IM-99A/GAM-77 (HOUND DOG) demonstration. A power failure during the mid-course phase of flight, however, made it necessary to destroy the IM-99A after 306 seconds in the air. It was, therefore, not a valid demonstration. This ended IM-99A testing.

APPENDIX B

TEST LAUNCHINGS -- IM-99B

(Cape Canaveral)

1-5. Sep-Dec 1959 -- All five launchings were failures because of ramjet malfunctions. No targets were used.

6. 30 Jan 1960 -- Missile veered off course shortly after launching and plunged into the Atlantic. The flight control system was at fault.

7. 14 Mar 1960 -- Seventh consecutive failure. The ramjets failed again.

(Santa Rosa Island)

8. 13 Apr 1960 -- First launching from Santa Rosa Island resulted in first successful flight. Missile climbed to 65,000 feet, transitioned to 40,000 feet, then reached a computed intercept point. Missile destroyed at 150 miles, the limit of range instrumentation. No target was involved.

9. 17 May 1960 -- Another successful flight. Missile was fueled for 204 miles, but actually flew 236 miles. No target.

10. 8 Jul 1960 -- First IM-99B mission involving a target, which was a Regulus at Mach 1.2 and 35,000 feet. Interception was made at 148 miles. Miss distance was 2,000 feet, but the fuze operated.

11. 11 Aug 1960 -- Boost phase of launching was normal, but the missile received no mid-course commands and terminal dive occurred 15 miles west of the target and 125 miles downrange.

12. 23 Aug 1960 -- Another failure caused by inability of missile to receive mid-course commands. Missile missed target by 25 miles.

13. 14 Oct 1960 -- This was first test of full IM-99B range. No target. Missile control successfully handed over to MacDill AFB Ground-to-Air Transmitter (GAT) at 250 miles. Flight terminated at 282 miles, whether because of fuel exhaustion or low-altitude self-destruction not determined.

14. 28 Oct 1960 -- Mission was not completed when the missile turned north toward the Florida land mass rather than southwest over the Gulf. Missile destroyed immediately. Cause of erratic action not determined.

15. 2 Nov 1960 -- Another incomplete mission. Missile operated properly until after it had transitioned from 72,000 to 42,000 feet. It then turned hard left toward the Florida coast and was destroyed when it crossed the destruction line west of Clearwater, Florida. The missile did not process commands from the MacDill GAT. Cause of malfunction unknown.

16. 17 Nov 1960 -- Second test of the IM-99B range. No target. Missile flew as programmed, dropping into the Gulf at 256 miles. Both GAT's successfully controlled the missile.

17. 23 Nov 1960 -- Target was a Regulus at Mach 1.8, 48,000 feet and 110 miles. Missile was to zoom upward from altitude of 40,000 feet. Mission failed because the target seeker did not work. Total flight covered 210 miles.

18. 2 Dec 1960 -- Target was a QB-47 at Mach .75 and 35,000 feet. Again the target seeker did not work and the interception was not completed. Also, SAGE control was lost at 335 seconds and not regained until 141 seconds later. By then the missile was past the target. Total flight covered 250 miles.

19. 16 Dec 1960 -- This was first missile of the first IM-99B "double shoot." Target as above. Target seeker worked this time and the interception was considered completed when the missile passed within 3,000 feet of the target.

20. 16 Dec 1960 -- The second part of the double shoot was not successful, since the target seeker failed again. The guidance transponder within the missile also failed, the missile being tracked during the entire flight by skin track alone. Total flight covered 298 miles.

21. 22 Dec 1960 -- Target was a QF-80 at 25,000 feet and 115 miles. The missile did not receive pre-launch commands and took a heading of 137 degrees rather than the planned 170 degrees. SAGE began correcting the heading at 73

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seconds, but the missile turned so sharply the ramjets blew out. No interception.

22. 28 Dec 1960 -- Mission was against a QB-47 at Mach .75, 20,000 feet and 250 miles. Interception was made at 142 miles. Range was shortened because the New Orleans FAA would not approve use of a lengthened corridor at the time required.

23. 20 Jan 1961 -- Intended mission was interception of a QB-47 at 35,000 feet and 300 miles. Because of faulty shelter alignment the missile crossed the eastern limit of the range at 282 miles and 68,000 feet and had to be destroyed. No interception.

