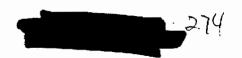


STUDY FOUR

THERMONUCLEAR WEAPON DELIVERY BY UNMANNED B-47: PROJECT BRASS RING

Delmer J. Trester, WADC

PROJECT BRASS RING

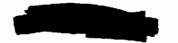


I INTRODUCTION

The year 1949 found the Air Force continuing its concerted drive toeard greater participation in the nation's atomic energy program. As a cart of this drive, on 8 December 1949, Air Force headquarters requested : the Air Materiel Command constructive ideas for research and development projects, limited within certain general guidelines. The broad catecories included weapon characteristics, weapon effects, logistics, and infensive methods. Particularly important, thought Lieutenant General tenneth B. Wolfe, Air Force deputy chief of staff for materiel, was the fact that the 1949 version of the A-bomb was not a completely satisfactory weapon. Its makers had failed to consider it as part of a whole unit-or weapon system. Furthermore, only a small trickle of cooperation existed between the Atomic Energy Commission, charged with constructing the bombs, and the Air Force, designated their carrier. Realizing ... these basic shortcomings, the Air Force wanted to participate in several phases of atomic weapon research, hoping to improve logistics and carrying techniques as a natural result of regarding the weapons as part of an overall system. The materiel command, with its capacity for research, development, procurement, and supply, ranked pre-eminent among Air Force organizations for such work.

Among the various comments which General Wolfe inserted in the catecories of Air Force interest were two which related specifically to the relivery of atomic weapons. He thought the Air Force should search for new methods of delivery, "...taking advantage of nuclear power plants, rocket developments, and guided missile techniques," as well as "optimize that weapons system employing new atomic weapons and new methods of





delivery." The general urged the material command to "...exercise full initiative in originating projects based on the guidance contained in the attached program."

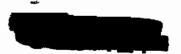
Upon receipt of the letter, materiel command machinery began grinding.

out a comprehensive study program for General Wolfe's consideration. But
before the facts were fully assembled, some of the effort was sidetracked
to another purpose, for the materiel command had learned that quite likely
there would be an urgent need within two and one-half years for a vehicle
to do "a very special job."

This information arrived by a circuitous raute. Colonel Robert E.

Jarmon, chief of the Special Weapons Section in the Engineering Division,
disclosed the first scraps of information which subsequentl, became modified and enlarged in a conference with Lieutement Colonel Edward G. Nabell,
material command resident representative at the Special Weapons Command,
Kirtland Air Force Base, New Mexico. It appeared that the Air Force would
need some method to deliver a 10,000-pound package over a distance of
4,000 nautical miles with an accuracy of at least two miles from the center of the target. It was expected the package would produce a lethal
area so great that, were it released in a normal manner, the carrier would
not survive the explosion effects. Although mot mentioned by name, the
"package" was a thermonuclear device—the hydragen, or H-bomb.

Following General Wolfe's injunction, the material command quickly took the initiative. Major Gwynne S. Curtis, in the office of the Director of Research and Development, prepared a study investigating methods to deliver such a weapon under the specified requirements. At first glance, it appeared that this was an ideal job for a guided missile. Unfortunately, the time element—within two and one-half years for a completely operational missile—ruled out all missiles the Air Force



had under development. The only other option seemed to be an aircraft in the Air Force inventory which could assume the guise of a drone or missile.

Casting about for a suitable vehicle, Major Curtis set up certain criteria it would have to meet. The aircraft had to be inexpensive, dependable, reasonably invulnerable to enemy counteractions, scheduled as a production item, easily stabilized for automatic control, and available for flight test in the near future. Only three aircraft met the basic load and range requirements: the B-36, B-47, and B-49. The giant B-36 was too expensive and easily susceptible to enemy attack. The only point in the B-49's favor was its relative invulnerability. The sleek, new B-47 met all the requirements except low cost; yet it was the least expensive of the three aircraft for this purpose.

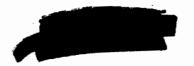
Feeling quite certain that the B-47 would be the first convenient carrier of the hydrogen bomb, Major Curtis examined the aircraft's virtues which made it suitable as a drone and a missile. The first ten B-47's to roll off the production line would be non-standard tactical versions which were scheduled largely for development work. Modification and test of one of these B-47's could easily result in a prototype drone and make available the engineering data for application to future B-47B's and C's. Such modification would strip the aircraft of its standard bombing system, defensive armament, and the many items a crew required. In listing a summary of the equipment to change a B-47A to a drone configuration, the major pointed out that the stabilization and light controls, power controls, speed controls, the flight and altitude controllers, and other auxiliary controllers were either already standard or under development.

There were no navigation and guidance systems in production which could be installed into a B-47; however, development of such items was



already under way. Major Curtis reasoned that in one year's time (by January 1951) a decision could be made on which guidance system seemed best suited for the range and accuracy aspect. He believed that within. an additional one and one-half years a prototype of the selected system .. could be fabricated to convert the drone B-47A to a missile. Concluding ... his study, Major Curtis made a number of recommendations, all dependent upon Washington approval of his basic plan. He recommended diverting delivery of the last three B-47A's from the Strategic Air Command to the Air Materiel Command. Considerable money could be saved if the armament, bombing, and navigation systems were omitted during the aircraft's trip along the assembly line. Still further savings would accrue if the aircraft were converted first to drones and then to missiles at Wright Field. Engineering Operations of the Engineering Division should establish a project office in its Special Weapons Section to cooperate with ... the Guided Missiles Section on the selection of appropriate navigation .. and guidance systems. This project office should work closely with the Sandia Corporation to insure compatibility of the B-bomb with the B-47 and solve expected problems of bomb bay changes and fuzing. Finally, Major Curtis felt that the materiel command ought to pursue a vigorous intelligence program to obtain information on targets, maps, and weather-all important factors in guidance design and fabrication.

Major General St. Clair Streett, deputy commanding general of the material command, reviewed the study and emphasized to General Wolfe the importance of the program which Major Curtis had dubbed "Project Eagle." He assured General Wolfe that he regarded as sound the Air Force effort in aircraft and guided missile development. But the abrupt and immediate need for an H-bomb carrier dictated that a compromise be made, namely, a B-47 drone or missile. Although General



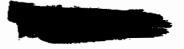


Streett realized the tremendous task involved in developing such a vehicle, in addition to using a costly aircraft as a one-shot item, he thought the project "...wholly justified in view of the total expense and destructive capability of the package carried." To expedite the work, General Streett suggested that the project come under a special weapons category—thus escaping the existent low priorities accorded the guided missiles field.

Prior to receiving Air Force headquarters reaction to the proposed Project Eagle, the material command acquired information that made acceptance of the proposal extremely likely. A 10 February 1950 letter from Major General Francis H. Griswold, the assistant deputy chief of staff for material, cited a Presidential order which assigned to the Air Force the role of working on a thermonuclear weapon and being its official carrier. General Griswold suggested that the chief of the Engineering Division be assigned as the Air Force field project officer with the responsibility of insuring that the Air Force could carry the bomb by the time the Atomic Energy Commission had built it. 7

The materiel command's suggested method of delivery, as outlined in the Curtis study, initially did not find full approval in Air Force head-quarters. Major General Donald L. Putt, director of research and development on General Wolfe's staff, disputed the contention that an H-bomb carrier would mete out its own destruction. "Preliminary analysis by this headquarters," the general wrote on 9 March, "indicated that a piloted B-47 should be able to drop the weapon and withdraw with a reasonable degree of safety." To widen the safety gap, he suggested that either the bomb's rate of fall be slowed or more thrust be added to increase the B-47's turning speed.

General Putt did not accept the philosophy of a drone B-47 as a final answer to the problem; on the other hand, he did regard it as a secondary



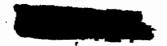


concept to either follow or parallel the preparation of some better method of delivery. He thought that human direction of the aircraft and the bombing sequence was a strong argument for a manned version to do the job. Consequently, he approved only a portion of Project Eagle: the development of a vehicle by the end of 1952 to deliver the hydrogen bomb within two miles of a target 4,000 miles distant. General Putt asked the material command to reexamine the overall aspects suggesting that some thought be given to air-to-air refueling, plus a careful study of the destructive area of the bomb.

General Putt's request went down the line, finally landing on the desk of Mr. Joseph Kelley, an engineer in the Aircraft Laboratory's Design Criteria Unit. Lacking complete information, Mr. Kelley joined forces with two men, Mr. Lawrence Levy and Dr. James W. Mar, both of the Massachusetts Institute of Technology. Other outside assistance came from conferences with two representatives (Dr. F. Reines and Mr. S. W. Burriss) of the Los Alamos Scientific Laboratories. This galaxy of scientists and engineers pondered General Putt's queries from one specific angle: could a manned B-47B deliver the super bomb without sacrificing the crew?

Naturally, most of the data which the group used as basic assumptions hinged on the various effects of a hydrogen bomb. And inassuch as such a bomb had not been devised, let alone exploded, most of the information lay within the realm of guesswork. However, by methods best known to scientific workers—interpolation, extrapolation, and other theoretical computations—the group did offer some figures and by 16 March had arrived at some conclusions.

Mr. Kelley and other members of the study group assumed that the B-47 would drop the bomb in a conventional manner from an altitude of 40,000 feet while flying at a speed of 600 miles per hour. They estimated the

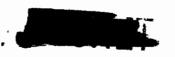


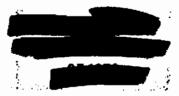
Because of the distances involved, no harmful radioactive effects on the aircraft or its crew were expected. It was not certain, however, that distance would completely obviate the effects of thermal radiation. This factor depended largely on exposure time—10 seconds being considered as only marginally safe. Computations showed that

at a height of 2 miles would create an inferno capable of charring wood at a distance of 20 miles. Because the weapon would probably provoke a small-size hurricane, the investigators also had to consider the gust velocity and pressure that a B-47 could withstand. Although these factors created a somewhat hazardous operational condition, the scale leaned slightly in favor of the aircraft's hanging together.

These calculations and conclusions were neither entirely pessimistic nor completely optimistic. In effect, Mr. Kelley and his colleagues might as well have stated that a B-47 crew's chances of survival depended on the toss of a coin. Yet, there was one angle that planners had to keep in mind: the study group used maximum figures for unknown quantities and their dubious basic information forced them to plead that no final decision result from their study. Perhaps it was for this reason that Colonel Bruce B. Price, Special Weapons Section head, included manned B-47's as well as drogue parachutes, drones, and missiles as suggested means of delivery when he sent the study and his recommendations to Erigadier General Ralph P. Swofford, Engineering Division chief. 9

Probably General Putt had neither seen nor heard about the above





study at the time he forwarded his acceptance of Project Eagle on 29 March 1950. But apparently he gained similar information from some source, for his remarks took a slightly different tack from his earlier course of logic. He wrote, "Realizing that the characteristics of the H-bomb cannot be determined with any degree of accuracy at this time, it is essential that the carrier development provide for both piloted and drone delivery." Futher, he stated that work under Project Eagle should not be confined to the B-47 aircraft alone. But the general clearly stated that "...there should be no distinction made as to any priority between the piloted and drone aspects in the implementation of Project Eagle."

This negated his earlier consideration of the drone and missile ideas as secondary features.

Boiled down to simple terms, General Putt wanted the best method—but in all events, some method—of carrying the hydrogen bomb as soon as it became available. Because of the aura of uncertainty beclouding the H-bomb's size, blast, and lethal power, it was doubtful that a manned aircraft could safely carry it. Therefore, a parallel drone and missile investigation offered the Air Force an insurance policy.



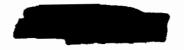
THE B-47 SPECIAL BOMB CARRIER PROJECT.

Having full approval for beginning its H-bomb carrier plans, the Air Materiel Command published a technical instruction (a directive document) on 7 April 1950 to cover specifically the unmanned B-47 proposal. The technical instruction made it apparent, however, that the B-47 alterations were only one phase of a large program to investigate all delivery methods of any merit. This overall program received the designation,

The Project Gets Under Way

To cover the unmanned B-47 proposal of the overall program, a statement of the principal work to be done included modification of one B-47A and two B-47B's, plus the development of stabilization, automatic control, and guidance systems—all under a l-A priority. Arrangements had already been made for the allocation of the B-47A; moreover, in a conference at the material command on 29 March, representatives from Air Force head-quarters tentatively agreed to provide the other two aircraft. Definite earmarking of specific B-47B's, however, was to be withheld until four months prior to their production.

The materiel command programmed \$500,000 of fiscal year 1951 funds for the B-47 work. Of this, \$100,000 applied to the study phase; the remainder came under the heading of initial modification costs. 11 Subsequently the project co-leaders, Major Richard C. Anderson and Mr. Joseph Jordan, in the Engineering Division's Aircraft and Guided Missiles Section, estimated the total funds needed for the project. An additional \$3,000,000 was required for fiscal year 1951, and in the next fiscal year, 1952, the project required \$1,400,000. Thus, preliminary estimates pegged the total cost of the project at \$4,900,000.



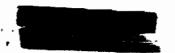
In his study on the B-47, Major Curtis had recommended that the Air Majoriel Command headquarters perform the engineering for the B-47 modifications and its depots make the physical changes to the aircraft.

Later, however, two circumstances ruled out these suggestions: the current Engineering Division workload was too large and it was feared that the depots could not complete the modifications by July 1952. Consequently, the material command searched for a contractor to undertake the work.

The two principal problems faced in the B-47 carrier project—guidance and aircraft modification—quickly narrowed the field of potential.
contractors to two: Sperry Gyroscope Company and Boeing Airplane Company.
Which of these constituted the better choice hinged primarily on the engineering philosophy as to which problem was the more basic one. It was
mandatory that the selected contractor perform the complete integration
of all automatic functions. Major Anderson, along with other material
command engineers, visited Sperry and Boeing before making their decision.

Sperry representatives stated that they would accept the prime contract provided the aircraft modifications were subcontracted to Boeing. But Sperry admitted that their facilities were not spacious enough or adequately equipped to accommodate the aircraft for component installation. Company officials recommended either Mitchell Air Force Base, New York, or Boeing's field at Wichita, Kansas, as suitable sites for such work.

Following the visit to Sperry, a basic difference of opinion appeared between engineers from the Aircraft and Guided Missiles Section and the Equipment Laboratory. The former had decided on Boeing, the latter on Sperry. Equipment Laboratory engineers argued that the H-bomb carrier development dealt primarily with stabilization and control, and they had

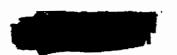




had previous unfortunate experience in letting contracts to aircraft manufacturers on such work. The Aircraft and Guided Missiles Section engineers pointed out that those cases had not involved first class aircraft companies, such as Boeing, and held firm in their belief that Boeing should be awarded the contract. Because guided missile projects proved more successful in the hands of airframe manufacturers and because of the questionable operational status of the B-47 aircraft itself, the material command decided in favor of Boeing. 15

In mid-May 1950, Boeing submitted its proposal for the initial engineering study. 16 However, its scope was far too general for the command; when Mr. Jordan wrote the purchase request for the study, he outlined more fully what was wanted. He asked Boeing to analyze the requirements for and the desired characteristics of such subsystems as initial guidance, automatic and remote flight control, mid-course guintance, auxiliary controls, engine controls, emergency controls, and anywethers Boeing considered pertinent. Mr. Jordan also wanted lists of all parts or services (as well as their available sources) to carry cut the modification. Boeing was asked to furnish configuration illustrations, showing how and where the company planned to install the various equipment. In addition, Boeing was to list the specific production items to be deleted as the B-47's passed along the production line. Finally, Mr. Jordan wanted Boeing's outline of a test program. Concerning the important guidance system, the engineer stated that the materiel command was in the midst of selecting one from several under evaluation; the flight control system would have to be designed to operate with it. 17 Boeing promised to finish the study in three months at an estimated cost of \$50,205. 18

Disagreement on minor points, coupled with the usual delay of government contracts, postponed signing of the agreement until 11 August 1950-



the same date appearing on Boeing's completed study. Inasmuch as the ir Force already had a B-47 contract with Boeing, the document for the study was designated as a supplemental agreement. Summarizing how it proposed to carry out the modifications, Boeing stated that it appeared possible to do the job in the allotted time. There were, however, a few limitations. Although the project office had stipulated that the carrier be operable under all weather conditions, automatic navigation state of the art required stellar monitoring. Because of inherent gyroscopic drift—or error—an automatically guided aircraft could stay under heavy cloud cover for only one hour and still meet the accuracy requirements. However, above 28,000 feet, cloud formations were usually negligible factors. A somewhat more serious limitations to around—the—clock operation was the fact that stellar monitoring was not yet effective during day—light, and Boeing could only hope that such tracking capabilities would become practical during the guidance system development.

Another requirement was for non-jammable operation of the entire weapon system. Boeing stated this could not be met fully because radio and radar were needed for take-off and also during flight when the B-47 drone was under director control. Jamming, however, might be minimized by incorporating directional antennas, high threshold signal receivers, maximum transmitter power, and high frequencies. Furthermore, once the director, or mother aircraft, committed the carrier to the mission, jamming was impossible. Other questionable factors—complete reliability and a 4,000 nautical mile range—depended on adequate test time and certain flight, weight, and speed characteristics. 20

The original contract bore the number AF 33(038)-12883 and the date 17 May 1950.

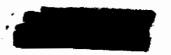


Although subject to several major amendments and many small changes, Boeing's study remained the basic document which was followed throughout the course of the project.

Guidance for Brass Ring

Indicative of the materiel command's solicitude that a proper autonavigator development parallel B-47 modifications was a meeting of selected aircraft manufacturers early in March 1950 with Major General Samuel R. Brentnall, director of research and development. The general quickly discovered that no self-contained guidance existed to meet the requirements of a mission of more than 1,500 miles. Although some progress had been made on several autonavigators, the good points of one were not readily applicable to another, for each was designed for the specific vehicle it would inhabit and the particular task it had to perform. The aircraft industry representatives thought that a "crash program" of at least one year was necessary to obtain an operational and producible guidance system for the B-47. As it turned out, this proved to be grossly optimistic.

In view of the urgency of the guidance development, General Brentnall stressed this phase of the H-bomb carrier as soon as the technical instruction came out. Rather than await recommendations of a contractor study, the general urged "...that an attempt should be made at this time by the Engineering Division to select a self-contained, nonjammable guidance system or systems, specifically tailored to fit the B-47 application and more specifically to meet the 4,000 nautical mile, all-weather, plus or minus $2\frac{1}{2}$ mile target accuracy requirement...."²² Accordingly, the project mentors asked several laboratories for their comments on autonavigators then under development, pointing out the desired design and operating characteristics of the B-47 as a carrier.



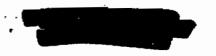


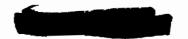
By the end of May, the laboratories had responded with their informal evaluations and General Swofford advised General Brenthall which guidance systems appeared most suitable. The Armament Laboratory was currently sponsoring one—the Norbs, or Non Radiating Bombing System—which was based on a Massachusetts Institute of Technology design study for a long-range stellar inertial bombing system. The laboratory had \$1,250,000 on hand and evaluation of contractor bids for construction of the device was currently under way. The Armament Laboratory felt that Norbs might meet the demands of the B-47 carrier.

Northrop Aircraft's Octave III-1 guidance mechanism for Snark failed to meet the stiff B-47 requirements, but a projected Octave III-3 did. The company expected a version of the latter to be ready for production by May 1952.

North American Aviation, Inc., had inherited an autonavigation development (originally begun by Hughes Aircraft Company) which it intended to use with its Navaho missile. However, it could be aimed specifically toward incorporation in the B-47 missile; moreover, it was also adaptable to both the B-36 and B-52. Flight tests of the first experimental item were planned to be completed by February 1952, with flight evaluation of a pre-production model to start one month later.

Although these three autonavigators appeared most suitable for guiding an H-bomb carrier to its target, there still remained vast holes in the state of the art. Theoretical calculations were abundant, but the step from theory to hardware was uncertain. Therefore, General Swofford cautioned that evaluation of the three guidance schemes be regarded as only preliminary. He hoped that by the beginning of 1951 the Engineering Division could make a more valid appraisal and point out the one autonavi-gator most easily tailored to the B-47 missile. He added, "If the many







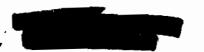
unknowns that attend these experimental guidance systems are not eliminated by February 1951, it may be necessary to procure two of these guidance systems to provide insurance against development contingencies. 123

Air Materiel Command engineers continued to evaluate and reevaluate autonavigators through conferences with various aircraft companies. On 12 July they asked Boeing's opinion of their preliminary preferences—Northrop, Norbs (contracts having been let to Sperry and the AC Spark Plug Company), and North American. Boeing suggested consideration of five others as well. Then, measuring in terms of availability, performance, space, and weight, Boeing selected the North American autonavigator. Of the eight, Boeing engineers placed Sperry's Norbs in the fifth position. 24

The entire evaluation, however, proved invalid because of a misunderstanding that had crept into the proceedings. Boeing had failed to realize that the Air Materiel Command had two Norbs systems under contract.

The first—AC Spark Plug's—was to be installed in manned aircraft and included universal features (over any part of the world). The second—
Sperry's—was specifically geared for the H-bomb carrier project and inccrporated relaxed course and accuracy features. Such an autonavigator
presented a somewhat less difficult task in construction. In a conference at materiel command headquarters on 24 August, the Boeing representative, Mr. Robert J. Helberg, stated that he had been unaware of the "intent and scope" of the contract the Armament Laboratory had signed with
Sperry. These facts completely altered Boeing's classification of the
Sperry autonavigator and Mr. Helberg agreed that the system ranked second
to North American's. 25

Thus, the conferees agreed unanimously that the North American and Sperry autonavigators had the greatest potential of meeting the project's performance standards and time schedules. Air Materiel Command





representatives therefore decided to procure two North American and two Sperry systems. 26 The North American development was considered first choice with the Sperry autonavigator as the alternate. 27 Rather than postpone selection of autonavigators for amother four or five months, the material command had decided to gamble on one of these experimental systems, hitting pay dirt.

Signing of Contract for Phase II*

As of 28 August 1950, the Pilotless Aircraft Branch of the Aircraft and Guided Missiles Section assumed the role of project office for the B-47 missile portion of Continuity of administration was provided by retaining Mr. Jordan; however, Captain Robert T. Franzel replaced Major Anderson. The latter continued as head of the overall H-bomb carrier program. Initially, the special bomb carrier project was designated only by its code number, MX-157; later on, Mr. Jordan conjured up the colorful nickname of Brass Fing **—which, intentionally, was devoid of any relation to the project.

Because of the need for dispatch, Phase II negotiations quickly followed Boeing's letter of proposal, and by 7 September the two parties had agreed to the first major revisions to the Boeing document. 30 Also, by that time the Brass Ring purchase request had already been drawn up and was being hand-carried through the Engineering Division for coordination. 31 The request passed its final test when Mr. Eugene Euckert, Assistant Secretary for the Air Force, approved the contract

Throughout the subsequent narrative continual reference is made to the various phases of Brass Ring. These should not be confused with other air Force definitions of these terms. Here, Phase I is the study; Phase II, the basic development program; and Phase III, the supplemental flight test program.

his name officially adopted in April 1951 but is used here indiscriminately.



on 13 September 1950.³² Shortly thereafter, on 27 September, Boeing and Air Materiel Command representatives signed the agreement.

This initial document was in the form of a letter contract, designed to wrap up the basic agreements in legal terms until a definite contract could be worked out at a later date. The 27 September document placed only \$500,000 at Boeing's disposal to begin work on Brass Ring. 33 Additional funds, either allocated or budgeted, totalled \$3,112,000. 34 The definitive contract, labelled supplement two to the basic B-47 contract, was signed on 9 February 1951 and provided \$3,300,000 for the completion of the second phase of work. 35

The letter contract outlined in general terms the extent of Boeing's obligations. The company agreed to modify two B-47B's to missile configurations, furnishing and installing two sets of missile controls and two autonavigators. In addition, another set of missile controls was to be furnished Wright Field laboratories for evaluation purposes. Boeing also had the job of converting the B-47A into a director aircraft. Finally, Boeing had to furnish one ground director station and a mobile service facility. The Air Force agreed to send Boeing all standard items to be used in the work. Delivery date for the director and one missile B-47 was set for 31 July 1952 and for the second carrier, two months later. 36

In accordance with the terms of the contractual agreement, Boeing subcontracted three major items to other companies. Under these arrangements, North American became responsible for the principal guidance system for Brass Ring; Sperry was to supply the automatic flight control system; and Collins Radio Company accepted Boeing's invitation to furnish the command guidance equipment. The Sperry autonavigator—the alternate to North American's—was to be supplied as government-furnished equipment

because of the materiel command's existing contract with that company. 37

Although the exact scheme of the Brass Ring mission was not definite because of unknown quantities in the development process, the ultimate objective was to fashion a B-47 carrier with completely automatic operation from take-off to bomb drop. Since the possibility of achieving this. goal by the scheduled completion date was extremely questionable, the immediate plan included the director B-47A as a vital part of the mission. Under direction from the mother aircraft, the missile would take-off, climb to altitude, and establish cruise speed committions. While still in friendly territory, the crew aboard the director checked out the missile and committed its instruments to automatica Livraccomplish the remainder of the mission. This was all that was required of the director. The missile, once committed, had no provision for returning to its base, but would follow a great circle course to the target; area. It had not yet been decided how the H-bomb would be detonated. There were two choices: either the B-47 became a true missile ask dived toward the target, the bomb exploding still in the aircraft; or a mechanism triggered the bomb free, as in a normal bombing run. If the bomb were dropped, the aircraft had to carry a means of selfdestruction.38

A Major Delay

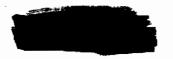
Because the super-bomb carrier was a research antidevelopment undertaking, because it was to transport an item about which there were several nagging vagaries, and because autonavigator knowledge was merely adolectent, the project personnel continually contended with threats of program changes and delays. Indeed, the project scarcely started to roll before several of its wheels—representing subcontractors—began to wobble, thus slowing down the entire conveyance.



In mid-November 1950, for example, both the Armament Laboratory and Sperry voiced a fear that the Norbs autonavigator might be compromised by the tight schedule. North American, responsible for the first choice autonavigator, stated that it foresaw no discrepancy between its work and the time schedule. And Boeing, responsible for the entire modification, reiterated its original contention that the first B-47 missile would be ready by July 1952. Nonetheless, the project office adopted a tongue-incheek attitude toward this optimism, feeling quite certain that postponements would creep in as work progressed. On 13 November, Mr. Jordan noted, "It is felt that a change in schedule at this time would curtail the impetus of the program and still not provide for the anticipated delays that are common for projects of this nature." At the same time he thought it proper to inform General Swofford that a July 1953 date was more realistic for a completely evaluated B-47 missile. 39

Of some concern was the expected delay in delivery of Sperry's autonavigator. Yet there was no great cause for alarm inasmuch as the Norbs was only the alternate system for Brass Ring. Sperry's schedule for this item allowed only two months for flight test, and this was regarded as extremely inadequate. The project office, on 16 November, therefore suggested that Sperry's schedule be extended a full year.

As pointed out above, North American doggedly refused to evidence any misgiving that its autonavigator would be completed on time. A 3 January 1951 report contained this statement: "A preliminary conversation with Boeing indicates that North American has not yet expressed any concern over not being able to meet the proposed schedule, nor has North American indicated that it will be an undue hardship." However, a month earlier, indications that the company did feel pressed for time became apparent from their plans to incorporate time-saving modifications in their



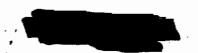


autonavigator. For instance, the company thought it might have to use air bearings instead of the liquid type. Unfortunately, this would increase the instrument's weight from 400 to 525 pounds, 42 and this later proved to be a significant underestimation.

Toward the end of 1950, therefore, Captain Franzel and Mr. Jordan asked Boeing to study the advisability of setting the program back for six months. Boeing's reply in mid-January 1951 granted that a delay would enable North American to use the liquid bearings as well as provide sufficient time to replace the five-inch telescope with a startracking periscope. The latter provision was desirable, providing greater efficiency and reduced weight. But such a delay in the autonavigator would unquestionably upset the entire Brass Ring program and postpone missile delivery.

Boeing admitted that it too had troubles. The company was experiencing a shortage of engineers and any postdating of missile delivery would naturally relieve such a condition. Nevertheless, Mr. J. B. Connelly, Boeing's contract administrator, stated that "...in view of the present world situation and in the interest of advancing the long-range missile program, the delay in schedule should not be made at this time, but should be considered only when and if it becomes obvious that the present schedule cannot be met."

Still more forbidding circumstances revolved about Sperry's modified E-4 autopilot system. In mid-October 1950 Sperry had received Boeing's proposal and contract for the automatic flight control equipment. The subcontractor's immediate reaction was that Boeing envisioned something quite different from Sperry's original proposal. The latter, because of the time element, had outlined a system which would incorporate existing engineering philosophy and "hardware" components. Holding development to



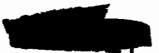


a minimum, it felt, would save considerable time. But Boeing's specification for the automatic pilot pictured a device designed to "reduce the necessity for, or entirely eliminate the need for a 'Mother Ship.'"

Sperry engineers were quite certain that their efforts to meet such a requirement would extend beyond Boeing's deadline. To evade this apparent impasse, Sperry suggested that its engineers review the specifications for a few weeks, submit a counter-proposal, and then Boeing and Sperry blend their differences. To save precious time, however, Sperry started work on the contract immediately.

In December, Sperry and Boeing engineers met to amend the auto-pilot specifications and schedule. Despite apparent agreement at that time, Sperry several weeks later came up with a more realistic delivery time-table which implied a six to eight months' delay for the entire program. Sperry laid the blame at Boeing's doorstep, charging that its revision stemmed directly from Boeing specification changes. A conference of Boeing, Air Materiel Command, and Sperry representatives on 31 January 1951 failed to discover a way out of the schedule labyrinth. Therefore, the material command asked Boeing to review the overall program and make schedule revisions to conform with Sperry's projected deliveries. 47

Before Boeing could work out the details for a reshuffling of project dates, Major Franzel (recently promoted) made a presentation of Brass Ring to General Putt at the Pentagon on 7 February 1951. A hastily concected schedule showed that the B-47 missile could not be ready for delivery until January 1953. Upon finishing its computations later in the month, Boeing arrived at the same conclusion. The revised dates gave promise of injecting smoother progress in the program and obtaining better products from the subcontractors. "It is felt," stated a project office report, "that the changes in schedule will benefit



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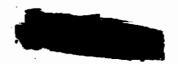
the overall program as the concept of the original schedule was dictated by a desired missile delivery date rather than by estimated development and test time. 49

Mock-up and Progress

Because of the tentative nature of Brass Ring components there was a general feeling among interested people that a formal and complete mock-up was unnecessary; on the other hand, general sentiment favored some sort of inspection. Therefore, on 14 and 15 December, Boeing held an informal progress inspection of the nose sections of the B-47 director and missile, including the pilot and co-pilot compartments. Although the Air Materiel Command team of inspectors in attendance made no revolutionary alterations, they asked Boeing to re-locate several instruments and study the adequacy of several pieces of equipment and operational procedures.

Shortly after the inspection, conversations between Wright Field personnel and Boeing engineers uncovered a subject which held promise of considerably affecting Brass Ring operations. They agreed that because of the huge load the B-47 was slated to carry, it might be well to provide a refueling crew for the carrier. These men could take off the aircraft, assist with the inflight refueling, and then bail out. 53 The two B-47 carriers already contained refueling apparatus and could receive the additional fuel from either a C-97 or a C-124. 54

Locally, at Wright Field, the advice of Lieutenant Colonel Henry M. Sweeney and Captain Vincent Mazza, Aero Medical Laboratory experts on ejection seat and bailout techniques, was solicited. They held the opinion that bailout at high altitude could be accomplished with little risk, provided proper equipment was used. They suggested utilizing



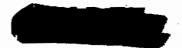


spoilers at the exit points to protect the crew members from windblast and allow the men to drop downward more freely, giving them a safe margin for clearing the aircraft's tail section. 55

Thereafter, Boeing studied the possibility of making the necessary modifications to the B-47. The special problem facing Boeing was finding a sure-fire method to retract the spoilers and close the escape hatch once the crew had evacuated. By early February 1951, Boeing had figured out a way to re-seal the aircraft and received approval to incorporate bailout provisions.

Initially, Boeing and project engineers had held forth another possible gain in utilizing a crew—that of eliminating the director or mother aircraft. They suggested that the crew stay with the carrier until it arrived at a position where its instruments could be set for automatic flight, and then bail out. However, shortcomings cropped up and it was determined that the crew could only supplement, not supplant, the director type of control. 56

The bailout concept, as well as all phases of Brass Ring and were presented to General Putt and his staff at Washington head-quarters on 7 February 1951. Major Franzel outlined the new schedule for Brass Ring which changed B-47 missile delivery from July 1952 to January 1953. He expressed the belief that this revision allowed Boeing about eight months for the Phase III, or testing, period and gave the Air Force a 10-month flight evaluation and training period. The delay did not compromise in any manner, since according to the latest information at hand, the H-bomb would not be ready for use until 1953. Moreover, this was only in the nature of a guess. Only six months earlier a Sandia Corporation spokesman had expressed some doubt that an H-bomb could be built at all, and forecasted that if it were possible, development

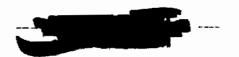


time could run from three to five years. In any event, it seemed certain that a B-47 would be available to carry the weapon.

The conferees also discussed the perennial question of manned aircraft performing the mission. But, as Major Franzel later stated,
"The presentation of other parts of brought out the
facts that it has not been definitely established as yet that manned aircraft can safely deliver the weapon because of possible heat and radiation effects, although from a blast standpoint it does appear marginally
safe at certain altitudes and certain speeds." Eliminating Brass Ring,
therefore, appeared out of the question.

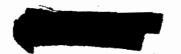
Instead of weakening the position of the project, the conference actually served to strengthen it. Major Franzel pointed out that he envisioned three valuable by-products. The B-47 missile could serve as an emergency carrier for A-bombs; the end item would be a completely automatic aircraft, thus contributing to aircraft operations in general and the B-47 in particular; and lastly, this was another remote-controlled aircraft development which had several possible applications. The by-products alone appeared so valuable to General Putt that he thought the project stood on its own merits; therefore, even though the H-bomb "cannot or should not be developed," the B-47 missile work should be completed. Additionally, General Putt stated that "...at the end of de- relopment, even if no reason were apparent now, a use would be found for it the E-47 missile by the Air Force, as has previously been the case with radio-controlled drones."

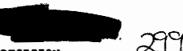
There were several minor disturbing factors which Air Force headquarters representatives aired at the conference. They thought it desirable to separate B-47 missile funds from monies in order to
keep a closer tab on both. Also, the high security aspects of





parties. These circumstances, together with the increased stature of
Brass Ring, were important enough to completely divorce the administration
of the project from General Putt agreed. Finally, the conference members concurred that its high priority be continued—at the expense of other Air Force projects, if necessary.





III SEVERAL IRRITATIONS, SOME INDECISION AND ONE CANCELLATION

There were several facets to Brass Ring which were tangential to the regular path of project progress. Although mentioned somewhat frequently in office correspondence and reports, they were minor details when compared to the overall development. Their frequency of appearance only emphasized the fact that a project officer and project engineer not only had to monitor contractor progress, attempt to adhere to schedules, and plug sudden holes which threatened to weaken plans, but they had to doctor minor irritants as well. Unfortunately, it seemed that a resolution of these problems required as much time, typing, and travel as were expended on major crisis.

Irritating Details

Such circumstances were particularly true of government-furnished equipment—some of which was in critically short supply. The project office had to discover where these items were, try to jar them loose from their owners by using the "big stick" of Brass Ring priorities, or borrow them from other agencies, such as the Navy, until they could be replaced. Also of apparent considerable moment was the correspondence flowing between Wright Field and Boeing when project workers studied and evaluated similar radar or radio sets to determine which was best or was most adaptable for Brass Ring use.

The project office had to study and stamp its approval on a contract which Boeing negotiated with the Raymond Rosen Engineering Products, Incorporated, for telemetering instruments, in April 1951. 58 Inasmuch as

If all these heterogeneous items were followed from beginning to end they would only distort the principal facts and controversial points in the Brass Ring story. A few are mentioned here only for purpose of illustration.

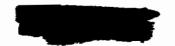


one mission profile pictured the B-47 dropping the H-bomb (instead of diving with it toward the target), the engineers had to designate the kind of destructors to blow up the aircraft and determine the spots to place charges for best effect. In the end, the directing office asked the Armament Laboratory to monitor this particular aspect. 59

Government and Boeing personnel engaged in mild polemics on the relative merits of coolers for the three trailers (one more was required after the Phase II contract was signed) which were to house the director ground stations and mobile service facility. Boeing favored the type A-1 cooler, a standard Air Force item, whereas Wright Field thought a Chrysler Air Temp Unit, a commercial product, had more merit. Although the A-1 cooler was standard, it was an old item that did not measure up to new requirements. After months of writing letters and airing the subject in general conferences, the parties decided in favor of the A-1, despite its shortcomings.

There were other little irritating details, such as the project office's scurrying about to find additional funds for the Sperry miniaturized airspeed and mach control system. The sum—in vivid contrast to ensuing major budget crises—was only \$35,000. The office obtained the money only after some budget juggling in which another project was robbed to pay Brass Ring. 62

By June 1951, plans had been worked out to provide a degree of flexitility in accomplishing an actual mission. Under these procedures, the ground director in a completely automatic manner committed the carrier to the mission on the runway or shortly after take-off. An alternative was for the director aircraft to chaperone the carrier an undetermined distance and check out the carrier's instruments carefully before committing it to its route. In this manner, if a failure was detected, the



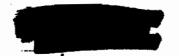
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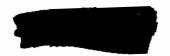


director could escort the carrier back to its home base. Thirdly, a crew_flew the carrier for a portion of the trip, assisting in refueling and performing the necessary monitoring, and then bailed out. No matter which method was employed, the carrier was to follow a great circle route to the target. It had been determined that for purposes of feint and maneuver, the North American guidance system allowed a deviation of 350 nautical miles from course and the Sperry autonavigator 180 nautical miles.

Radii of action studies revealed interesting possibilities for the Brass Ring aircraft. For instance, 60.5 per cent of Russia's key targets were within reach of a B-47 with a 4,000 nautical mile range—if the airplane took off from the vicinity of Limestone, Maine. Moreover, no important target in Russia was more than 5,500 nautical miles distant from Limestone. For strategic targets in eastern Russia, the Brass Ring B-47 could start its journey from Alaska. On the other hand, manned versions of the B-36, B-47, and B-52 would be unable to strike many of these Russian targets.

Inasmuch as Air Force planners contemplated Brass Ring operations over routes previously not used, it became apparent that the sparse weather information available must be supplemented. Consequently, the project office, along with Boeing, contacted the Air Weather Service at Andrews Air Force Base, Maryland. The latter agreed to make a series of weather studies of the routes from Alaska and northern Maine to Russia, emphasizing frequency, velocity, and rates of change of head winds, tail winds, and cross winds. It also established a study aimed at discovering a method to improve accuracy of barometric altitude measurements over Russian target areas. 65





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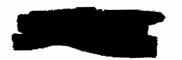
Boeing engineers wanted to know if the Brass Ring aircraft would enter-polar regions. The autonavigators in the carriers provided the heading reference in such an area; however, the director aircraft was not so equipped, and navigation would be severely handicapped. Although both the Air Research and Development Command headquarters and Washington felt that polar navigation seemed unnecessary or unlikely at the moment, they encouraged Wright Field and Boeing to include provisions for such contingencies. Accordingly, in November 1951, the project office suggested that Boeing use the N-1 compass, in order to give the director an operational ability equal to that of the carrier. Bata on specific operational routes never become available to the Wright Air Development Center.

Meanwhile, another facet of the B-47 modification program, crew bailout, underwent evaluation at Wichita, Kansas, in mid-June 1951.