24. 31 Jan 1961 -- First Category II missile and first of seven Contractor Functional Demonstration (CFD) missiles. Successful mission against a Regulus at Mach 1.2, 40,000 feet and 225 miles. Miss distance 60 feet.

25. 31 Jan 1961 -- Second missile of a "double shoot." Category I. Target was a QB-47 at Mach .75, 35,000 feet and 300 miles. Because of drone control problems, interception was made at 268 miles. Miss distance 60 feet.

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26. 14 Feb 1961 -- Similar mission, also Category I, with interception made at 300 miles. Miss distance 500 feet.

27. 2 Mar 1961 -- Category I close-in mission against a QB-47 at 40 miles and 35,000 feet failed because of erratic target seeker operation.

28. 10 Mar 1961 -- Second Category II mission involved a QB-47 at 35,000 feet and 250 miles. No interception was achieved because of a malfunction in the target seeker clutter calibration circuitry.

29. 23 Mar 1961 -- Target was a Regulus at Mach 1.5, 55,000 feet and 260 miles. Category I. Because of faulty drone positioning, the missile and drone did not pass within 20 miles of each other. After the missed interception the missile zoomed to 106,000 feet and finally hit the water at 392 miles.

30. 30 Mar 1961 -- Target was a QB-47 at Mach .75, 35,000 feet and 200 miles. Category I. Interception at 205 miles. Miss distance 20 feet.

31. 14 Apr 1961 -- Low-altitude, close-in mission (1,500 feet, 40 miles) against a QB-47. No interception because of erratic operation of the target seeker.

32. 18 Apr 1961 -- First missile of the first IM-99B "triple shoot." Category I. Target was a Regulus at Mach 1.5 and 55,000 feet. Interception was missed because the Regulus was flown at 40,000 feet and SAGE had programmed interception at 55,000 feet.

33. 18 Apr 1961 -- Second missile of triple shoot and third Category II launching. Left ramjet failed to light and the missile hit the water 21 miles from shelter.

34. 18 Apr 1961 -- Third missile of triple shoot. Category I. Successful interception of a QB-47 at Mach .75, 35,000 feet and 200 miles. No precise measurement of miss distance.

35. 26 Apr 1961 -- Fourth Category II launching failed to complete mission when left ramjet again failed to light. The missile hit the water 23 miles from launch site.

36. 2 May 1961 -- Target was an inbound Regulus at 55,000 feet and 125 miles. Category II. Mission failed because a malfunction in the velocity acquisition circuitry of the target seeker did not permit lock-on.

37. 11 May 1961 -- Target was a QB-47 at 35,000 feet. Category I. The missile, in a head-on attack, missed the target by 25 feet.

38. 23 May 1961 -- This was the first missile of a "triple shoot." Target was a QB-47 at Mach .75, 20,000 feet and 175 miles. Category II. Miss distance 40 feet. Actual range was 163 miles. This was the first use of the low velocity target seeker (LVT) in a Category II missile.

39. 23 May 1961 -- Second missile of the triple shoot. Target was a QB-47 at Mach .75, 35,000 feet and 50 miles. Category I. Miss distance 25 feet.

40. 23 May 1961 -- Third missile of the triple shoot. Category II. Target was a Regulus at Mach 2, 55,000 feet and 125 miles. Miss distance was only 75 feet, although the spotting

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charge fired early and the right ramjet blew out 20 seconds before interception.

41. 25 May 1961 -- Target was low, slow and close -- QB-47 at Mach .60, 10,000 feet and 70 miles. Category II. Miss distance 86 feet. This was the last launching of the Contractor's Functional Demonstration. Of seven CFD launchings, four missiles made successful interceptions.

42. 22 Jun 1961 -- Target was a QB-47 at Mach .75, 35,000 feet and 255 miles. Category II. Mission failed, because the missile destroyed itself at 235 miles. A short circuit apparently activated the fail/safe mechanism.

43. 13 Jul 1961 -- Test of the low-altitude structural stability of the missile. Category II. Target was a QB-47 at Mach .60, 5,000 feet and 50 miles. The missile apparently exploded before interception. This may have been due to structural failure, but Boeing insists this was not true. Results were inconclusive.