Dummies were dropped through an escape hatch which had a spoiler lowered into the windstream. Tests at speeds lower than 300 miles per hour gave satisfactory results; however, above that speed, escape without injury was problematical. Colonel Robert H. Blount, chief of the Aero Medical Laboratory, informed the project office that representatives of his laboratory who witnessed the drops thought a thorough study program was mandatory. The spoiler needed re-designing, as did some items of personal equipment. And a careful procedure had to be worked out for a step-by-step exit. Major Franzel had already authorized funds amounting to \$70,000 for Boeing's study of a suitable escape hatch modification, and the Aero Medical Laboratory agreed to support this work.

The Air Research and Development Command became operationally independent on 2 April 1951. On the same date, the research and development facilities at Wright Field were reorganized into the Air Development Force; subsequently, on 8 June 1951, it was designated Wright Air Development Center.



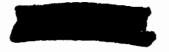


Brass Ring Testing -- How, Where, and When

The Air Force delivered the B-47A-to be converted to the director configuration—to Boeing on 1 May 1951. 72 Inasmuch as Boeing expected no particular difficulty, it began modification of this aircraft immediately. The center, for its part, began posthaste arrangements for a field at which to evaluate the converted airplane. Originally, because of time limitations, the initial schedule slated the three aircraft for operational availability after contractor tests and without the usual Air Force—conducted tests. However, the autopilot delay of six months threw the schedule awry and permitted a change in test plans. 73

As early as one month previous to deliver of the B-47A, center personnel met with Boeing in an attempt to negatiate a workable test arrangement. A 30 March 1951 conference resulted in apparent agreement that the subcontractors perform laborators and flight tests of their respective contributions to Brass Ring. Then Boeing would follow through with experiments on the systems as well as check out the director and missiles—this to be done at Boeing Field, Seattle, Washington. Thereafter, the Air Force planned to conduct operational suitability flights at some other site—perhaps the Air Proving Ground at Eglin Air Force Base. 74

Subsequently, in the midst of preparing a request for the testing at the Air Proving Ground, discussions with Basing representatives disclosed that the project office and Boeing were not actually in agreement on the latter's test duties. Boeing interpreted their responsibilities to cover "as much testing as time permits." The project office thought it covered "delivery of articles to the Air Force sufficiently tested so as to be able to be used operationally."



When Colonel Otto R. Haney, chief of the Pilotless Aircraft Branch, and Mr. Jordan visited Boeing from 14 to 18 May, they found Boeing amenable to the Air Force arguments. Boeing agreed to include the performance of one 4,000-mile test mission as a part of the current contract. On the question of training personnel, company officials stated that it was too early to make an accurate estimate, and "only actual results could dictate the amount." 76

Additionally, in order to facilitate Boeing's work and because of the project's special nature, the center secured approval to partially waive the usual Air Force standards relative to environmental, laboratory, and flight testing. 77 In view of the "interim missile aspect" of Brass Ring, tests were not to extend beyond 1 January 1954.

After carefully surveying the facilities at the Air Proving Ground and at the Long Range Proving Ground at Patrick Air Force Base, the project office, on 18 June, selected the latter. Information received from the Patrick installation indicated that the base would have a 10,000-foot runway and B-47 support equipment by 1 January 1953. However, the availability of an instrument landing system (ILS) and an operational drone group at the base at that time was questionable. A month later, in July, the Air Force Missile Test Center's assistant chief of staff,
Major Eugene G. Mulling, informed Wright Field of additional shortcomings of his installations—a lack of trained personnel and a heavy workload with conventional missiles. This was disturbing news inasmuch as the Air Force's desire for an early operational capability with Brass Ring aircraft made it obligatory that a maximum number of Air Force personnel be trained as early and as quickly as possible.

^{*}Redesignation of Long Range Proving Ground.



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In an attempt to extricate Brass Ring from this maze of negotiations and indecision, Boeing and the center re-examined the proposed test program once again. This study included two other sites for the long-range tests; Edwards Air Force Base and Boeing Field. Edwards seemed satisfactory, but from the standpoint of convenience, Boeing Field appeared even better because basing the flights at the contractor's plant would enable. all flight evaluation to be done at one place. In addition, it was estimated that use of that site would result in a minimum saving of one month's time and a "substantial" reduction in costs. The 4,000-mile flight, thought project workers, could be flown along routes using distance measuring equipment (DME). Planned positioning of this equipment followed a great circle course stretching diagonally across the United States from Boeing Field to Patrick Air Force Base. 82 Although the entire testing arrangement was not in accord with established Air Force policy, it was considered the best practical approach to completion of a special project.

In summary, therefore, the project office had secured approval to conduct "a special combined R&D and Operational Suitability test and training program." The former was to be held at Boeing, but Air Force headquarters had not yet designated a site for the latter. Another question still hung fire: which unit would be appointed to perform the operational mission? This issue became enmeshed with several others and resulted in a long series of correspondence among Wright Air Development Center, the Air Research and Development Command, and Headquarters, United States Air Force.



^{*}Continuous wave radio equipment used by commercial and craft.

See pages 63-71.



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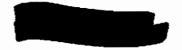
Examination of Autonavigators

Although the Air Force had given Sperry the go-ahead signal on the development of their autonavigator for Brass Ring, there existed more than a modicum of doubt as to the wisdom of that decision. A general conference on Sperry's progress was held on 23 April 1951 with representatives present from Sperry, Boeing, Armament Laboratory, Equipment Laboratory, Analysis Section, and Guided Missiles Section. The conferees quizzed Sperry engineers in great detail as to their guidance philosophy, specific components they planned to use, and progress they were making.

Taking notes on Sperry personnel's responses, Mr. Lee Showen, of the Analysis Section, compared Sperry's development with North

American's autonavigator. He reiterated the well-known conclusion that considerable duplication existed in the two projects. One Sperry component of concern was the daylight star tractor. This not only duplicated effort at North American, but that of other companies as well. Furthermore, Sperry's progress on this item was slow-being only in a "paper study" form. Mr. Showen suggested Sperry either take advantage of other daylight star tractor development knowledge or subcontract the item to another company. Despite this and other similarities to the North American autonavigator, Sperry's unique approach to the gyroscope and accelerometers, plus the solar and magnetic monitoring devices (to be used in the event the daylight star tracker proved impossible), seemed sufficient reason to keep Sperry in the Brass Ring autonavigator business, in order to provide "back-up" insurance. 86

Colonel Bruce B. Price, Equipment Laboratory head, commented on the conference, and in general, was more severe than Mr. Showen. His remark relative to Sperry's weakest point was devastating: "Sperry is

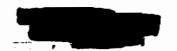


fantastically optimistic with respect to the development of daylight star followers." He further stated, "In general, the system approach by Sperry is sound but the availability of adequate, fully developed components, both basic (accelerometers, star trackers) and intermediate (computers, resolvers, integrators) to meet the delivery date appears doubtful." Colonel Price recommended that Sperry adopt North American star tracker and accelerometer designs, both of which were further along in development than Sperry's. 87

Boeing—who was responsible for delivery of the Brass Ring aircraft—felt that, "...the Sperry system, which is in the early design stage, is not far enough advanced to properly evaluate its worth as an alternate for Brass Ring." If any changes in concept were made, the company's engineers felt that it was more realistic to regard only specific Sperry components as alternates, rather than the entire guidance system. 88

The North American autonavigation system seemed more satisfactory to Boeing and Wright Air Development Center. The new Brass Ring project officer, Major George R. Vanden Heuvel, and Mr. Jordan visited the North American plant late in August 1951. The entire program—as outlined by the company—appeared adequate from a development standpoint and was in step with Brass Ring schedules. The only complaint that company engineers made was over lack of bomb data. Since the autonavigator computer was built for a single purpose—to drop an H-bomb—the engineers needed bomb ballistics information so they could fashion the computer accordingly. As yet, no such information was available to Wright Field.

In mid-August, still another general conference at the center's Armament Laboratory probed into the question of the adequacy of Sperry's development. This time, however, Sperry's autonavigator emerged from the conference somewhat less badgered and battered. Conference members agreed





that with one exception, the daylight star tracker, Sperry's progress was satisfactory. They also agreed that cost and time could be cut by subcontracting for the star tracker. The two subcontractors proposed were Pacific Mercury and Northrop. 91

In the latter part of September, Sperry agreed to subcontract the star tracker to Pacific Mercury. After working out a completion date for that item, Sperry estimated the delivery date of the autonavigator as February 1953. 92 The North American product was scheduled for August 1952. 93 Inasmuch as the company had succeeded in extricating itself from a morass of uncertainties, the project office inserted the Sperry autonavigator into a more proper place in Brass Ring planning and proposed that Boeing complete the engineering necessary to install the Sperry system in the B-47 missile. Boeing would monitor flight tests of both guidance methods in B-50 and C-97 aircraft and try to include the Sperry autonavigator in B-47 tests as well. However, no change was contemplated from the original stand that North American's product would be used for the first Brass Ring mission. 94

No sooner had project leaders successfully leaped over one autonavigator hurdle than they encountered another. The barrier emerged during a meeting Boeing and North American engineers in which the latter revealed that they expected their equipment to weigh nearly three times the original estimates, they feared a "considerable delay" in their schedules, and they warned that there would be a concomitant increase in cost. Boeing looked askance at these statements and on 26 October 1951 "...urged North American to carefully review the autonavigator subcontract with a view to minimizing delivery delays and increase in cost and weight and that Boeing be immediately advised as to the best schedules that may be realistically expected."95

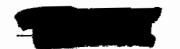


North American's explanations indicated that the root of its trouble lay in its treatment of the Brass Ring contract on an equal basis with other 1-A priority work for the Air Force. It also frankly admitted that the lack of production potential of Brass Ring aircraft was a pertinent factor in their lack of complete emphasis on the project. Nevertheless, because of the atmost importance of Brass Ring to the strategic plans of the Air Force, Wright Field could not tolerate such handling of any Brass Ring components.

This turn of events was doubly irritating because priorities had been carefully delineated during initial contacts with Boeing and the subcontractors at the project's beginning. Therefore, in clear-out terms, Colonel R. L. Johnston, chief of the Weapons Systems Division, informed North American on 20 November that the Brass Ring autonavigator took precedence over similar developments for the Snark and Navaho missiTes. He futher stated, "The special nature of Brass Ring dictates that the current schedule must be met if the operational goal of the project is to be realized."

When Mr. Jordan visited North American during the first week of December 1951, he learned that the contractor had reviewed the schedule and now held the opinion that the autonavigator could still meet the deadlines. This, however, was the only bright spot in an otherwise gloomy situation. Contractor engineers informed Mr. Jordan that their autonavigator weight would increase from approximately 525 to 1,350 pounds. Also, the cost of the two autonavigators on contract, plus basic spares, would increase from \$500,000 to around \$1,250,000. The cost of other spare parts, probably necessary for operational missions, would be in the neighborhood of \$170,000.

Such deviations from original estimates required an explanation. Mr.





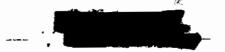
Jordan noted that North American's "...original estimates submitted in the summer of 1950 were based on the contemplated advancement of the state of the art rather than factual data. The results of a current North American evaluation reveal that the original estimates were grossly optimistic."

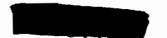
Company officials stated that they had originally planned to freeze the design of the Brass Ring autonavigator in the spring of 1951 and then divorce it from a somewhat parallel system for the Navaho missile. But as work progressed, they saw that a digression from the Navaho system would have resulted in a more expensive and less advanced gadget for Brass Ring. The engineers felt that dependence on the Navaho system was the only logical means by which they could comply with Brass Ring requirements. They averred that they had not realized the extent of the added cost and weight factors until their recently completed evaluation. 98

In one of the project office reports, the writer stated somewhat bitterly, "No further explanations were offered by North American as to why the matter was not brought to the attention of Boeing or WADC during the various discussions conducted on...Brass Ring autonavigators during periodic visits by Boeing and WCSGD project office personnel."

North American's revelations created a stir of changed plans and forced Boeing to calculate the effect of the added weight on the B-47 center of gravity. Meanwhile, Wright Field had to seek means of plugging cracks in the seeping dike of project funds. These seemed to be the only solutions at hand.

Following the above moments of crises and Emlution, the autonavigator programs gave little time for relaxing vigil. The schedule was still tight; some problems still unsolved. Mr. Thomas Pienkowski, Armament Laboratory expert in navigation systems, continually kept a watchful eye on autonavigator progress. His visit to Sperry in the latter part





of December 1951 caused him to report the appearance of a storm warning on yet another portion of the autonavigator program—astro-window de—inition.

The astro-window, through which the star tracker operated, had to be kept free of ice to allow constant stellar visibility; however, Sperry had not yet come up with any means of eliminating ice formation—nor, for that matter, had any other autonavigator engineers.

Mr. Pienkowski, in mid-April 1952, raised another storm signal.

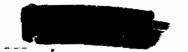
Sperry's subcontractor for the daylight star tracker was embroiled in a legal battle with its subsidiary, the Pacific Mercury Research Center.

The situation was a complex one, involving impossible personnel shifts, and caused Mr. Pienkowski to comment depairingly, "Whatever may happen, the program will suffer unless the development people who have been associated with the Pacific Mercury Research Center do the star tracker work for Sperry at an early date and these same people have access to the star tracker data that is presently linked with the Pacific Mercury Research Center.

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The Armament Laboratory engineer spotted a disturbance on still another front. This related to the lack of complete exchange of engineering data between Boeing and Sperry. In several conferences in the past, Mr. Jordan had called attention to this matter but the companies had not followed through completely. Seemingly, both held the assumption that Sperry was working on an autonavigator which might never be installed in the B-47 missile. At the beginning of 1951 such an opinion was partially valid since the North American autonavigator delivery date far preceded that of Sperry. By May 1952 this great lag no longer existed. Therefore, it was certainly more within the realm of possibility that Sperry's system would be tested in a B-47 or even used operationally.

Lack of cooperation had placed the two companies in a position where





one's obligation was not clear to the other; more specifically, there were mutual engineering questions, such as autonavigator cooling and interconnections for aircraft controls, which could be answered only by close association. Mr. Pienkowski called a spade a spade: "...Boeing-Sperry relations and obligations to each other are not clear to anybody. WADC must soon step forward and outline the contractors obligations to each other. If WADC does not act as intermediary, the two contractors will get lost in the sea of indecision."

Flight Control Difficulties

At the same time (November 1951) that the center experienced schedule and priority frustration with the North American guidance, like troubles appeared in Sperry's work on the automatic flight controls. Sperry officials had failed to digest properly the project office's early and positive statements which emphasized the importance of strict schedule adherence. Sperry maintained that it could treat its Brass Ring contract only on an equal status with other I-A priority projects, and because of this fact it seemed likely, in November, that the flight control equipment delivery dates might have to be pushed back.

Both Wright Field and Boeing immediately set about to exert pressure on Sperry. Boeing advised its subcontractor of the great importance of its part in the project and stressed that any delay of flight control deliveries could only result in an overall program postponement. In a conference with Sperry's representative, Mr. Frank Conace, project office members repeated Boeing's admonitions and asked that Sperry "...examine closely their effort on Brass Ring to determine whether the possibility exists of eliminating delays in the program." Sperry was asked to make every effort to eliminate such delays, even at the expense of other projects.





The subcontractor took the advice to heart and by the latter part of April 1952 development of the flight control equipment was apparently back in step with the rest of the project. 104



IV BRASS RING PROJECT AT MID-COURSE

The H-bomb's physical size and its blast effects were two stubborn enigmas that doomed to failure any attempt to nail down firmly a set of fully valid carrier requirements. Consequently, there was a great deal of uncertainty always gnawing at the minds of and Brass Ring personnel. Could manned aircraft do the job? Could the weapon fit within the B-47's bomb bay? And could the Air Force produce a suitable carrier concurrently with the first super-bomb? Wright Air Development Center continually plagued the Sandia Corporation for pertinent and exact information, trying to get some leads, some ideas, some clues as to the bomb's characteristics. But the atomic scientists themselves were not sure. They could only forward guesses, or give minimum and maximum dimensions—which only deepened the quandary.

Project Brass Ring and the H-Bomb

The uncertainty of the H-bomb's characteristics became even more evident at a 14 June 1951 conference of representatives from Sandia Corporation, the Los Alamos Scientific Laboratories, Baltimore, and the center. The Los Alamos scientists indicated that it was obviously their intention to build a super-bomb small enough to carry in conventional Air Force aircraft. However, when they hazarded bomb size estimates, they thought in general terms of from 35,000 to 80,000 pounds in weight, about 20 feet in length, and approximately 9 feet in diameter. 105 (This was indeed a far cry from the 10,000-pound bomb envisioned in the Air Force's early planning days of 1949.) Sandia Corporation's assistant technical associate director, Dr. Harold M. Agnew, pointed out that the larger the bomb the better, because it could then contain a greater proportion of high explosives and less of



the costly fissionable material. For this reason, the B-36 and B-52 aircraft looked very appealing to the scientists inasmuch as they allowed greater packaging freedom.

Annual Contract

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Even more attractive was a proposed large cargo aircraft which would probably carry anything the scientists devised. When confronted with Air Force comments that such an aircraft would be extremely vulnerable, the scientists suggested that only one aircraft in an entire formation carry the H-bomb, forcing the enemy to play the role of a small-town sucker in a carnival shell and pea game.

Major Franzel informed the conferees that according to studies made at the Massachusetts Institute of Technology and the University of California, it was still considered dangerous for manned aircraft to deliver the bomb. When told of drogue parachute studies, the Los Alamos people objected because they regarded such a drop method as too vulnerable to ground and air interception. Major Franzel's presentation on Brass Ring disclosed that the B-47 missile could probably carry up to 50,000 pounds, but might be limited to a package only 25 by 5 feet. Whether or not the B-47 could even perform the mission depended entirely on the final H-bomb configuration. Los Alamos and Sandia personnel expressed the hope of furnishing more exact measurements within six 106 months.

Only four months later, on 3 October, Dr. Agnew informed the center that, "some major developments in the field of thermonuclear weapons have taken place since our meeting with your organization on 14 June 1951...." He wrote that Los Alamos planned to test a "thermonuclear device" in the fall of 1952, and if the test were successful, the scientists could probably have one or two custom-made bombs ready for aerial delivery by the fall of 1953. Dr. Agnew offered another set of dimensions, representing



latest scientific guesswork: a weight of 50,000 pounds, a length of 20 feet, and a diameter of 6 feet.

Thinking of B-36 or B-52 aircraft as carriers, Dr. Agnew expressed the fear that the Air Force could not safely transport a bomb of more than At least, information then on hand so indicated. However, he revealed that "the construction of presently conceived devices is such that they are absolutely immune to antiaircraft fire or shell fragments." Thus, he reopened the way for drogue parachute delivery. He also suggested increasing the reflectivity of aircraft surfaces to lessen the effects of the bomb's heat radiation.

The center, after receiving this information, wanted to make certain that the B-47 missile could carry a weapon of Dr. Agnew's description inasmuch as Brass Ring had been set up on the basis of a 10,000-pound bomb. Therefore, on 3 November, Mr. Jordan requested Boeing to undertake such a study. As a basis for the computations, the project engineer allowed Boeing a certain amount of leeway: it could make major bomb bay modifications, it could assume the bomb's center of gravity to be at its geometric center, it could plan on inflight refucing, and it could modify the existing bomb rack or select multiple bomb racks. In exchange for these assumptions, the project office wanted to know the extent of modification, maximum range of a one-way mission, the cost, and the effect of such a modification on the Brass Ring schedule. 108

When Mr. Jordan visited Boeing on 4 and 5 December 1951, he secured preliminary information on the study (subsequently verified late in January 1952). Boeing engineers told him that with a slight bulge and a minor bomb bay door change they could give the B-47B a capacity for a package 50,000 pounds in weight, 20 feet in length, and 6 feet in diameter. Although the added weight considerably reduced the aircraft's

range, a 4,000-mile range was attainable with two inflight refuelings. The basic mission speed (Mach .74) would remain unchanged, but the maximum altitude for the bomb drop was lowered from about 44,500 to 36,500 feet. Boeing put a price tag of approximately \$620,000 on such Brass Ring modifications. Late in February, the center gave Boeing permission to modify the fuselage of the two B-47B's to a weight-carrying capacity of at least 50,000 pounds (and 65,000 pounds if feasible). Modification of the bomb bay itself was kept in abeyance pending more certain super-bomb dimensions.

Shortly after the opening of 1952, Dr. Agnew revised much of the information he had given the center about the lethal effects of an H-bomb and the inability of manned aircraft to Tee safely from the explosion.

Based on calculations of the asserted that damage from neutrons, gamma rays, and thermal radiation would be unlikely at a distance beyond seven miles. "I feel certain," he stated, "that the manned delivery of the completely within our present capability using a B-36D or better aircraft."

Going further, Dr. Agnew told center efficials, "I have talked to the proper organizations and have endeavored to convince them that it is important not to have 'black' aircraft surfaces, and we are investigating the possibility of slowing the dement of such an object by means of some sort of drogue chute etc. Bouhling the descent time would give almost another 10 miles of distance which would allow fourfold increase in the deliverable yield." During a discussion with Dr. Agnow, center personnel pointed out that the University of California studies indicated that a manned aircraft would have to be approximately 100 miles from burst center to be completely out of harm's way. 112

Obviously, with such disparities of apinion, the Air Force could make





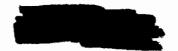
no immediate intelligent selection of either manned or unmanned aircraft for H-bomb delivery. Such a decision had to await the explosion of the thermonuclear device.

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Creation of the Air Research and Development Command with attendant personnel and responsibility changes, in addition to the constantly changing and perplexing implications of the H-bomb's characteristics and their effect on the carrier project, hampered precise direction on the part of Baltimore and Washington headquarters. In turn, these factors played havoc in the project office because it and the center lacked authority to make overall decisions. Consequently, starting in the fall of 1951 the center began to emit a flood of correspondence, a stream of teletypes, and a flow of representatives in an effort to prod "higher authority" into action.*

The first such major effort came in the latter part of October 1951. In a letter to the research and development command headquarters, Mr. Jordan outlined Brass Ring progress up to that time. He referred to previous verbal approval of the additional Brass Ring requirements: a carrier for high yield bombs in addition to the H-bomb, a completely automatic B-47 (as opposed to the main objective wherein the director participated in the take-off and initial portion of the journey), and a B-17 drone. Baltimore and Washington had never given their official blessings to these alternate objectives, and existing funds and aircraft allocations were geared only to the primary mission. More money and aircraft were needed if Washington sanctioned the secondary Brass Ring features. Also of importance was the assignment of an alternate high yield weapon to Brass Ring, either warhead or bomb type, so that Boeing could calculate ballistic requirements and accomplish structural changes to the two

^{*}For a detailed list of events relating to this fluid project situation, see App. 121.

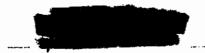


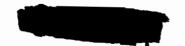
B-47B's, one of which had been delivered to Seattle on 30 August and the other on 10 October. In addition, the project office needed head-quarters' agreement that manned take-off and crew bailout provisions be incorporated in case the autonavigators failed to meet the schedule.

In order to follow the existing Brass Ring timetable of an operational weapon system by 31 December 1953, Mr. Jordan made several recommendations concerning test procedures. He suggested that all research and development be conducted at Boeing's field in Seattle. Also, he asked that command headquarters obtain designation of an operational unit to begin training on the complicated guidance system on 1 January 1952, with full-fledged Brass Ring training to start the following September. Along with these actions, he believed that selection of an operational field and preparation of facilities, instrumentation, and runways was in order. To create the smooth-running organization needed to completely check out Brass Ring equipment, Mr. Jordan suggested a task force composed of members from the operational unit, Boeing, the subcontractors, and the center-this group to be placed under direct control of Air Force headquarters.

Finally, in attempting to bring the entire picture into sharper focus, Mr. Jordan carefully and clearly outlined what the center assumed to be the responsibility of each Air Force component in the Brass Ring program. The entire letter was a simple and concise statement of the step-by-step cooperation needed to ready Brass Ring aircraft and operating personnel within the time limitations. On 26 November, Brigadier General John W. Sessums, the Air Research and Development Command's deputy for development, forwarded the above information to Brigadier General Donald N. Yates, director of research and development at Headquarters, United States Air Force.

On 12 December, Brigadier General Floyd B. Wood, the center's chief





command headquarters. He stressed the importance of an early decision by Washington on its choice of a super-bomb carrier, "...because of the time, study, and expense required for the design, modification, and structural tests required for accommodation of the weapon." On the basis of all available data, General Wood thought that the Air Force could have two aircraft—the B-36 and the B-47B (either manned or in a Brass Ring configuration)—to carry the bomb by December 1953. From studies under way, the center believed that the B-36D constituted "...the most practical airplane for tactical utilization...," although perhaps marginal from an escape viewpoint. General Wood noted, however, that the B-36 had a probable radius of 1,920 nautical miles whereas the unmanned B-47 (with two inflight refuelings) had a one-way range of 4,000 nautical miles.

Seeking official guidance for future officers on 13 and 14 December presented the existing status of possible H-bomb carriers to Brigadier General Alfred R. Maxwell, special assistant to Lieutenant Earle E. Partridge, commander of the Air Research and Development Command. Major Vanden Heuvel, who was at the presentation, reported that "...in the informal discussion at Eq., ARDC, General Maxwell voiced an opinion that since the B-47 can technically do the job, it should be given prime consideration as the carrier." General Maxwell also suggested the possibility of a manned B-47 and thought that only future developments and studies would determine which B-47 version should be used. A similar presentation at Air Force headquarters evoked like opinions. However, these opinions were informal only.

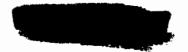
General Yates' comments on 5 February 1952 cleared up a few, but not all, of the questions posed by Mr. Jordan's letter of 24 October and



General Sessums' letter of 26 November 1951. General Yates noted that no requirement then existed for a drone delivery of any bomb except possibly the H-bomb. This cast considerable doubt on one of the alternate objectives set up for Brass Ring. The general approved manned take-off and bailout procedures as a safeguard in the event automatic navigators were not developed before projected deadlines. He briefly instructed Baltimore headquarters to proceed with Brass Ring development testing, but gave no directions for operational testing other than to say, "Other commands will be issued support directives when this is proven necessary for the proper continuance of the development testing."

The director of research and development questioned the need for the degree of complexity in the completely automatic B-47 missile. He wrote, "It is probable that the director aircraft could escart the carrier to a position sufficiently close to the target where an inertial system could control the carrier to the target with an improved degree of accuracy." He asked that this or other simplified delivery concepts be given consideration. Then General Yates made a remark which emphasized the point that Brass Ring was only one possible means of delivering the H-bamb and had never actually been designated as a definite operational method. He stated, "The operational needs for unmanned 'H' weapon carriers has not been established. This headquarters is taking the necessary action to determine the requirements and make plans accordingly."

Following the chain of command, on 5 March, General Sessums informed the center of General Yates' comments and added some of his own. In response to the center's query, General Sessums approved the additional objectives of project Brass Ring, provided fulfillment required no more funds or material than the primary mission. But the road toward test completion was not so clear-cut. General Sessums asked the center to

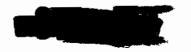


"...prepare and submit to this Headquarters, for check by AFMTC Air Force Missile Test Center, a recommended testing program to comply as closely as practicable with AFR 80-14." Stating that he realized the unique qualities of Brass Ring, the general nevertheless felt that the regulation should be followed as closely as time permitted. Contractor testing, however, should begin immediately. Meanwhile, Baltimore would set machinery in motion to arrange for Air Force personnel to begin on-the-job training at the contractor plants by 1 August. 119

More than four months had elapsed since the project office sent its letter to Baltimore. A project office report summed up the action on its letter by saying, "It is the opinion of WADC that the ARDC Indorsement was too general in nature and did not specifically delineate responsibilities as requested by WADC. In view of the special nature and time limitation imposed upon Brass Ring, it is felt that the assignment of the outlined responsibilities is paramount if the project is to be completed as programmed."

In a meeting with Major Franzel, who had become Brass Ring project officer at command headquarters, center personnel aired their difficulties. Although most of their original questions had been answered, the center felt they had not been answered adequately. Individuals responsible for and Brass Ring agreed that little direction had been given to their need for specific test information, selection of an operational test site, and requirements for a training program. Upon their return from Baltimore, the center representatives noted, "It was the consensus of WADC and ARDC personnel that a definite difference of opinion exists among Hq. USAF, ARDC and WADC personnel as to the scope of Brass

^{*}This regulation outlined in detail the research and development test programs for Air Force aircraft, materiel, and equipment.



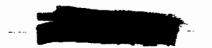


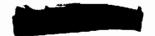
Ring and means for implementing the program. Hq, ARDC contacted Hq, USAF and established the above fact." Upon General Yates' suggestion, the three parties agreed that Wright Field should give a presentation to General Yates, to be followed by a conference to resolve unsettled issues.

The conference took place on 24 March 1952. Apparently such a meeting was needed all along, for the conferees came up with some concrete decisions. First of all, General Yates advised the and Brass. Ring representatives that the general opinion in the Air Staff tended to alter, or extend, the Air Force responsibility for H-bomb delivery. Not only did the Air Force have to have a method on hand to carry the first weapon, but it had to be capable of delivering "...production versions of the bomb in quantities and in accordance with the present concept of strategic bombing." Project Brass Ring satisfied the first requirement and all agreed that it be pushed vigorously toward completion.

The center won a point at the conference that it had been trying to establish for some time—that Brass Ring was a "special project." Upon Mr. Jordan's and Major Vanden Heuvel's suggestion, Air Force and command headquarters accepted that term as meaning that the center could waive any existing testing or training regulations which did not specifically apply to the performance of the Brass Ring mission, and both headquarters agreed to the project office's proposal that it draw up a special testing and training program for submission to Baltimore.

Finally, General Yates pointed out that there still were no plans for large-scale production of the Brass Ring aircraft; however, this would be firmly decided by a Washington headquarters' study of how to provide carriers for production versions of the super-bomb. 121 This





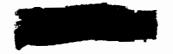
study had to take into consideration certain facts which were not as yet known—dependability and accuracy of Brass Ring and the characteristics of the H-bomb, among them.

A few days previous to the conference, General Yates made a decision on which indicated official Air Force thinking on another phase of the program. He stated that because only minor structural changes were necessary for the B-36 to carry the H-bomb, that aircraft was designated as the manned carrier. B-36 alterations would not begin, however, until the Air Force had conducted drogue parachute drops in addition to witnessing the Operation Ivy explosion (the code name for testing the thermonuclear device).

On 8 April 1952, shortly following the meeting with General Yates, Wright Field outlined the Brass Ring training program. Consistent with the interpretation of a "special project," the project personnel based the program on "the ability to perform a specific mission rather than universal operation." In March, Boeing had already started the first three phases of testing: air worthiness and equipment functioning, contractor compliance, and design refinement. The next three phases—performance and stability, all-weather, and functional development—would be by-passed. Phase VII, operational suitability, was to vary from the usual procedures, in essence, being "a combined operational evaluation of the project and unit training for the Air Force personnel." The three phases to be carried out would continue from March 1952 until November 1953; Phase VII would take place during the last two months of 1953. 123

The center "strongly recommended" that Air Force training take place at the contractor plants during the time of the development and test programs. Training should begin immediately because the Brass Ring operation needed highly specialized skills, because no training equipment other





than Brass Ring hardware was available, and because an extensive period to complete the training was required. Therefore, Mr. Jordan and Major Vanden Heuvel asked Baltimore to obtain expeditious action in selecting and assigning personnel, setting up the training program at the contractor site, providing necessary training aids, and scheduling the training period to fit the Brass Ring end dates.

Changes in Brass Ring Mission Profile

Before the Air Research and Development Command acted on the center proposals, Brass Ring plans, still somewhat uncertain pending the completion of the Air Force study, suddenly moved forward—but in so doing, they took a different tack.

In the 24 March conference General Yates had mentioned the Air Force study under way to consider all aspects of super-bomb delivery. The Air Research and Development Command, at the same time, had agreed "...to study alternate modifications of B-47 airplanes to accomplish the same mission for which Brass Ring is intended." Thus, on 4 April, Baltimore asked Wright Air Development Center for alternate modifications proposals, "...which would be simpler, cheaper, and easier of accomplishment... and more suitable tactically to SAC." Command headquarters envisioned a director aircraft to "mother" a B-47 drone all the way to the target and then dive the drone or release the bomb from it.

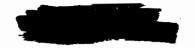
On 22 April, Wright Field personnel met to evaluate radiating guidance systems available for installation. The initial reaction among the conferees was that three equipments seemingly filled the bill: a modification of Goodyear's Atran System, an adaptation of the Rascal system, and a method employing the director aircraft's radar and computer system for tracking and commanding the carrier. Although Baltimore had asked for the results of the study by 4 May, other events

intervened and no answer was made until 5 June. 127

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Late in May, Baltimore passed along information received from General Yates earlier in the month. Inasmuch as it had become apparent that neither the North American nor Sperry guidance systems could be ready for a Brass Ring operational date of July 1954, and imasmuch as the complex automatic B-47 might not be the best approach to unmanned H-bomb delivery, General Yates directed a search for some other technique. As a matter of fact, the more practicable avenues the general suggested were already being considered. These points, which the general reiterated, included manned take-off, inflight refueling, crew bailout, directing the B-47B to a point within 40 to 50 miles from the target, and amtomatic guidance from that point to the target. In addition, the general made the bomb burst method optional: the bomb could be automatically dropped or could remain in the aircraft as part of a diving missile. General Yates made it quite clear that these directives were not intended to cascal Brass Ring but were issued only to arrive at a more simple unmanned delivery of the ьоть. 129

Paralleling General Yates' letter to Baltimore and its further dissemination to Wright Field were events occurring at North American. In the first week of May, North American, which from the beginning had maintained that its autonavigator would meet Brass Ring schedules, announce a major alteration. The company stated that it had to postpone delivery of the autonavigator from 1 August 1952 to at least 15 February 1953 and it would not be completely tested until October 1953. The net effect was necessarily a 50 per cent reduction of the B-47 missile flight test period of 12 months—a period hardly sufficient to test guidance reliability for an operational Brass Ring aircraft. North American representatives contended that the principal reason for the imbroglio in which they found



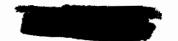


themselves was their dependence on Navaho guidance development. Such dependence was fine until the company reached the point where it had to conduct special research and development for items peculiar to Brass Ring, such as ground checkout and flight test support equipment and a star tracker.

The company officials proposed salvation of the program by completely reorganizing their effort "...to enable North American to expediate
all applicable phases of Brass Ring." Relative to this remark, an entry
in the project office diary drily stated, "It was the understanding of the
project office that this effort was in effect from the origin of the project." Major Vanden Heuvel asked North American to study its position
carefully and outline its capability at a conference with Eoeing and
Wright Air Development Center officials. 130

By conference time, 27 May, North American had failed to find a panacea for its schedule ailments. The company's presentation and the ensuing round-table discussions brought out these unequivocal points: no matter what priority or expedited action North American worked under, it could not deliver the autonavigator within the Brass Ring time scale; conversely, the Brass Ring completion date could not be further extended. In addition, North American complained that its work on Brass Ring adversely affected its progress on Navaho guidance. The project office saw no alternative but to agree to North American's request for cancelling its autonavigator from the Brass Ring program. North American's development work cost the government approximately \$850,000.

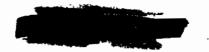
Thus it was apparent that no mode of automatic navigation would be available for the first battle-ready B-47 missiles and that another method, although proposed only as an alternative, would in reality replace the originally scheduled inertial guidance system. Sperry's autonavigator

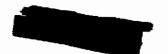


was essentially worthless to existing Brass Ring schedules for it would not be operationally suitable until December 1954. Accordingly, on 5 June, in answer to Baltimore's request of 4 April, the center offered the concept of a "B-47B drone-director technique with pre-set Dead Reckoning" as its solution for a mid-1954 unmanned H-bomb carrier. This was the only sure-fire method of meeting Brass Ring accuracy requirements as well as providing quantity production. In order to carry out such a new approach, however, the center stated that it needed three more B-47B aircraft to be modified as directors--the original B-47A director lacking the range capabilities for a full-scale mission. The director-drone version required two directors to accompany one carrier to within 40 or 50 miles of the target. The two directors were necessary in the event one or the other command guidance system failed. Should there be two carriers on the mission, they would have to be accompanied by three directors—one for each carrier, and the third to replace either of the two directors if they were forced to abort. The pre-set dead reckoning equipment was the only such system available within the projected deadlines. 133

Ten days later, the center further explained the existing positions. On the question of production Brass Ring aircraft, the center estimated that a limited quantity could be ready about 18 months from date of contract signing. This meant that if Air Force headquarters allowed production, it must issue the procurement directives and allocate funds by 1 August 1952. Unit modification costs were calculated to be in the neighborhood of \$1,000,000 for each carrier, \$400,000 for each director, in addition to \$1,000,000 for supporting spares and equipment for an operational unit.

The changed mission conditions, the center went on to explain,
"...will provide the technical capability (the tools) to accomplish





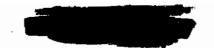
delivery of the 'H' Bomb by the dates specified December 19537" To be certain of an operational capability, however, there were other actions that had to be taken. First of all, Wright Field required permission to establish a direct liaison with the Sandia Corporation to obtain weapons data at the earliest possible moment to give the contractor vital measurements for his modification work—data still missing at that late date. An Air Force operational unit had to be designated so training could begin without delay.

By this time the training program had risen well toward the top of major Brass Ring problems. Because of already serious delays, the center proposed that the 3205th Drone Group, of Eglin Air Force Base, be considered for forming the cadre for the operational unit and taking over the Brass Ring system following project office acceptance of Boeing's B-47 work. This group was a logical choice, as it had participated in the Cross Roads, Sandstone, and Greenhouse operations. 134

It was during this period (June 1952), when the above information germinated in Baltimore, that responsibility and direction of shifted from the Wright Air Development Center to the Air Force Special Weapons Center, at Kirtland Air Force Base, New Mexico. The reason behind the move was to insure that the special weapons center remained in the atomic energy test program. Although was the overall administrative instrument for H-bomb delivery and Brass Ring only a part of it, the special weapons center felt that Wright Field should retain the extensive B-47 modification program under way. Accordingly, the Brass Ring portion did not accompany the

The transfer of the responsibility meant, of course, that the special weapons center would initiate future policy decisions

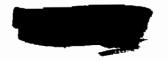




which could affect the Brass Ring program. Therefore, Wright Field stressed that "if, during the course of the development of an H-Bomb carrier, it is determined by AFSWC that the BRASS RING project is not necessary to the solution of the H-Bomb delivery, it is the considered opinion of the WADC that the project should be carefully evaluated for other possible applications prior to a decision for cancellation." 136 The transfer began in July 1952.

On 16 July, the center suggested to Baltimore that a conference be held among all interested Air Force echelons to settle some of the questions which remained outstanding on Brass Ring, such as training, funding the new work, and assigning additional aircraft to the project. The conference was scheduled for 30 July; however, Washington postponed it until 12 August. Time grew shorter and shorter and the project office became impatient. Its diary entry for 29 July slated, "In view of previous hesitancy by Hq. ARDC and Hq. USAF to resolve critical Brass Ring problems, this additional delay will add to the list of circumstances that are making the established delivery date appear unrealistic. 138

The conference, held on 12 and 13 August, was all-embracing, in that it brought together all Air Force units interested in and Brass Ring. Held at the research and development command head-quarters the first day, and Air Force headquarters the next, the conferences included representatives from the Air Research and Development Command, Strategic Air Command, Air Proving Ground Command, Wright Air Development Center, and the Air Force Special Weapons Center. With no qualms about repeating themselves, the center representatives asked for definitive statements on Brass Ring operational plans (if any), for the assignment of three additional B-47B's, for a decision on the





training program, and finally, for a new allocation of money (the lack of which was acute at this time).

Following the Brass Ring presentation, special weapons center officers reported on the status. They stated that their commander, Major General John S. Mills, interpreted the Air Force emergency requirement for an operational capability by December 1953 to
mean the ability to deliver a number of bombs instead of only one.

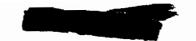
This placed increased emphasis on carrier production as opposed to a
few specially modified aircraft. Up-to-date studies on potential Hbomb blast and thermal effects indicated a strong possibility that
manned aircraft could carry the weapon, but manual unequivocal findings
were possible until the completion of Ivy Operations.