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44. 13 Jul 1961 -- First Category III test mission. Target was a Regulus at Mach 1.2, 48,000 feet and 125 miles. Miss distance 20 feet, but fuze did not fire.

45. 27 Jul 1961 -- Second Category III missile and another check on the tail flutter problem. Target was a QB-47 at Mach .75, 20,000 feet and 150 miles. Interception was completed with miss distance of 75 feet and fuze fire, but missile apparently broke up one second after interception.

46. 27 Jul 1961 -- Another test of the flutter problem, using a Category I missile. The QF-80 drone aborted, but the missile was sent against a simulated QF-80 at Mach .60, 12,000 feet and 50 miles. Instrumentation on the vertical fin and rudder showed severe vibration. The missile seemed to have serious structural problems at low altitudes.

47. 14 Aug 1961 -- Still another test of the flutter problem, involving a Category III missile. Target was a QF-80 at Mach .60, 5,000 feet and 50 miles. The missile operated erratically from the moment of launch, because the proper

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corrections had not been made in the ailerons. Destruction was ordered when the missile was only 4.5 miles from the launcher and debris fell within 1.5 miles of Santa Rosa Island.

48. 17 Aug 1961 -- Similar test against a QB-47 target. Category II. The missile made a direct hit on the QB-47 at 50 miles. Because of the direct hit the effect of the mass balanced rudder on structural stability of the missile was not shown, although it appeared likely that added stability made the direct hit possible.

49. 7 Sep 1961 -- The last Category I missile was used in another stability test. Target was a QB-47 at Mach .50, 1,500 feet and 42 miles. Miss distance 200 feet, without flutter. Problem apparently solved.

50. 19 Sep 1961 -- Target was a Regulus at Mach 1.2, with the missile to make a final "button-hook" maneuver at 35,000 feet and 215 miles. Interception was apparently successful, although the exact miss distance was not determined. Category II.

51. 21 Sep 1961 -- The mission was intended to be the interception of a zooming Regulus at 80,000 feet and 130 miles. Category II. The drone did not zoom and the mission was not completed.

52. 28 Sep 1961 -- First ECM mission. Category II. Target was an ECM-equipped QB-47 at Mach .75, 25,000 feet and 150 miles. Direct hit. While valuable as a test, the direct hit was unfortunate in that it destroyed one of the two QB-47's equipped for ECM operations.

53. 30 Sep 1961 -- Another attempt to hit a zooming Regulus at 80,000 feet and 130 miles. Category III. Drone could not achieve the speed necessary to zoom to 80,000 feet, so the interception altitude was changed to 30,000 feet, but it was too late. Missile and drone were never closer than 13.5 miles.

54. 12 Oct 1961 -- Target was a QB-47 at Mach .75, 35,000 feet and 250 miles. Category III. Miss distance of 150 feet, although target seeker operation was below par, because it did not acquire the target until the drone was within 11.5 miles.

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55. 17 Oct 1961 -- Same mission as above. Category III. The missile rolled abnormally and finally hit the water 11.5 miles from the launcher. Malfunctions included failure of left ram-jet to light and a coordinate converter anomaly.

56. 21 Nov 1961 -- Second ECM mission. Category II. Target was an ECM QB-47 at Mach .75, 20,000 feet and 250 miles. Flight control malfunctions caused such violent maneuvers that the missile broke apart at 30,000 feet after 610 seconds of flight.

57. 6 Dec 1961 -- Target was a maneuvering QB-47 at 35,000 feet and 250 miles. Category III. The target seeker failed to clutter calibrate and never acquired the target.

58. 13 Dec 1961 -- Same mission against the same target. Category III. Following transition at 71,000 feet, the missile went into a series of rolls and dived uncontrolled into the Gulf. The failure was in the Coordinate Converter Electronics Roll System.

59. 31 Jan 1962 -- Target was an augmented QF-104 at Mach 1.2, 35,000 feet and 125 miles. Category II. Miss distance 50 feet. First flight of the ECP-2200 target seeker against an augmented QF-104.

60. 7 Feb 1962 -- Third ECM mission. Category II. Target was an ECM QB-47 at Mach .75, 35,000 feet and 257 miles. The missile, operating in an ECM environment, made a direct hit.