How did these statements affect Brass Ring? Mr. Jordan, present at the meeting, wrote, "It was the consensus that, providing the bomb could be delivered manned, Brass Ring should not be continued solely for this purpose. However, in view of the advanced stage of development of the drone aspects of Brass Ring, it was agreed that this part of the program should be continued to completion regardless of the decision on Brass Ring."

With this basic agreement in mind, the second-day conference members set up three different approaches to comminue Brass Ring. The first envisioned only a limited drone capability (one B-47% director and two B-47% carriers) in which the Sperry extonavigator would not be used and Boeing would make no bomb bay modification. This concept was based on the premise that manned aircraft would carry the bomb. The second approach provided for Brass Ring equipment to carry the

^{*}For a discussion of Brass Ring Funds, see pages 87-91.





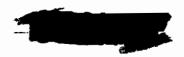
first H-bomb in a director-drone type of operation. This meant bomb bay and bailout modifications to the two B-47B carriers on hand and the assignment and modifications of three B-47B's into director configurations. The final alternative was providing for delivery of several bombs and meant modification of five B-47B carriers and five B-47B directors.

This type of program, however, left the Brass Ring project still up in the air. Although Boeing could continue work on the first plan, there was no chance for it to meet existing deadlines should either of the two latter alternatives be chosen. Therefore, conference members agreed to a compromise: Wright Field should continue to consider Brass Ring aircraft as the vehicle for delivery of the first H-bomb, while initiating action to acquire carrier and director equipment needed to deliver several bombs. Thereafter, 1 January 1953 at the latest, Air Force and command headquarters would forward program changes based on findings from Ivy and the drogue parachute dummy drops. The conferees decided to delay the training program until the same date and then, if necessary, carry it out expeditiously. These were the decisions carried back to Dayton. 139

Contractor Progress

During the period when the Air Force personnel corresponded and held periodic conferences in an attempt to straighten out the kinks in the Brass Ring program, the various contractors continued their development and modification work.

After having cleared up priority and schedule difficulties by April 1952, it was assumed that the development of the Sperry automatic flight control equipment would remain in phase. However, in the latter part of July 1952, the center learned that Sperry feared a 10-week delivery post-ponement of the final group of parts—the air speed follow-up unit, the





Mach reference unit, and the throttle control unit. These items had been marked for shipment by 1 August. Because there had been no advance indication of such trouble, the project office immediately contacted Sperry.

At first, company representatives placed the blame on its subcontractors' shoulders. These plants, Sperry explained, sent in equipment which either had to be returned or reworked at Sperry. Furthermore, Sperry went on to what it considered the heart of the matter, indicating that "...as long as Government policy emphasizes so strongly the utilization of small contractors, these delays will be encountered with short advance notice."

A few days later, after the company thought the matter over, it revised its explanation. Shifting the blame to its own shoulders, Sperry stated that it had allowed no leeway for rejection of subcontractor equipment—which was usually a factor that had to be considered. The company was caught flat-footed because the number of rejections was greater than normal. Representatives informed the center that company employees were working practically around the clock and through their vacation period in an attempt to recoup some of the lost time.

As it turned out, the company managed to make deliveries earlier than it anticipated. 142

Shortly thereafter, a new unavoidable wrinkle appeared. The B-47A director, to be ready for acceptance in September, fell afoul an Air Force B-47 grounding order which called for a fuel cell inspection and modification. By mid-October, however, Boeing informed Wright Field that the two B-47B carriers and the B-47A director were ready and awaiting government acceptance, according to the terms of the Phase II contract, although there had been no changes to the bomb bay nor were bail-out provisions incorporated. This statement could not be swallowed





completely by development and procurement officials. Boeing's basic

Phase II document, incorporated as a part of the contract, specifically

stated that "...Boeing will evolve a system which would be capable of

refinement to a highly reliable system although trouble shooting of the

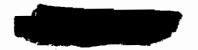
design can not be expected." This statement was not in line with Boeing's

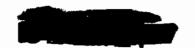
letter of 25 September 1952 which indicated that "...only sub-systems

will be tested by 30 September 1952."

While talking to Boeing officials, Major Vanden Heuvel learned the company was willing to make the statement that it had developed "...a complete system without further flight testing, even considering that the complete system has not yet been airborne. The project office feared that any additional Phase II work, except deficiencies, would come under Phase III contract and be paid for on a cost-plus-fixed-fee basis. Boeing representatives argued that further flight testing, "simply to prove the system is a complete system," was a needless expense and would probably only delay the entire program. They felt the government should accept the aircraft, proceed with the extended flight test program (Phase III), and then worry about reliability.

Despite the difference of opinion, both parties were interested in arriving at a workable system for Brass Ring; therefore, they reached a compromise. Major Vanden Heuvel agreed to recognize Boeing's contention that it had a complete system—but unconditional engineering acceptance would be withheld until flight tests proved Boeing's point. Air Force observers would be present at these flight demonstrations, which were actually a part of the extended flight test program. Summing up the agreement, Major Vanden Heuvel stated, "If this demonstration is not successful and a complete system is not yet available, the work by Boeing, until a system is demonstrated, becomes a matter of renegotiation to apply the costs to the



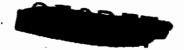


correct phase of the contract. 148

In the last week of October, the B-47 director made its functional test flight, and after the aircraft had flown a total of 23 hours, center representatives gave it their stamp of approval required for engineering acceptance. 149 Because the director was not needed for further test purposes (the B-47B's contained equipment which simulated the director's function), the aircraft was transferred to the Air Force Flight Test Center early in December for use with other Air Force projects until it was required for Brass Ring. Because of subsequent testing delays and project termination in April 1953, the two B-47B carriers never received formal engineering acceptance.

by the time Boeing began flight testing the director and carrier aircraft, the company was working under terms of the contract's final phase. Negotiations for Phase III had actually begun before the 12-13 August 1952 conference had been held in Baltimore and Washington, the center attempting to get a head start on the decisions it hoped—and expected—General Yates would make. Consequently, when Wright Field obtained tentative permission to proceed with the extended flight test work and modification of the three additional directors (as well as the two carriers on hand), Boeing's contract proposal was already in the project office. 152

As was the case with the development contract, the Phase III negotiations initially appeared in the form of a letter contract, which was signed on 31 October 1952. It had a face value of \$500,000. The contract covered four principal units of work: the extended flight test program on the original Brass Ring director and two carriers, training of Air Force personnel at Sperry and Boeing on the remote control and telemetering subsystems, conversion of three B-47B's into directors, and further modification of the two B-47B carriers for the director-drone concept. 152



Although Boeing proceeded with the flight evaluation of the original Brass Ring aircraft, the government did not allocate the three other aircraft or send personnel for the training program. The necessity for the last two actions hinged on the ultimate fate of Brass Ring-whether Air Force headquarters accelerated, decelerated, or stopped the project. Its action, in turn, awaited the outcome of Ivy results and drogue parachute test drops of simulated heavy weapons. Mr. Jordan and Major Helms (the latter working on the project since September 1952) closely watched another modification task that Boeing had undertaken. As a part of its work on the Air Force Special Weapons Center had authorized a bomb bay modification on two B-47B's to be used in drogue parachute drops from manned aircraft. This work paralleled that to be carried out on Brass Ring carriers—should the unmanned version receive the nod from Washington. 154

The only Boeing modification that had not received much attention up to December 1952 was the bailout provision in carriers. In December, Major Helms, Mr. Jordan, and Lieutenant Edward G. Sperry, aircraft escape expert from the Aero Medical Laboratory, inspected Boeing's B-47B Brass Ring bailout provisions for the contemplated one-man crew. The escape hatch installation met the requirements for accessibility and allowed sufficient room for movement while in escape position, but previous tests (in conventional B-47's, not Brass Ring aircraft) had not proven conclusively that there was an adequate margin of safety for a man to drop through the hatch, past the spoiler, and into the windstream. The three center inspectors agreed that additional tests were necessary, even though the proposed speed (250 knots) and height (15,000 feet) were not excessive for bailouts without an ejection seat. 155

Three dummy drops were held at Boeing during the early part of





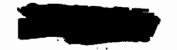
March 1953. Center witnesses agreed that the tests proved that an escaping person should use a "cannon-ball" position in order to clear the aircraft. For the most part, the tests were regarded as successful; however, human drops would be necessary before the installation and the maneuver could be employed operationally. Because of project termination, these were never held. 156

The one item of Brass Ring equipment which had not yet been developed, of course, was the Sperry autonavigator. All during the summer of 1952, Mr. Pienkowski, of the Armament Laboratory, as well as the Brass Ring project office, wrestled with the slippery autonavigator problem. It was the star tracker development that was particularly elusive, and prompted Mr. Pienkowski to write what appeared to be a report in parody, entitled, "How to Beat the Subject of Star Trackers to Death." For some time after the legal battles within the Pacific Mercury organization had begun, Sperry's search for another subcontractor to construct the star tracker ran into nothing but blind alleys. Some companies could not promise a schedule compatible with the guidance system, some companies lacked competent personnel, and at least one company was on the brink of insolvency. 157

It was not until November 1952 that Sperry took decisive action, and this was only four months before the extended delivery deadline. The company decided to build a day-night star tracker itself as well as to subcontract for a similar item to the Santa Barbara Research Center.

Although the Brass Ring Sperry autonavigator was cancelled as such, the Armament Laboratory planned to carry the autonavigator to completion. Generally speaking, the idea behind the laboratory's sponsorship was to advance the autonavigation state of the art. In October 1953, it appeared that the Sperry autonavigator would be ready for flight test toward the end of the year—some 10 months past the February 1953 Brass Ring delivery

^{*}See App. 80.

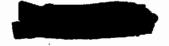


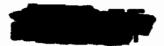
Brass Ring Funds

The project office's original estimate of \$4,900,000 (made in May 1950) to complete Brass Ring, remained unchanged until the beginning of 1952. Although it had become apparent from Boeing's fiscal reports that the company was beginning to accumulate a substantial overrun, center personnel believed that some reprogramming could take care of the matter. However, in mid-February 1952, Boeing dropped a budget bomb-shell on the center. After a review of overall funds requirements, the contractor stated he had to revise the estimate from \$4,900,000 to a staggering \$10,300,000.

Boeing broke down the increase in cost with the explanation that it had an overrun of \$1,600,000 on its books, North American foresaw a \$700,000 overrun on the autonavigator work, and \$3,100,000 was needed to cover the expanded scope and lengthened schedule for Brass Ring. The latter category Boeing also explained. When the project began, Boeing had submitted its proposal on the basis of "time available," rather than "time required." Thus, when the deadlines were set back, more time became available; this, in turn, allowed an expansion in the scope of work. This aided that Air Force and the contractor in devising a more realistic development program; unfortunately, it was a costlier one. Boeing enumerated several other factors that had contributed to raising the last cost item to \$3,100,000. Among these were the training program for Air Force personnel, consultant services for planning the operational mission, extra flight evaluation time, and the bomb bay modification not originally

For an excellent overall picture of project Brass Ring funds, see App. 132.



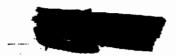


included. Finally, Boeing admitted that it had grossly underestimated the cost per hour to flight test a B-47. Taking a look at the financial status in mid-February 1952, the center calculated that the money then under contract—\$3,900,000—would support the project until approximately the first of April 1952. From that date until 30 September, the expected delivery date of the three airplanes, it appeared that \$2,400,000 would have to be allocated. Wright Field immediately informed command headquarters of the situation and requested the \$2,400,000 for fiscal year 1952, plus \$4,000,000 for fiscal year 1953.

Toward the end of March 1952 the contractor began to run out of money; in fact, on 25 March Boeing officials dispatched a frantic wire stating that Brass Ring work would halt as of 1600, 28 March, unless the company received an immediate allocation. The center barely met the deadline and managed to thwart the threatened stoppage of work by obtaining \$1,200,000 of fiscal year 1952 money. During July, an additional amount (\$500,000) had to be secured to cover further overruns.

The financial difficulties encountered during fiscal year 1952 were mild in contrast to the Brass Ring woes of fiscal year 1953. The request for \$5.200,000 in research and development funds was slashed to \$1,750,000. When queried, command headquarters stated, informally, that the difference would be supplied in the form of procurement funds. This supply of money never "panned out."

The Brass Ring financial status was given a complete airing at the important 12-13 August conference with General Yates. The center representatives also reviewed the costs that could be expected for the different Brass Ring concepts being entertained at that time. As mentioned previously, three avenues of action were open to the Air Force. To meet the drone configuration requirement only, Boeing needed an additional \$750,000



fiscal year 1953 funds; to provide the capability of delivering the first H-bomb required \$6,000,000 more in fiscal year 1953 funds; and to expand the program for delivery of several bombs required \$11,000,000, which could be distributed over two fiscal years.

The compromise effected at that time allowed Wright Field to proceed with the second alternative. However, no additional funds were forthcoming; instead, the program had to be continued with only the £1,750,000 contained in the original fiscal year 1953 appropriations. 167

For a time it seemed likely that Boeing would again run short of cash by 1 December 1952; in fact, the company's reports showed heavy month-bymonth expenses which promised to quickly dissipate the fiscal year 1953 appropriation. 168 However, the slow-down on the modification program, Boeing's re-examination of its accounts, plus the company's receipt from the government of \$850,000 for Phase III work, helped to delay another As it turned out, \$1,750,000 was all the project received during the remainder of the fiscal year (except for additional termination funds).

Outside the project office's surveillance was the money spent for the Sperry Brass Ring autonavigator. As indicated previously, this was an Armament Laboratory development and its funding was separate from that of Brass Ring. While the guidance system was being developed specifically for Brass Ring, Sperry received \$2,313,000.170

TERMINATION OF BRASS RING

According to agreements reached at the 12 August conference, Air Force and command headquarters promised to make a decision on Brass Ring's future by the end of 1952—following the Ivy operations and special weapons center drogue parachute tests with 50,000-pound objects. Because the Air Force Special Weapons Center had become the responsible agency for the wast that center's task to evaluate prospects in the overall H-bomb carrier field and make initial recommendations for any changes. General Mills forwarded to Baltimore his suggested policy changes on 31 December 1952.

The Reginning of the End

General Mills' basic premise emphasized that "the continuation of BRASS RING for delivery of thermonuclear weapons is dependent upon the non-existence of any alternate delivery methods of comparable effectiveness which are less expensive." However, from preliminary Ivy information, the special weapons center had concluded that delivery of H-bombs "...with yields of under certain conditions appears feasible..." by means of a B-36 employing drogue parachutes. In addition, the drogue parachute mode of delivery constituted a definite possibility for dropping a weapon having a still higher yield.

General Mills stated that tests had progressed to the point where it had become practical to deliver an H-bomb with drogue parachutes, and accuracy was "essentially equal" to that of conventional bomb drops. The safety factor for a E-36 or B-47 bomber was more than adequate. The apparent ability of an enemy to fire at the bomb as it wasted downward toward its target had also been taken into consideration.

From the information at his disposal, General Mills concluded that "comparison with BRASS RING delivery on the basis of cost, reliability, vulnerability, accuracy, and maximum yield capability for relation to probable yields, eliminates the requirement for BRASS RING for the 'emergency capability.'" Furthermore, he foresaw little or no role for the Brass Ring aircraft in Air Force operations involving thermonuclear weapons. General Mills recommended the cancellation of project Brass Ring in support of

The general recognized that much development effort and money had been spent on Brass Ring and complete cancellation would nullify the gains obtained from this expenditure. He thought there were probably other applications for a drone B-47, perhaps in weapon effects and atomic cloud tests and other experimental work requiring remotely controlled aircraft with high performance ratings. Therefore, General Mills made the further recommendations that the Brass Ring project be continued on a demphasized basis, but completely severed from its parent project.

Desiring background information for the Air Force Special Weapons
Center recommendations, Wright Field met with that center on 16 February 1953. As the Brass Ring representatives suspected, the special weapons center had predicated its recommendations only on the weapon effects point of view. Mr. Jordan pointed out that vulnerability of the carrier itself to enemy defenses should be recognized. According to aircraft standards at the beginning of 1953, the B-36 was more of a "sitting duck" than any other Air Force operational bember. Special weapons center officials replied that such considerations came under the purview of command headquarters. The Wright engineers, however, held the opinion that under the weapon system philosophy of development, the



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office should make recommendations concerning every angle of the delivery problem. The command representative present at the meeting thereupon agreed to schedule another conference in Baltimore on 22 January to discuss further the entire carrier program.

This conference, held on schedule, brought together command and Wright Air Development Center personnel. The Brass Ring representatives brought up the range aspect of super-bomb carrier operations and presented an analysis of the B-36, and B-52, and the B-47 (the latter in a manned and unmanned version) with a 50,000 pound bomb load. They also pointed out that the special weapons center's recommendation of using a manned B-36 failed to meet the 4,000 nautical mile one-way range requirements of

The center then asked Colonel Thomas S. Jeffrey, director of strategic combat systems in command headquarters, for any substantiating range
data upon which selection of the B-36 could be made. Although Colonel

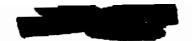
Jeffrey thought that the original range requirement still stood, he called
Colonel Albert M. Cate, in the Directorate of Research and Development,

Air Force headquarters, to clarify this point. The latter supplied no
direct answer but indicated that the range factor would definitely be
considered in making the final selection of the aircraft to carry out the

task.

On the center's question regarding vulnerability of the B-36, the conference brought out the point of view held by the Strategic Air Command—that the B-36 and B-47 were approximately equally vulnerable. The only circumstance modifying this was that the former had to spend more time over enemy defenses, since it was the slower of the two aircraft.

^{*}See Appendix;Ip-7.



The center recommended that Brass Ring be completed, "to provide a guided missile capability" (this included engineering for a "B" director and two "B" carriers—one of which incorporated the autonavigator). The primary approach to such capability incorporated the Sperry autonavigator; the secondary, a director—drone concept. Center representatives stated, "To this end, the due date (December 1953) for Brass Ring should be waived and the project conducted in line with other Guided Missile Programs." In addition, the center asked that consideration be given to procurement of carrier and director equipment in line with the drone version "emergency capability" (five to ten carriers).

Command headquarters' comment on these recommendations pointed out that, firstly, "it is not a fixed policy within the Air Force that all manned capabilities be 'backed up' by missile capabilities." Procurement of additional director and carrier equipment for emergency capability needed a required lead time of 18 to 24 months—too long to meet the established December 1953 delivery date. Summing up, command headquarters stated, "Due consideration should be given to continuing the Brass Ring drone and Sperry autonavigator programs because of the advanced status of development."

The center considered the conference a partial victory. Its representatives returned to the base with the belief that command headquarters intended to recommend to Washington that Brass Ring be continued until the autonavigator had been installed and evaluated in the B-47 carrier. Baltimore was also expected to ask that Wright Field be allowed to complete the procurement of three sets of director equipment, although installation in aircraft would only be done if definitely required. On the other hand, there was to be no further action on additional carrier equipment (beyond that already installed in the two original B-47B carriers). 172

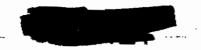
Despite these plans for Brass Ring continuance, however, the Air Force emergency operational H-bomb delivery plans appeared to be based on the manned B-36 with a drogue parachute. The basis for this decision lay in the existing interpretation of an operational capability—having five to ten carriers on hand. A B-47 modification program of such magnitude could probably not be ready until a few months before the appearance of an equal number of B-52's. This was the aircraft which could supplant the B-36 emergency method. 173

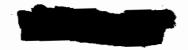
Relative to the decisions of the conference, Mr. Jordan remarked,
"The ARDC recommendations seem to represent a logical compromise. Carrying them out will insure the accomplishment of the engineering required to arrive at an unmanned delivery capability of the weapon for the minimum additional cost. If the requirement for this use is finally cancelled, we will still have a potentially useful by-product—a B-47 director-drone system."

Before the 22 January conference, command headquarters had been inclined to go along with General Mills' proposals; after that, however, the project personnel stated that Colonel Jeffrey indicated he would recommend completion of Brass Ring to provide a technical capability in support of project. In addition, headquarters representatives indicated that additional money would be obtained so that the project office would go ahead with the necessary development and procurement. 175

Although by this time the center did not expect rapid-fire coordination of conference results and unequivocal decisions on the exact course Brass Ring should pursue, it did hope that higher headquarters would soon make available more money. According to information from Eccing, the stream of funds would become dry about 1 March and \$1,300,000 was needed

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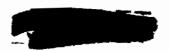
to continue Brass Ring operations until the end of the fiscal year, 30 June. The project office repeatedly pointed out that it had originally programmed enough fiscal year 1953 money (35,200,000) to complete Brass Ring, but it had actually received only about one third of this amount (\$1,750,000).

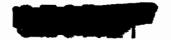
Despite the fact that Baltimore and Washington headquarters were aware of the Brass Ring funds situation, the information was reiterated in a letter which left Wright Field on 24 February. 177 The center by that time had almost reached the anomalous position of trying to proceed according to the 22 January agreements and not having the wherewithal to do it. To make the matter more confusing, the agreements had not yet assumed the shape of official directives.

Completely unknown to the center was the indication that Baltimore headquarters had soon shifted the position it had entertained at the 22 January conference. Less than two weeks later, on 4 February, Colonel Jeffrey dispatched information to General Yates' office which contained a complete review of and Brass Ring and recommendations for the immediate future course of action.

The overall project for emergency delivery of an H-bomb had pursued four tengents: manned aircraft with a free-falling bomb, manned aircraft with a drogue parachute bomb drop technique, manned aircraft with a glide weapon delivery, and an unmanned method using Brass Ring aircraft. The glide bomb principle had been temporarily rejected because it appeared more complex than the drogue parachute, while offering no peculiar advantages. However, there were three bomb shapes which were being given consideration for future application. These were "winged" glide bombs, "bluff-shaped" bombs, and bombs with streamers.

Preliminary data from Operation Ivy, Colonel Jeffrey pointed out,



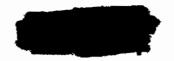


had shown that it was even possible for manned aircraft to deliver a free-falling H-bomb under certain conditions.

Such conditions limited the aircraft to a high performance jet bomber which could attain high speeds and high altitudes, allowing it to be as far away as possible when the bomb burst. Colonel Jeffrey repeated the information supplied by General Mills on the drogue parachutes and brought General Yates up to date on Brass Ring progress.

Colonel Jeffrey went on to cover the range capabilities of the B-36 a manned B-47B, the B-52, and the Brass Ring B-47B—all carrying a 50,000—pound bomb load. The B-36 had a combat radius of approximately 2,000 nautical miles. The manned B-47B had less than half the B-36's radius of action; however, when refueled, by a B-36 tanker or a KC-97, the manned B-47B could outdistance the B-36. The B-52 aircraft had a combat radius "the same or slightly greater than a B-47 manned refueled case"; after B-36 tanker refueling, however, the B-52's radius jumped to 3,500 or 4,000 nautical miles. Brass Ring, not manned even for take-off, had a range about the equal of the B-36; on the other hand, a Brass Ring manned aircraft (having provisions for bailout following refueling), with two refuelings, could travel in excess of 4,500 nautical miles. The first refueling took place over the home base; the second, at a predetermined spot after the B-36 tanker had departed from the home base or a KC-97 from an intermediate base.

From the above data, Colonel Jeffrey concluded that the manned B-36 and B-47 aircraft could offer the first emergency H-bomb delivery capability. The limited range of these two aircraft, however, made it mandatory to use pre-strike staging or inflight refueling (the latter for the B-47 only), in addition to post-strike staging. "Used intercontinentally," Colonel Jeffrey went on, "the B-47B manned and refueled by a "

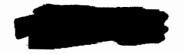


B-36 tanker can provide considerably more target coverage than can a B-36. This comparison assumes a post strike staging in each case."

Considering the initial 4,000-mile range requirements, however, only the Brass Ring B-47B and the B-52-both refueled by a B-36 tanker--offered a definite threat to any enemy on the globe.

Colonel Jeffrey recommended to Air Force headquarters that the B-36 and manned B-47B, both using drogue parachute delivery, be accepted as the emergency H-bomb carriers. He stated that "even though the BRASS RING program would provide an emergency thermonuclear delivery capability of somewhat greater range with the use of serial refueling, this system at best provides an operationally unfeasible, undependable and unproven method of delivery of this weapon." Furthermore, the colonel pointed out that the B-52 would come along by late 1954 to strengthen the Air Force H-bomb delivery potential. Consequently, Colonel Jeffrey recommended cancellation of Brass Ring in support of with the proviso that "...the additional range offered by this delivery system does not warrant its continuance." Recommendations for the disposition of Brass Ring, he wrote, would follow at an early date.

By 24 February, Major Helms and Mr. Jordan began to get some clues as to what had happened. Through telephone conversations with Mr. J. R. Trueblood, in the command's Directorate of Strategic Combat Systems, they learned that the position of Brass Ring had become weaker and that Colonel Jeffrey had wavered from the conclusions he had reached at the 22 January conference. On 24 February, in order to precipitate a decision, the center forwarded to Baltimore a plan for continuing Brass Ring "in accordance with the understandings reached at the conference," adding that implementation was under way despite the absence of a confirming directive. 150

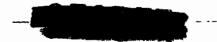




Two days later Wright Field sent a teletype to Baltimore stating that money would last only two more days. Mr. Jordan was scheduled to make a trip to Seattle during the first week in March and should the center not receive a Brass Ring funds authorization, he would be forced to begin preliminary termination arrangements with Boeing. 181

At this point-the last days of February and the first few days of March—the Brass Ring situation became very confused at the center. For instance, Colonel Homer A. Boushey, Weapons Systems Division chief, reported at the center staff weekly conference that the status of Brass Ring was uncertain and that command headquarters was in the process of contacting Washington for instructions. Meanwhile, Mr. Jordan was discussing termination proceedings with Boeing. On 5 March, Major Helms talked with Colonel Jeffrey, and the latter directed that the center continue its termination course and obtain Boeing's cost estimate for termination. Colonel Jeffrey stated further that the project file should carry through on termination although Air Force headquarters had not as yet issued a formal directive to that effect. 183 Major Helms also learned authoritatively for the first time that headquarters had recommended to Washington that Brass Ring be cancelled. In the various conversations, however, there was no indication as to the reasons behind the move. 184

In addition to discussing termination, Mr. Jordan's visit to Boeing's Seattle plant was made for the purpose of witnessing dummy drop tests (mentioned previously) and carrier demonstration flights. On 10 March, Boeing personnel flew the B-47B carrier a total of 63 minutes, during which remote control apparatus was in operation for 45 minutes. The automatic take-off, climb, and cruise sequence was initiated remotely from a ground control station. The aircraft azimuth, during take-off,



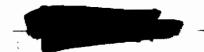


was controlled by an auxiliary control station at the far end of the runway. Subsequent maneuvers, descent, and landing (including remote release of a drag parachute and application of brakes) were accomplished from the ground control station. The test was generally satisfactory; however, there were several aspects—certain level flight conditions, turn characteristics, and the suitability of the aircraft as a "bombing platform"—which required further investigation.

Summing up his remarks on the test, Mr. Jordan noted, "The flight was successful in every respect and definitely proved the qualitative adequacy of the Brass Ring system. However, to attain B-47 drone capability, more flight time is deemed necessary to determine the realiability of the system and to incorporate refinements to the system components." Following this flight, Boeing had flown 117 hours of the 147 hours programmed to prove the Brass Ring drones concept; this represented about 75 per cent of project completion. 185

The above flight test was the last official act in the Brass Ring development program. Three days later (13 March) Major Helms wired Colonel Jeffrey that, "lacking both directive for plan of continuance and funds to continue, Project Brass Ring (MX-1457) is being orderly terminated effective 13 March 1953. All work stopped except compilation of data..." Another message to Baltimore on 18 March informed Brigadier General Floyd B. Wood, deputy for development, that the center had heard of a B-47 drone requirement in the office of Brigadier General Leighton I. Davis, director of armament. Until this was substantiated, or refuted, the center would hold off formal termination. 167

On 28 March, Wright Air Development Center received, in the form of a teletype, the first written evidence of the status of Brass Ring since the conference on 22 January. "This Hq.," the teletype read, "has



recommended to Hq. USAF that Proj. breashing be cancelled as a part of emergency thermonuclear bomb del_ivery/ means. To date, this recommendation has not been approved; however, indications are that it will be in the very near future." Furthermore, headquarters recognized no requirement for B-47 drones in the Air Research and Development Command; in fact, Air Force headquarters was thinking about converting the Brass Ring B-47's back to their original bomber configuration. Because the status of the Sperry Brass Ring autonavigator had been regarded as a separate item in termination talks, the teletype stated that Washington was investigating the possibility of continuing that item of development even though no specific requirement existed. The Baltimore message concluded, "In event our recommendations are approved, as anticipated, ...funds will be provided to close out various aspects of this program. 188

In response to a verbal request from Colonel Jeffrey, 189 and after it had talked over the matter thoroughly with Boeing, the center submitted Brass Ring termination estimates to Baltimore. In closing out the project the Air Force had two options: "immediate or orderly" termination. Both provided for a Boeing overrun of \$125,000 from Phase II work, and inspection and check-out flights for the carriers amounting to \$34,000, and additional Phase III contractor work costing \$347,000. In addition, an orderly conclusion required \$115,000 more to acquire technical data, drawings, test reports, and a summary report of the developmental status of the project. This brought the total to \$621,000. Relative to the latter category, Mr. Jordan was of the opinion that "the completion of data is considered essential by this Center if the Government is to realize any appreciable value from the Brass Ring equipment." The summary report, in addition to the technical data,



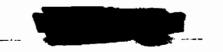
would serve as a substantial background should the project, or a similar one, ever be resumed.

Up to 28 February, when Boeing entirely depleted the supply of project money, Brass Ring had cost 35,846,500. The company had utilized its own funds until 13 March when development work stopped; after that, however, Boeing engineers continued to work for 10 days compiling data. Seeing no tangible signs of additional government allocations, they too halted this work. 191

Meanwhile, the center stand for completion of the Brass Ring program had not altered. It still considered the project as of the "utmost importance"—regardless of Brass Ring's supporting role of the salient factor behind this reasoning pointed to the importance of the director-drone technique as a step toward future missile projects a director concept. Futhermore, the work was in an advanced stage and needed only about \$2,500,000 for conclusion. This money would provide two B-47 carriers, one B-47A director—with their associated equipment—plus engineering and hardware for three B-47B directors.

The center also still urged completion of the Sperry autonavigator. As yet, there existed no proven developments in this field, and any autonavigator project in an advanced stage had to be considered as a possible source. 192 Up to March, \$2,300,000 had been put into the program and it required \$1,250,000 for producing a finished product. The Brass Ring autonavigator was cancelled, but with constant center prodding and the aid of Colonel Robert E. Jarman, deputy director of armament at Baltimore, the autonavigator received official blessing and the Armament Laboratory continued to foster the development for a different project.

The official termination directive on Brass Ring emanated from Washington on 1 April 1953. It reiterated what Baltimore had wired only



three days before. On 11 April Baltimore sent the center a brief wire, and nine days after that, it followed through with a near facsimile of the Air Force letter. This trio of Baltimore messages sounded the official death knell for Brass Ring. In line with Colonel Jeffrey's recommendations of 4 February and because General Yates could validate no B-47 drone requirements, the general ordered the cancellation. Apparently the Air Force did not feel that Brass Ring's greater range warranted project completion.

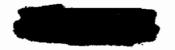
General Yates use of the opinion that any tests requiring a high speed and high altitude drone could be satisfied with the QB-61 and QB-62 pilotless aircraft. In answer to a point raised as to the need for Brass Ring aircraft to obtain cloud samples to measure blast effects in future high yield bomb tests, it had been determined that manned aircraft could carry out such assignments.

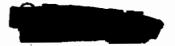
To obviate any other possible use for a drone B-47, the general also stated that the aircraft would not be required for the recently suggested B-47 vulnerability tests. He implied that actual firing tests would be held many months in the future; additionally, it might prove possible to use a B-29 "test platform" instead of a B-47 drone.

Colonel Jeffrey's letter of 20 April contained identical information, adding that his office planned to re-program some funds for the final wrap-up of Brass Ring. In conclusion, he asked the center for suggestions on disposing of the project's "hardware."

The center, in reply, made two alternate recommendations. Its first was that the aircraft be used for testing combat fire vulnerability. Although General Yates had specifically indicated the aircraft need not be

^{*}These drone programs were subsequently scrapped.





used for such evaluations, it was pointed out that a B-29 could not do
the job because of its altitude limitations. More specifically, the center foresaw possible employment of the aircraft in evaluating the blast
effects and warhead of project Bird Dog.* Such disposition of the B-47's,
however, could not be made until the aircraft had been further tested;
in other words, the remaining 25 per cent of Boeing's extended flight
test program had to be completed.

The second alternative for the aircraft was to convert them to their standard configuration. Should Boeing perform the conversion work, the cost was estimated in the neighborhood of \$1,250,000; however, the center estimated that such work performed at an Air Force depot would cost approximately \$288,000. All other equipment—trailers, ground support equipment, and spares—could be stored or parcelled out to other projects. 195

A telephone call from Colonel Jeffrey indicated that command headquarters would not agree to use of the B-47's as drames. Colonel Jeffrey
was of the opinion that such a plan would be, in reality, merely a continuation of the Brass Ring project. 195 About two weeks after the telephone conversation, a letter from Baltimore confirmed Colonel Jeffrey's
remarks. Colonel Ernest N. Ljunggren, assistant for weapons systems in
the Deputy for Development, replied that, "...the use of the Brass Ring
aircraft for a flight and/or drone vulnerability program is not favorably considered by this Headquarters in view of the excessive cost and
possibility of early loss of the aircraft in the flight program prior
to receipt of any appreciable amount of data." 197

While these dispositions and negotiations were progressing, the center had sent official contract termination notice to Boeing on 29 April-

^{*}This was a new, large, fragmenting, air-to-air rocket.

although, of course, company officials were already aware of the fact. The \$621,000 that the project office had requested for Boeing's additional services was trimmed slightly to \$618,744, but proved enough to

Project Brass Ring had come to an end, and the only function left was proper disposition of its remains. A large portion of the hardware—remote control, command link, and telemetering equipment—went to another project.* Other immediately usable items were drafted by the QB-17 and Navaho projects. The remainder entered the bailiwick of the Weapon Systems Division's Equipment Branch.

purchase the Brass Ring data. 198

The B-47A director remained at Edwards Air Force Base, becoming a part of the test inventory. One of the B-47B carriers participated in cold weather tests at Eglin Air Force Base, but by mid-October 1951, both of the B's were standing idle at the center; however, plans called for their subsequent shipment to Oklahoma City Air Materiel Area. There they would undergo condition checks to determine whether or not they should be scrapped or converted to their original configuration; additionally, previous conversion estimates could be verified or changed. Converting the aircraft to their original status seemed the more likely choice.

Conclusion

A proper analysis of Brass Ring could only be made by bearing in mind that it was but a part of the overall Air Force development to provide the nation with an K-bomb carrier. The existent state of the art for manned and unmanned aircraft made it obvious, for the time being, that the most efficient method required human intelligence and manipulation to deliver the bomb and trigger it over the target. However,

^{*}MX-2013--radar seeker, air-to-surface guided missile.







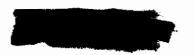
when the work began in 1950, it appeared that some of the desired efficiency might have to be sacrificed to forestall the destruction of the aircraft and their crews. Therefore, the Air Force had to investigate unmanned as well as manned delivery.

The unmanned development was costly; nevertheless, it could not be ignored when so much uncertainty surrounded the bomb!s destructive potential. As Brigadier General Fred R. Dent, Jr., the center's commander, stated in mid-1951, "...the required development time for the carrier precluded awaiting the developed weapon... This is not the most desirable and economical method of developing a weapons system."

Answers to the question marks revolving about the bomb (with the exception of its size) were not known until after completion of Operation Ivy.

Brass Ring development, from the center and project office level, was an extremely difficult task. Not only were the B-47 modifications, the autonavigator developments, and the integration of components tough assignments in themselves, but it was the center's opinion that such work did not receive proper direction from higher authority. This set of circumstances prompted the project office to state: "Although Brass Ring was established in April 1950 as a 'Special Project' in support of directives from higher headquarters covering changes in project policy have not been in keeping with the expedited nature of the project schedule. Delays in policy decisions and authorization of funds have made project planning and implementation very awkward."202

In defense of Air Force and Air Research and Development Command headquarters, however, it should be pointed out that in the face of so many variables and imponderables; it was not easy, and sometimes well-nigh impossible, to make concrete decisions.

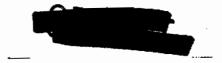


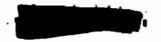


Because of the questionable and wavering status of Brass Ring during the last year of its development, it was interesting to speculate what would have happened if the center's request for \$5,200,000 for fiscal year 1953 had been fulfilled—instead of the receipt of the actual appropriation of \$1,750,000. Authorization of the larger amount might have balanced the scales in favor of Brass Ring completion, because the necessity for additional funds was one reason the drone configuration lagged and was not continued. On the other hand, the money could have been easily recalled and re-programmed to other projects.

According to the 4 February 1953 letter from Colonel Jeffrey to General Yates, the fate of Brass Ring hung on a single thread: it was the only emergency method which could deliver an H-bomb to a point over 4,000 nautical miles distant. If this were an absolute requirement, apparently Brass Ring warranted continuation. Otherwise, command head-quarters thought that a manned B-36 or manned B-47 could provide the immediate capability, with the B-52 soon to follow. The only conclusion that could be drawn from General Yates' reply (although not specifically stated) was that Air Force headquarters foresaw no outbreak of hostilities in the immediate future and waived the 4,000 nautical mile range as an absolute necessity. Undoubtedly, the availability of bases in Europe, Asia, and Africa also played a part in the decision.

The Brass Ring development was a rather costly one; yet, the stakes were high. In an era of constant international tensions, an interim method of H-bomb delivery was a substantial bulwark to the national defense. Although the Brass Ring method did not prove necessary, it was a very essential part of the super-bomb carrier program.

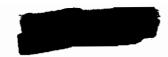




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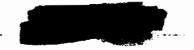
- Ltr., Lt. Gen. K. B. Wolfe, DCS/M, USAF, to Lt. Gen. B. W. Chidlaw, CG, AMC, 8 Dec 1949, subj.: Program for Atomic Warfare R&D in the USAF, in Sp. Weap. Br. files: see App. 29-a.
- 2. Interview with Mr. L. E. Toedte, BN and CW Br., Dir. of Sup and Servs., AMC, 31 Aug 1953.
- 3. Ltr., Wolfe to Chidlaw, 8 Dec 1949, see App. 29-a.
- 4. Ltr., Maj. Gen. S. Streett, DCG, AMC, to Lt. Gen. K. B. Wolfe, DCS/M, USAF, 26 Jan 1950, subj.: Proposal for Special Weapons Project ("Eagle"), in Sp. Weap. Br. files: see App. 2.
- Interview with Mr. L. E. Toedte, BW and CW Br., Dir. of Sup. and Servs., AMC, 31 Aug 1953.
- 6. Ltr., Streett to Wolfe, 26 Jan 1950, see App. 1.
- 7. Ltr., Maj. Gen. F. H. Griswold, Asst. DCS/M, USAF, to Lt. Gen. B. W. Chidlaw, CG, AMC, 10 Feb 1950, subj.: H-Bomb Development and Concurrent Carrier Development, in Sp. Weap. Br. files.
- 9. R&R, Col. B. R. Price, Chief, Sp. Weap. Sect., Eng. Div., to Brig. Gen. R. P. Swofford, Chief, Eng. Div., 20 Mar 1950, subj.: Project Eagle, and attached Rpt., "Feasibility Study of B-478 Aircraft as a Carrier for the Super Bomb," 16 Mar 1950, prep. by J. Kelley, Design Criteria Unit, Airc. Lab.; Dr. J. W. Mar, Mass. Institute of Technology; and L. Levy, Mass. Institute of Technology, in Sp Weap. files, See App. 3.
- 10. Ltr., Maj. Gen. D. L. Putt, Dir/R&D, USAF, to Lt. Gen. B. W. Chidlaw CG, AMC, 29 Mar 1950, subj.: Hydrogen Bomb Carrier, in Sp. Weap. Br. files, see App. 4.
- 11. Tech. Instruction, 2167-34, 7 Apr 1950, in Drone Missiles Br. files; Tech. Instructions, see App. 6.
- 12. Tech. Instruction Status Rpt., n. d., prep. by Airc. and Guided Missiles Sect., in Drone Missiles Br. files: Tech. Instructions, see App. 7.
- 13. R&R, Maj. R. C. Anderson, Airc. and Guided Missiles Sect., to B. F. Bayuk, Pilotless Airc. Br., Airc. and Guided Missiles Sect., 29 Aug 1950, subj.: Responsibility for Missile B-n7 Development, in Drone Missiles Br. files: Directives Priorities, and Termination, See App. 26.