61. 21 Mar 1962 -- Target was an unaugmented, maneuvering ECM QF-104 at Mach 1.2, 35,000 feet and 224 miles. Category II. Miss distance was not measured, but the missile passed close enough to the drone that the fuze fired. ECM environment.

62. 23 Mar 1962 -- Target was a maneuvering QF-104 at Mach 1.2, 48,000 feet and 224 miles. Category III. Missile destroyed at high cruise altitude (73,000 feet), 71 miles from the launch site because of anomalous operation of the accessory power unit.

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63. 8 Apr 1962 -- Target was an ECM QB-47 at Mach .75, 20,000 feet and 200 miles. Category II. Mission failed because the target seeker and/or the fuze called for so much power that the power source failed.

64. 16 May 1962 -- Another ECM mission against the same target. Last Category II missile. The missile climbed so steeply the ramjets blew out and the missile hit the water 34 miles from Santa Rosa Island.

65. 5 Jun 1962 -- Still another ECM mission against the same target. Miss distance 58 feet.

66. 14 Jun 1962 -- ECM mission against a maneuvering QB-47 at Mach .75, 20,000 feet and 100 miles. Because of a malfunction in the variable frequency oscillator, the target seeker never had a chance of acquiring the target.

67. 27 Jun 1962 -- ECM mission against a non-maneuvering QB-47 at Mach .75, 25,000 feet and 175 miles. Although the missile was given incorrect commands and probably would not have completed the interception, it was unintentionally destroyed 11 seconds before the planned time of

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interception. The reason for the inadvertent destruction was unknown.

68. 28 Jun 1962 -- Target was an unaugmented maneuvering QF-104 at 690 knots, 48,000 feet and 224 miles. Erratic operation of the target seeker prevented interception.

69. 10 Aug 1962 -- Same mission against the same target. Mission not completed for several reasons, most involving the target seeker.

70. 31 Aug 1962 -- Target was a non-maneuvering QB-47 at Mach .75, 35,000 feet and 250 miles. Direct hit.

71. 13 Sep 1962 -- Target was a non-maneuvering, augmented QF-104 at Mach 1.2, 35,000 feet and 224 miles. The missile overshot the target because of a faulty microwave oscillator in the target seeker.

72. 27 Sep 1962 -- Same mission against the same target, except at a range of 140 miles. The interception was apparently made, but the fuze did not fire.

73. 4 Oct 1962 -- Same mission against the same target, except at a range of 225 miles. Direct hit.

[redacted]

74. 17 Oct 1962 -- Target was an unaugmented, but non-maneuvering QF-104 at Mach 1.2, 48,000 feet and 140 miles. Miss distance 8 feet.

[Cuban crisis caused a delay of further testing until January 1963]

75. 2 Jan 1963 -- First ALRI mission. Target was a non-maneuvering QB-47 at 300 knots, 500 feet and 250 miles. ALRI (airborne control system) worked well, but the missile hit the water 2-3,000 feet ahead of the target. The target seeker was confused by reflections from the water.

76. 10 Jan 1963 -- Target was a QF-104, flying originally at subsonic speed at 35,000 feet, but after missile launching to climb to 55,000 feet and increase speed to Mach 1.6. Interception planned at 275 miles. The mission was unsuccessful because SAGE commanded the missile to receive on channel 9 when the GAT was transmitting on channel 8. The missile received no mid-course guidance.

77. 8 Feb 1963 -- A QF-104 was again the target on a similar mission. Ground control of the drone was lost at a crucial point and the missile had no chance of making the interception.

78. 13 Feb 1963 -- The third try at this same mission was successful. The interception was made at 240 miles.

79. 14 Feb 1963 -- Second ALRI mission, involving a non-maneuvering B-47 at 300 knots, 500 feet and 250 miles. Again ALRI worked well, but the mission was not completed because the target seeker was confused by reflections from the water.

80. 27 Jun 1963 -- Third ALRI mission with a similar target, except at a range of 85 miles. The target seeker was still troubled by the image reflected from the water and missed the target by 1,500-2,000 feet.

81. 19 Aug 1963 -- Fourth ALRI mission with a similar target. The missile hit the water near the target, but whether or not the terminal phase of the interception was successful could not be determined. End of IM-99B testing.

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