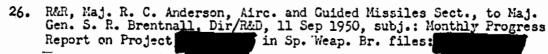




- 14. Trip Rpt., B-47, Automatic Pilotless Aircraft, Trip to Sperry Gyroscope Company, on 18-19 April, 1950, 24 Apr 1950, by Maj. R. C.

 Anderson, Pilotless Airc. Br., Airc. and Guided Missiles Sect., in
 Drone Missiles Br. files: Trip Rpts., see App. 10.
- 15. Interview with Mr. J. Jordan, Drone Missiles Br., WSD, 10 Sep 1953; R&R, Anderson to Bayuk, 29 Aug 1950, see App. 26.
- 16. Ltr., J. B. Connelly, Boeing Airplane Co., Seattle, Wash., to Airc. and Guided Missiles Sect., 16 May 1950, subj.: Proposal for Study Contract of Drone B-47 Airplane, in Drone Missiles Br. files: Contracts, see App. 12.
- 17. Purchase Request, 83207, 17 May 1950, in Drone Missiles Br. files: Purchase Requests, see App. 13.
- 18. Ltr., Connelly to Airc. and Guided Missiles Sect., 16 May 1950, see App. 12.
- Suppl. 1 to Contr. AF33(038)-12883, 11 Aug 1950, in Drone Missiles Br. files: Contr., see App. 22.
- 20. Rpt., Development Progress for Project Brass Ring, 11 Aug 1950, prep. by Boeing Airplane Co., in Drone Missiles Br. files: Progress (Prime Contractor), see App. 23.
- 21. Memo for Record, J. T. Clemens, Dir/R&D, 9 Mar 1950, subj.: Executive Committee Meeting, in Drone Missiles Br. files: Conf. Rpts., see App. 2.
- 22. Memo., Maj. Gen. S. R. Brentnall, Dir/R&D, to Brig. Gen. R.P. Swofford, Chief, Eng. Div., 10 Apr.1950, subj.: Special Bomb Carrier, in Drone Missiles Br. files: Navigation Sys. (Subcontractor), see App. 8.
- 23. Memo., Brig. Gen. R. P. Swofford, Chief, Eng. Div., to Maj. Gen. S. R. Brentnall, Dir/R&D, 31 May 1950, subj.: Special Bomb Carrier, see App. 15; R&P, Col. C. G. Damberg, Chief, Airc. and Guided Missiles Sect., to Elect. Subdivision. Eng. Div., 20 Apr 1950, subj.: Project MX-1457, see App. 9a; Cmt. 2, Vol. J. C. Harvell, Chief, Equip. Lab., to Col. C. F. Damberg, Chief, Airc. and Guided Missiles Sect., 1 May 1950, see App. 9b; Cmt. 2, Sys. Analysis Office, Airc. and Guided Missiles Sect., 3 May 1950, see App. 9c; Cmt. 2, Col. G. A. Blake, Chief, Arm. Lab., to Airc. and Guided Missiles Sect., 12 May 1950, see App 9d. All of the above in Drone Missiles Br. files.
- 24. Ltr., M. L. Pennell, Chief, Preliminary Design, Boeing Airplane Co., to Airc., and Guided Missiles Sect., 21 July 1950, subj.: Preliminary Tentative Evaluation of Guidance Systems for MX-1457, in Drone Missiles Br. Files: Navigation Sys. (Subcontractor), see App. 19.
- 25. RER, J. Jordan, Pilotless Airc. Br., Airc. and Guided Missiles Sect., to Airc. and Guided Missiles Sect., 28 Aug 1950, subj.: Guidance Systems for MX-1457, in Drone Missiles Br. files: Navigation Sys. (Subcontractor), see App. 25.





- 27. Ltr., Col. C. F. Damberg, Chief, Airc. and Guided Missiles Sect., to R. J. Helberg, Boeing Airplane Co., Seattle, Wash., 15 Sept 1950, subj.: Project 1457—Phase II, in Drone Missiles Br. files.
- 28. R&R, Maj. R. C. Anderson, Pilotless Airc. Br., Airc. and Guided Missiles Sect., to B. F. Bayuk, Pilotless Airc. Br., and Guided Missiles Sect., 29 Aug 1950, subj.: Responsibility for Missile B-47 Development, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 26.
- 29. R&R, Col. R. L. Johnson, Chief, Airc. and Guided Missiles Sect., to Security Policy Div., Intell. Dept., 22 Mar 1951, Subj.: Nickname for Project MX-1457, in Drone Missiles Br. files: Security Classification.
- 30. Ltr., Damberg to Helberg, 15 Sep 1950.
- 31. DIR, Pilotless Airc. Br., 30 Aug 1950, in Drone Missiles Br. . . files: DIR.
- 32. Notification of Findings and Determination, 13 Sep 1950, by E. M. Zuckert, Asst. Secy. of the AF, in Contr. Distribution and Files Sect. files: AMC, AF33(038)-12883.
- Ltr. Contr., designated Suppl. No. 2 to Contr. AF33(038)-12883, 27
 Sep 1950, in Contr. Distribution and Files Sect. files: AMC, see
 App. 27.
- 34. R&D Info. Rpt. 3 Oct 1950, prep. by Pilotless Airc. Br., Airc. and Guided Missiles Sect., in Drone Missiles Br. files: R&D Info. Rpts.
- 35. Suppl. 2 to Contr. AF33(038)-12883, 9 Feb 1951, in Drone Missiles Br., files: Contr., see App. 41.
- Ltr., Contr., designated Suppl. No. 2 to Contr. AF33(038)-12883, 27 Sep 1950, see App. 27.
- 37. Rpt., Project MX-1456, 31 Dec 1950, prep. by J. Jordan, Pilotless Airc. Br., Airc. and Guided Missiles Sect., in Drone Missiles Br. files: Presns., see App. 36.
- 38. Rpt., Brief Summary—Project MX-1457, 8 Dec 1950, prep by Pilotless Airc. Br., Airc. and Guided Missiles Sect., in Drone Missiles Br. files: Presns., see App. 36.
- 39. Memo for Record, J. Jordan, Pilotless Airc. Br., Airc. and Guided Missiles Sect., 13 Nov 1950, subj.: Conference Report Status of MX-1457, in Drone Missiles Br. files: Conf. Rpts., see App. 33.

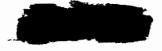




- 40. R&R, Col C. F. Damberg, Chief, Airc. and Guided Missiles Sect., to Col. G. A. Blake, Chief, Arm. Lab., Eng. Div., 16 Nov 1950, subj.: Project Progress Report for October, in Drone Missiles -Br. Files: Remote Flt. Control Instruments, see App. 34.
- 41. DIR, Pilotless Airc. Br., 3 Jan 1951.
- 42. R&D Info. Rpt., 1 Dec 1950.
- 43. Ltr., J. B. Connelly, Boeing Airplane Co., Seattle, Wash., to Capt. R. T. Franzel and J. Jordan, Pilotless Airc. Br., Airc. and Guided Missiles Sect., 16 Jan 1951, subj.: Project MX-1457 Schedule, in Drone Missiles Br. files: Trip Rpts., see App. 39.
- 44. Rpt., Trip Report to Sperry Gyroscope Company, 19 Oct 1950, prep. by N. F. Schrein, Arm. Lab., Div., in Drone Missiles Br. files: Gen. Proj., see App. 31.
- 45. R&D Info. Rpt., 1 Jan 1951.
- 46. DIR, Pilotless Airc. Br., 26 Jan 1951.
- 47. Ibid., 7 Feb 1951.
- 48. R&R, Maj. R. T. Franzel, Pilotless Airc. Br., Airc. and Guided Missiles Sect., to Col H. J. Sands, Asst. for Guided Missiles, Airc. and Guided Missiles Sect., 12 Feb 1951, subj.: Presentation to General Putt, in Drone Missiles Br. files: Presns.
- 49. R&D Info. Rpt., Pilotless Airc. Br., 24 Feb 1951.
- 50. Ibid., 1 Jan 1951.
- 51. DIR, Pilotless Airc. Br., 20 Nov 1950.
- 52. R&D Info. Rpt., Pilotless Airc. Br., 24 Feb 1951.
- 53. Ltr., Col R. L. Johnston, Chief, Airc. and Guided Missiles Sect., to R. Jewett and R. Helberg, Boeing Airplane Co., Seattle, Wash., 22 Dec 1950, subj.: Dail-out Provisions for Crew, MX-1457, in Drone Missiles Br. files: Crew Bailout, see App. 37.
- 54. DIR, Pilotless Airc. Br., 22 Jan 1951.
- 55. Daily Records, Cps. Office, Eng. Div., 20 Jan 1951.
- 56. R&D Info. Rpt., Pilotless Airc. Br., 12 Feb 1951.
- 57. R&D, Col. C. F. Damberg, Chief, Airc. and Guided Missiles Sect., to Sp. Weap. Sect., Ops. Office, 3 Aug 1950, subj.: Monthly Progress Report on Project in Sp. Weap. Br. files: see App. 21.

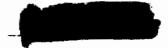


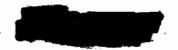
- 58. RMR, Mr. J. Jordan, Pilotless Airc. Br., Airc. and Guided Missiles Sect., to Col. H. J. Sands, Airc. and Guided Missiles Sect., WSD, 7 Apr 1951, subj.: Project Brass Ring, MX-1457, in Drone Missiles Br. files: Trip Rpts., see App. 40; R&R Info. Rpt., Pilotless Airc. Br., 15 Apr 1951.
- 59. R&D Info. Rpt., Pilotless Airc. Br., 1 Jun 1951.
- 60. Ibid.
- 61. Interview with Maj. W. B. Helms, Drone Missiles Br., WSD, 25 Sep 1953.
- 62. R&R, Col. M. F. McNickle, Chief, Arm. Lab., to Mr. J. Jordan, Guided Missiles Sect., WSD, 29 May 1951, subj.: Miniaturized Airspeed and Mach Control System for Project Brass Ring, in Drone Missiles Br. files: Funds, see App. 47; R&R, Col R. L. Johnston, Chief, WSD, to Bud. and Fiscal Br., Compt. Dept. 4 Jun 1951, subj.: Miniaturized Airspeed and Mach Control System for Project Brass Ring, in Drone Missiles Br. files: Funds, see App. 47-a.
- 63. Rpt., Project Brass Ring, 11 June 1951, by Maj. R. T. Franzel, Pilotless Airc. Br., Guided Missiles Sect., in Drone Missiles Br. files: Presns., see App. 48.
- 64. R&R, Col. C. F. Damberg, Chief, Airc, and Guided Missiles Sect., to Ops. Office, Eng. Div., 1 June 1950, subj.: Monthly Progress Report on Project in Sp. Weap. Br. files:
- 65. Ltr., M. C. Calloway, Boeing Airplane Co., Seattle Wash., to Pilotless Airc. Br., Airc. and Guided Missiles Sect., 2 May 1951, subj.: Atmospheric Information, in Drone Missiles Br. files: Atmospheric Data, see App. 43.
- 66. Ltr., Col. R. L. Johnston, Chief, WSD, WADC, to Dir/R&D, USAF, 20 July 1951, subj.: Operational Routes for Brass Ring, in Drone Missiles Br. files: Operational and Routes Data, see App. 51.
- 67. 1st Ind., (ltr., Johnston to Dir/R&D, 20 July 1951), Col. E. A. Romig, Airc. Div., D/R&D, USAF, to CG, ARDC, 6 Aug 1951, in Drone Missiles Br. files: Operational and Routes Data, see App. 51-a; 2nd Ind. (ltr., Johnston to Dir/R&D, 20 July 1951), Erig. Gen. J. W. Sessums, D/Dev., ARDC, to CG, WADC, 21 Aug 1951, no subject, in Drone Missiles Br. files: Operational and Routes Data, see App. 51-b.
- 68. Ltr., Col. R. L. Johnston, Chief, WSD, to Boeing Airc. Co., Seattle, Wash., 1 Nov 1951, subj.: Navigational Instrumentation for Brass Ring, in Drone Missiles Br. files: Operational and Routes Data, see App. 56.
- 69. Interview with Mr. J. Jordan and Maj. W. B. Helms, Drone Missiles Br., WSD, 21 Oct 1953.
- 70. R&D Info. Rpt., Pilotless Airc. Br., 31 July 1951.



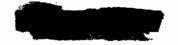


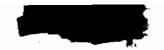
- 71. R&R, Col. R. H. Blount, Chief, Aero Med. Lab., WADC, to Guided Missiles Sect., Proc. Div., AMC, 10 July 1951, subj.: Recommended —Test Program Relative to B-47 Aircraft Without Ejection Seats, in Drone Missiles Br. files: Crew Bailout, see App. 50; R&R, Maj. R. T. Franzel, Pilotless Airc. Br., Guided Missiles Sect., to Guided Missiles Sect., WSD, 18 June 1951, subj.: Report of Visit to Boeing, Wichita, Kansas, Project Brass Ring, in Drone Missiles Br. files: Trip Rpts., see App. 49.
- 72. Rpt., Project Brass Ring, 11 June 1951, by Major R. T. Franzel, Pilotless Airc. Br, Guided Missiles Sect., in Drone Missiles Br. files, see App. 48.
- 73. DIR, Pilotless Airc. Br., 12 Apr 1951.
- 74. R&D Info. Rpt., Pilotless Airc. Br., 15 Apr 1951.
- 75. Ibid., 1 Apr 1951.
- 76. R&R, Mr. J. Jordan, Pilotless Airc. Br., Guided Missiles Sect., to Chief, Guided Missiles Sect., 25 May 1951, subj.: Project Brass Ring, MX-1457, in Drone Missiles Br. files: Trip Rpts., see App. 46.
- 77. DIR, Pilotless Airc, Br., 27 Apr 1951.
- 78. <u>Ibid</u>., 24 May 1951.
- 79. Ibid., 18 June 1951.
- 80. <u>Ibid</u>., 19 July 1951.
- 81. <u>Ibid</u>., 23 Oct 1951.
- 82. R&D Info. Rpt., Pilotless Airc. Br., 31 Oct 1951.
- 83. MCL3 Form No. 2, R-426-272, 31 Oct 1951, see App. 55. This form was subsequently replaced by ARDC Form 82.
- 84. Rpt., Report of Conference with AMC Personnel on Brass Ring Navigator, 30 Apr 1951, prep. by M. D. Lockwood, Sperry Gryoscope Co., in Brone Missiles Br. files: Navingational Sys. (Alternate), see App. 42.
- 85. R&R, Lt. Col. D. L. Anderson, Chief, Anal. Sect., to Mr. J. Jordan, Pilotless Airc. Br., Guided Missiles Sect., 3 May 1951, subj.: Comments on Sperry Norbs Project, in Drone Missiles Br. files: Navigational Sys. (Alternate), see App. 44.
- 86. R&D Info. Rpt., Pilotless Airc. Br., 1 Apr 1951.
- 87. R&R, Col. B. R. Price, Chief, Equip. Lab., to Maj. R. T. Franzel, Pilotless Airc. Br., Guided Missiles Sect., 3 May 1951, subj.: Sperry NORES Navigation System, in Drone Missiles Br. files: Navigation Sys. (Alternate), see App. 45.
- 88. RAR, Mr. J. Jordan to Chief, Guided Missiles Sect., 25 May 1951, see App. 46.



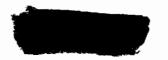


- 89. R&R, Mr. J. Jordan, Pilotless Airc. Br., Guided Missiles Sect., to Col. O. Knox, Guided Missiles Sect., WSD, 5 Sep 1951, subj.: Report of Visit to Contractor—Project Brass Ring, in Drone Missiles Br. files, see App. 52.
- 90. DIR, Pilotless Airc. Br., 20 Aug 1951.
- 91. R&D Info. Rpt., Pilotless Airc. Br., 31 Aug 1951.
- 92. <u>Ibid</u>., 30 Sep 1951.
- 93. DIR, Targets and Drones Br., 9 May 1952.
- 94. MCLS Form No. 2, R-426-272, 31 Oct 1951, see App. 55.
- 95. Ltr., Mr. R. B. Bow, Boeing Airplane Co., Scattle, Wash., to North American Avn., Inc., 26 Oct 1951, subj.: Project Brass Ring, Autonavigator Schedules, in Drone Missiles Br. files: Navigation Sys. (Subcontractor), see App. 54.
- 96. DIR, Targets and Drones Br., 14 Nov 1951.
- 97. Ltr., Col. R. L. Johnston, Chief, WSD, to L. L. Waite, North American Avn., Inc., 20 Nov 1951, subj.: Precedence for Brass Ring Autonavigator Schedules, in Drone Missiles Br. files: Navigation Sys. (Subcontractor), see App. 58.
- 98. DIR, Targets and Drones Br., 11 Dec 1951.
- 99. <u>Ibid</u>.
- 100. R&R, Mr. T. M. Pienkowski, Strat. Bombing Br., Arm. Lab., to Ops. Office, Arm. Lab., 10 Jan 1952, subj.: Brass Ring Autonavigator, in Drone Missiles Br. files: Navigation Sys. (Alternate), see App. 62.
- 101. R&R, Mr. T. M. Pienkowski, Strat. Bombing Br., Arm. Lab., to Ops. Office, Arm. Lab., 28 Apr 1952, subj.: Trip Report, in Drone Missiles Br. files: Mavigation Syo. (Alternate), see App. 72.
- 102. R&R, Mr. T. M. Pienkowski, Strat. Bombing Br., Arm. Lab., to Ops. Office, Arm. Lab., 19 May 1952, subj.: Trip Report, Brass Ring Autonavigator, in Drone Missiles Br. files: Navigation Sys. (Alternate), see App. 74.
- 103. DIR, Targets and Drones Br., 14 Nov., 22 Nov 1951.
- 104. Ltr., R. C. Lyons, Sperry Gryoscope Co., Great Neck, N.Y., to Boeing Airplane Co., Seattle, Wash., 15 July 1952, subj.: Revised Delivery Schedule, MX-1457, in Drone Missiles Br. files: Remote Flt. Control Instr.
- 105. Ltr., Col. F. B. Wood, C/S, WADC, to Dir/RAD, USAF, 12 July 1951, subj.: Carrier for H-bomb, in Sp. Weap. Br. files:





- 106. RAR, Maj. R. T. Franzel, Pilotless Airc. Br., Guided Missiles Sect., to Col. R. L. Johnston, Chief, WSD, 2 July 1951, subj.: Status of Project in Sp. Weap. Br. files:
- 107. Ltr., Dr. H. M. Agnew, Asst. to the Tech. Dir., Los Alamos Scientific Labs., Los Alamos, N. M., to CG, WADC, 3 Oct 1951, no subj.: in Sp. Weap. Br. files:
- 108. Ltr., Col. R. L. Johnston, Chief, WSD, to Mr. R. J. Helberg, Boeing Airplane Co., Seattle, Wash., 3 Nov 1951, subj.: Bomb Bay Potential for Brass Ring, in Drone Missiles Br. files: Warhead and Bomb Bay Mods., see App. 57.
- 109. R&D Info., Rpt., Targets and Drones Br., 31 Dec 1951; DIR, Targets and Drones Br., 12 Dec 1951 & 26 Jan 1952; Interview with Mr. J. Jordan, Drone Missiles Br., WSD, 21 Oct 1953.
- 110. R&D Info. Rpt., Targets and Drones Br., 29 Feb 1952.
- 111. Ltr., Dr. H. M. Agnew, Asst. to the Tech. Dir., Los Alamos Scientific Labs., Los Alamos, N. M., to Lt. Col. M. A. Cristadoro, Sp. Weap. Sect., MSD, 8 Feb 1952, subj.: Delivery of in Sp. Weap. Br. files:
- 112. Rpt., Discussions on Project 29 Jan 1952, prep. by Sp. Weap. Sect., WSD, in Sp. Weap. Br. Illes: R&R, Lt. Col. B. D. Witwer, Nucleonics Br., Sp. Weap. Sect., to Col. L. V. Harmon, Sp. Weap. Sect., WSD, 18 Feb 1952, subj.: Trip Report, in Sp. Weap. Br. files: See App 66.
- 113. DIR, Pilotless Airc. Br., 5 Sep., 15 Oct 1952.
- 114. Ltr., Col. R. L. Johnston, Chief, WSD, WADC, to CG, ARDC, 24 Oct 1951, subj.: Delineation of Responsibility for Project Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 53.
- 115. Ltr., Brig. Gen. J. W. Sessums, D/Dev., ARDC, to Brig. Gen. D. N. Yates, Dir/R&D, USAF, 26 Nov 1951, subj.: Operational Organization for Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 59.
- 116. Ltr., Brig. Gen. F. B. Wood, C/S, WADC, to CG, ARDC, 12 Dec 1951, subj.: Status of Project in Sp. Weap. Br. files:
- 117. DIR, Targets and Drones Er., 28 Dec 1951.
- 118. 1st Ind. (ltr., Wood to CG, ARDC, 12 Dec 1951), Brig. Gen. D. N. Yates, Dir/R&D, USAF, to CG, ARDC, 5 Feb 1952, Subj.: Operational Organization for Project Brass Ring, in Dir/Strat. Combat Sys., ARDC, files: Prass Ring, 2, see App. 61A.



- 119. 1st Ind. (ltr., Johnston to CG, ARDC, 24 Oct 1951), Erig. Gen. J. W. Sessums, D/Dev., ARDC, to CG, WADC, 5 Mar 1952, subj.: Delineation of Responsibility for Project Brass Ring, in Dir/-Strat. Combat Sys., ARDC, files: Brass Ring, 2, see App. 53A.
- 120. DIR, Targets and Drones Br., Guided Missiles Sect., 20 Mar 1952, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 69.
- 121. R&R, Mr. J. Jordan, Targets and Drones Br., Guided Missiles Sect., to Col. O. R. Haney, Guided Missiles Sect., WSD, 26 Mar 1952, subj.: Memorandum, in Drone Missiles Br. files: Directives, Priorities, and Termination.
- 122. Ltr., Maj. Gen. D. N. Yates Dir/R&D, USAF, to CG, ARDC, 19 Mar 1952, subj.: in Dir/Strat. Combat Sys., ARDC, files: Brass Ring, 3, see App. 68.
- 123. 2nd Ind. (ltr., Johnston to CG, ARDC, 24 Oct 1951), Col. R. L. Johnston, Chief, WSD, WADC, to CG, ARDC, 8 Apr 1952, subj.: Delineation of Responsibility for Project Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination; AFR 80-14, 11 Sep 1951.
- 124. 2nd Ind. (ltr., Johnston to CG, ARDC, 24 Oct 1951), Johnston to CG, ARDC, 8 Apr 1952.
- 125. Ltr., Col. H. J. Sands, Dir/Airc., D/ Dev., ARDC, to CG, WADC, 4 Apr 1952, subj.: Simplified System for Project Brass Ring, in Drone Missiles Br. files: Drone Version, see App. 71.
- 126. DIR, Targets and Drones Br., 29 Apr 1952.
- 127. 1st Ind. (ltr., Col. Sands to CG, WADC, 4 Apr 1952), Col. M. C. Demler, C/3, WADC, to CG, ARDC, 5 June 1952, in Drone Missiles Br. files: Drone Version, see App. 71A.
- 128. Ltr., Maj Gen. D. N. Yates, Dir/R&D, USAF, to CG, ARDC, 8 May 1952, subj.: B-47 Drone Capability, in Dir/Strat. Combat Sys., ARDC, files: Brass Ring, 3, see App. 73.
- 129. Ltr., Lt. Col. H. B. Hewett, Asst. for Strat. Combat Sys., D.Dev., ARDC, to CG, WADC, 28 May 1952, subj.: B-47 Drone Capability, in Dir/Strat. Combat Sys., ARDC, files: Brass Ring, 3, see App. 76.
- 130. R&R, T. M. Pienkowski, Strat. Bombing Br., Arm. Lab., to Ops. Office, Arm. Lab., 19 May 1952, subj.: Trip Report, Brass Ring, Autonavigator, in Brone Missiles Br. files: Navigation Sys. (Alternate), see App.74.
- 131. DIR, Targets and Drones Br., 9 May 1952.
- 132. R&D Info. Rpt., Targets and Drones Br., 31 May 1952; RDB Form 1A, R-426-272, 12 Dec 1952.

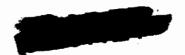


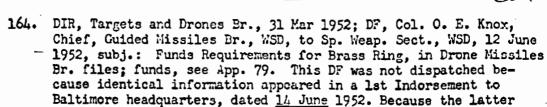
- 133. 1st Ind. (ltr., Col. Sands, to CG, WADC, 4 Apr 1952), Col. Demler to CG, ARDC, 5 June 1952, see App. 71A.
- 134. 1st Ind. (ltr., Hewett to CG, WADC, 28 May 1952), Col. M. C. Demler C/S, WADC, to CG, ARDC, 14 June 1952, subj.: B-47 Drone Capability, in Drone Missiles Br. files: Top Secret files.
- 135. Sum. of WADC Wk. Conf., 27 June 1952, in Hist. Div. files.
- 136. Ltr., Col. M. C. Demler, C/S, WADC, to CG, AFSWC. 18 July 1952, subj.: Transfer of Responsibility for the see App. 5.
- 137. DF, Mr. J. Jordan, Drone Missiles Br., WSD, to Chief, WSD, 31 Mar 1953, subj.: Items for Commanders' Conference, Project Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 121.
- 138. DIR, Targets and Drones Br., 29 July 1952.
- 139. RAR, Mr. J. Jordan, Targets and Drones Br., Guided Missiles Sect., to WSD, 14 aug 1952, subj.: Trip Report—Project Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination.
- 140. DIR, Targets and Drones Br., 24 July 1952.
- 141. <u>Ibid</u>., 28 July 1952.
- 142. Memo, Mr. J. Jordan, Targets and Drones Br., Guided Missiles Sect., to Lt. Col. R. B. Gooch, Chief, Targets and Drones Br., Guided Missiles Sect., 5 Sep 1952, subj.: Trip Report, in Drone Missiles Br. files: Trip Rpts., see App. 26.
- 143. ARDC Form 82, R-426-272, 12 Oct 1952.
- 144. DIR, Drone Missiles Br., 15 Oct 1952.
- 145. Ltr., Col. K. L. Garrett, Chief, Airc. Br., Proc. Div., AMC, to Eceing Airplane Co., Scattle, Mash., 16 Oct 1952, subj.: Contract AF 33(038)-12883, in Drone Missiles Br. files: Specs., see App. 90.
- 146. Memo., Maj. G. R. Vanden Heuvel, Drone Missiles Br., Guided Missiles Sect., to Lt. Col. R. B. Gooch, Chief, Targets and Drones Br., Guided Missiles Sect., /about 1 Nov 19527, subj.: Report of Visit to Beoing on 27 October thru 31 October 1952, in Drone Missiles Br. files: Trip Rpts., see App. 92.
- 147. ARDC Form 82, R-426-272, 12 Oct 1952.
- 148. Memo., Vanden Heuvel to Gooch Zabout 1 Nov 19527, see App. 92.
- 149. WADO WOR, 6 Nov 1952.
- 150. RDB Form 1A, R-426-272, 12 Dec 1952.





- 151. Interview with Miss C. P. Pope, B-47 Unit, Proc. Div., AMC, 12 Oct 1953.
- 152. Ltr., Contr. designated Supp. II to Contr. AF33 (038)-12883, 31 Oct 1952, in B-47 Unit, Proc. Div., AMC contracts file, see App. 95.
- 153. RDB Form 1A, R-426-272, 12 Dec 1952.
- 154. DF, Mr. J. Jordan, Drone Missiles Br., WSD, to Chief, WSD, 17 Dec 1952, subj.: Report of Visit to contractor for Project Brass Ring, in Drone Missiles Br. files: Trip Rpts., see App. 97.
- 155. DF, 1st Lt. E. G. Sperry, Sp. Proj. Office, Aero Med. Lab., to Drone Missiles Br., WSD, 23 Dec 1952, subj.: Trip Report, in Drone Missiles Br. files: Trip rpts., see App. 98; ARDC Form 82, R-426-272, 12 Jan 1952.
- 156. Rpt., Evaluation of Bailout Provisions, 11 Mar 1953, prep. by 1st Lt. E. G. Sperry, Sp. Proj. Office, Aero Med. Lab., in Drone Missiles Br. files: Crew Bailout, see App. 117.
- 157. RAR, Mr. T. M. Pienkowski, Inertial Sys. Unit, Arm. Lab., to Ops. Office, Arm. Lab., 17 July 1952, subj.: Trip Report Brass Ring Autonavigator, in Drone Missiles Br. files: Trip Rpts., see App. 82.
- 158. Rpt., A History of the Autonavigator for Project Brass Ring 20 Jan 1953, prep. by Mr. T. M. Pienkowski, Inertial Sys. Unit, Arm. Lab., in Drone Missiles Br. files: Navigational Sys. (Alternate), see App. 105: Interview with Maj. W. B. Helms, Drone Missiles Br., WSD, 13 Oct 1953.
- 159. Interview with Maj. W. B. Helms, Drone Missiles Br., WSD, 13 Oct 1953.
- 160. DIR, Targets and Drones Br., 14 Feb 1952, in Drone Missiles Br. files: Funds, see App. 65.
- 161. Ibid.; RAR, Col. C. R. Haney, Chief, Targets and Drones Br., Guided Missiles Sect., to Maj. P. Murray, Guided Missiles Sect., WSD, 22 Jan 1952, subj.: Budget Requirements for Project Brass Ring, in Drone Missiles Br. files: Funds, see App. 63.
- 162. Ltr, Brig. Gen. F. B. Wood, C/S, WADC, to CG, ARDC, 20 Feb 1952, subj.: Funds Status of BRASS RING Project, in Drone Missiles files: Funds, see App. 67.
- 163. TT, 460-60607, Mr. J. B. Connelly, Boeing Airplane Co., Seattle, Wash., to Mr. M. P. Crews, Boeing Airplane Co. Br. Office, Dayton, Ohio, 25 Mar 1952, subj.: Project Brass Ring, in Drone Missiles Br. files: Funds, see App. 10.





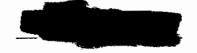
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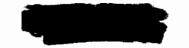
165. ARDC Form 82, R-426-272, 12 Aug 1952.

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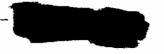
- 166. DIR, Drone Missiles Br., 30 Sep 1952.
- 167. R&R, Mr. J. Jordan, Targets and Drones Br., Guided Missiles Sect., to WSD, 14 Aug 1952, subj.: Trip Report—Project Brass Ring, in Drone Missiles Br. files: Trip Rpts.
- 168. TT, 460-65-594, Mr. R. Gelzenlichter, Boeing Airplane Co., Seattle, Wash., to Mr. L. C. McMahen, Boeing Airplane Co. Br. Office, Dayton, Ohio, 30 Oct 1952, subj.: Project Brass Ring Modification and Extended Flight Test Programs, in Drone Missiles Br. files: Funds, see App. 93.
- 169. Rpt., Fiscal History of Project Brass Ring, 1 Oct 1953, prep. by Maj. W. B. Helms, Drone Missiles Br., WSD, in Drone Missiles Br. files: Funds, see App. 132; Interview with Maj. W. B. Helms, Drone Missiles Br., WSD, 14 Oct 1952.
- 170. lst Ind. (ltr., Col H. J. Sands, Dir/Airc., D/Dev., ARDC to CG, WADC, h Apr 1952, subj.: Simplified System for Project Brass Ring), Col. M. C. Demler, C/S WADC, to CG, ARDC, 5 June 1952, in Drone Missiles Br. files: Directives, Priorities, and Termination.
- 171. Ltr., Maj. Gen. J. S. Mills, CG, AFSWC, to CG, ARDC, 31 Dec 1952, subj.: Continuation of ERASS RING in Support of Project in Dir/Strat. Combat Sys., ARDC, files: Brass Ring, 7, see App.100.
- 172. DF, Mr. J. Jordan, Drone Missiles Br., WSD, to Chief, WSD, D/Ops., 29 Jan 1953, sub.: Trib Report for Project Brass Ring, in Drone Missiles Br. files: Trip Rpts., see App 107.
- 173. ARDC Form 82, R-426-272, 12 Feb 1953.
- 174. DF, Jordan to Chief, WSD, 29 Jan 1953, see App. 107
- 175. D/Ops. DAR, 27 Jan 1953.

- 176. DF, Lt. Col. R. B. Gooch, Chief, Drone Missiles Br., WSD, to Chief, Sys. Planning Office, WSD, 8 Jan 1953, subj.: Funding Deficiencies, in Drone Missiles Br. files, see App. 102.
- 177. Ltr., Col. C. E. Knox, Asst. Chief, WSD, D/Ops, to CG, ARDC, 24 Feb 1953, sub.: Plan of Continuance for Project Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 111.





- 178. Ltr., Col. T. S. Jeffrey, Asst. for Strat. Combat Sys., D/Dev.,
 ARDC, to DCS/D, USAF, 4 Feb 1953, subj.:
 Dir/Strat. Combat Sys., ARDC files:
- Phone transcript (summary), Maj. W. B. Helms, Mr. B. Bayuk, and Mr. J. Jordan, all of Drone Missiles Br., WSD, with Mr. J. R. Trueblood, Dir/Strat. Combat Sys., ARDC, 13 Feb 1953, in Drone Missiles Br. files: Eng. Proj. Record Book.
 - 180. Ltr., Knox to CG, ARDC, 24 Feb 1953, see App. 111.
 - 181. Wire, WCOWD-1308-E, Col. V. R. Haugen, D/Ops., to CG, ARDC, 26 Feb 1953, in Drone Missiles Br. files: Funds, see App. 112.
- 182. Sum. of WADC Wk. Conf., 4 Mar 1953, in Hist. Div. files.
 - 183. Phone transcript (summary), Col. T. S. Jeffrey, Dir/Strat. Combat Sys., ARDC, and Maj. W. B. Helms, Drone Missiles Br., WSD, 5 Mar 1953, in Drone Missiles Br. files: Eng. Proj. Record Book.
 - 184. ARDC Form 82, R-426-272, 12 Mar 1953.
 - 185. DF, Lt. Col. R. L. Midkiff, Asst. Dir/Flt. and All-Wx Testing, to Mr. J. Jordan, Drone Missiles Br. WSD, 20 Mar 1953, subj.: Report on Preliminary Results of Remote-Controlled B-47B Flight, in Drone Missiles Br. files: Trip Rpts, see App. 118; Rpt., Trip Report, 19 Mar 1953, prep. by Mr. J. Jordan, Drone Missiles Br. WSD, in Drone Missiles Br. files: Trip Rpts., see App. 117.
 - 186. Wire, WCOWD-1389-E, CG, WADC, to CG, ARDC, 14 Mar 1953, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 114.
 - 187. Wire, WCOWD-1408-E, CG, WADC, to CG, ARDC, 18 Mar 1953, in Drone Missiles Br. files: Funds, see App. 115.
 - 188. Wire, RDDSS-3-23-E, CG, ARDC, to CG, WADC, 28 Mar 1953, in Drone Missiles Br. files: Funds, see App. 119.
 - 189. Phone transcript (summary), Col. T. S. Jeffrey, Dir/Strat. Combat Sys., ARDC, and Maj. W. B. Helms, Drone Missiles Br., WSD, 11 Mar 1953, in Drone Missiles Br. files: Eng. Proj. Record Book.
 - 190. Ltr., Col. N. A. Boushey, Chief, WSD, WADC to Col. T. S. Jeffrey, Dir/Strat. Combat Sys., ARDC, 30 Mar 1953, subj.: Termination of Project Brass Ring, in Drone Missiles Br. files: Funds, see App. 120.
 - 191. DAR, Drone Missiles Br., 24 Mar 1953.
- 192. D/Ops, DAR, 19 Feb 1953.
- 193. DF, Col. R. E. Jarmon, Dep. Dir/Arm., D/Dev., ARDC to Col. T. S. Jeffrey, Dir/Strat. Combat Sys., ARDC, 4 Mar 1953, subj.: Sperry Autonavigator, in Dir/Strat. Combat Sys., ARDC, files: Brass King, 5, see App. 113.

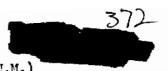




- 194. Ltr., Maj. Gen. D. N. Yates, Dir/R&D, USAF, to CG, ARDC, 1 Apr 1953, subj.: Brass ring, in Dir/Strat. Combat Sys., ARDC, files: Brass Ring, 8, see App. 122; wire, RDDSS-4-11-E, CG, ARDC, to CG, WADC, 11 Apr 1953, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 123; ltr., Col. T. S. Jeffrey, Dir/Strat. Combat Sys., ARDC, to CG, WADC, 20 Apr 1953, subj.: Termination of Project Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 124.
- 195. 1st. Ind. (Col. Jeffrey, to CG, WADC, 20 Apr 1953), Col. V. R. Haugen, D/Ops., to CG, ARDC, 20 May 1953, subj.: Termination of Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 124-a; 1st. Ind. (1tr., Col. E. E. N. Ljunggren, Asst. for Weap. Sys., D/Dev., ARDC, to CG, WADC, 9 June 1953, subj.: Termination of Brass Ring), Lt. Col. R. B. Gooch, Chief, Drone Missiles Br., WSD, WADC, to CG, ARDC, 3 July 1953, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 129-a.
- 196. Phone Transcript (summary), Col. T. S. Jeffrey, Dir/Strat. Combat Sys., ARDC, and Maj. W. B. Helms, Drone Missiles Br., WSD, 18 May 1953, in Drone Missiles Br. files: Eng. Proj. Record Book.
- 197. Ltr., Col. E. N. Lunggren, Asst. for Weap. Sys., D/Dev., ARDC, to CG, WADC, 9 June 1953, subj.: Termination of Brass Ring, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 129.
- 198. Memo., Lt. T. F. Olson, Drone Missiles Br., WSD, to all personnel of Drone Missiles Br., WSD, 17 June 1953, no subj.; in Drone Missiles Br. files: Funds, see App. 130; WADC DAR, 29 May 1953.
- 199. WADC WIR, 31 July 1953.
- 200. Interview with Maj. W. B. Helms, Drone Missiles Br., WSD, 23 Oct 1953.
- 201. Speech, Remarks by General Dent at Conf. on 1951, in Sp. Weap. Br. files:
- 202. DF, Mr. J. Jordan, Drone Missiles Br., WSD, to Chief, WSD, D/Ops, 31 Mar 1953, subj.: Item for Commanders' Conference, in Drone Missiles Br. files: Directives, Priorities, and Termination, see App. 121.



APPENDIX I



RADIUS OR RANGE FROM HOME PASE (N.M.)

Carrier	Without Refueling 3	11.	With Ref	ueling (Transition
B-36H (Manned)	1925 Rad.		2745 Rad	. (this is only a comparative figure as the B-36 does not current-
			•	ly have provision for refueling.)
B-47 (Manned)	755 Rad.	:	1390 Rad	
B-52 (Manned)	2450 Rad.	i	2955 Rad	•
Brass Ring (Unmann	ed) 1720 Range*		4250 Ran	ge* (two refuelings are required— one over the

^{*}Brass Ring is a one-way mission.

Source: This information was presented at the conference by Lieutenant Colonel Witwer, Special Weapons Branch, Weapons Systems Division and is contained in Mr. Jordan's trip report, 29 January 1953.