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T H I S P A G E I S U N C L A S S I F I E D

FOUR

THE ROCKET-BEARING INTERCEPTORS

Rocket Armament and the Lead-Collision Course

The fixed-gun interceptor, sole weapon of the ADC Fighter force up to the spring of 1953, was limited in its effectiveness in an attack on a well-defended bomber. The reasons were as follows: In order to deliver enough bullets to score a kill, the interceptor's guns had to be trained on a bomber for an appreciable time. To hit the target continuously and to provide the necessary lead angle for the guns, the interceptor had to be flown so that it was headed slightly ahead of the target and turned with the target. This resulted in a curved course that brought the interceptor in on the bomber's tail as the attack progressed. A bomber, more heavily armed than the interceptor and being a more stable gun platform, had considerable advantage over an interceptor approaching from the rear. Therefore, with this type of attack, plus the fact that the relatively short range of gun armament made it necessary for the interceptor to move within range of the bomber's guns, the probability of a gun-armed interceptor obtaining a kill on a well-defended bomber was low.

Rocket armament removed many of these disadvantages, giving the interceptor a much greater kill capability. Armed with rockets, the interceptor had to be in firing position for only an instant,

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for a single salvo was sufficient to knock out a bomber. This obviated the necessity of following the bomber on a curved course and made it possible to attack a bomber in a straight line from any direction.* Finally, greatly increased range was possible with rocket armament.

In consequence of the increased probability of interceptor survival and of bomber kill that rockets provided, the Air Force designed its new all-weather interceptors to use this armament, thereby instituting a major innovation not only in equipment, but in tactics. The rocket-firing interceptors were of three types -- the F-86D, the F-94C, and the F-89D. Each carried the 2.75 inch folding fin air rocket. The F-86D was armed with twenty-four, the F-94C with forty-eight, and the F-89D with the amazing number of 104 rockets.

All new and even more highly complex equipment was required for rocket fire control. The control system in the F-86D was designated the E-4, in the F-94C the E-5, and in the F-89D the E-6. Although tailored to fit the individual needs of each aircraft, these systems were similar in function: they located the target regardless of conditions of visibility; when the target was found, they directed the pilot on a straight-line attack course

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* A ninety degree side approach was the most advantageous, for in this position the bomber gave the largest cross-section to the interceptor's radar and rockets, it made the bomber fire into a cross-wind, and it gave assurance that the interceptor would not collide with the bomber.

to a point at which the rockets could be launched; and at the correct instant for firing, they launched the rockets automatically. The equipment performing these functions consisted essentially of two parts -- a radar, the AN/APG-37 in the E-4 and the AN/APG-40 in the E-5 and E-6, and a computer, the AN/APA-84 in all three fire control systems.* On a B-29 type target, the detection range of the E-4, E-5, and E-6 systems averaged between fifteen and twenty-five miles.[1] These systems could automatically track a selected target from fifteen miles to a minimum of around 150 yards. The average lock-on range (at which point automatic tracking was initiated) on a B-29 was from ten to fifteen miles.

The F-86D represented the most radical departure from previous all-weather interceptors, for it was a single-place aircraft. The presentations previously placed on the radar observer's scope in two-place interceptors were combined in one scope for the pilot. This meant that the pilot was responsible not only for search and target acquisition, but also for target tracking and rocket firing.**

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* See Appendix III for a complete listing of the E-4, E-5, and E-6 fire control system components.

** An operational suitability test was conducted by the Air Proving Ground Command of the F-86D equipped 94th Fighter-Interceptor Squadron at George AFB, California during January and February 1954. On the subject of one man operation, the final report of this test concluded that, "Although this test does not provide material for comparison of the single versus two place concepts, it does tend to indicate that an average individual can perform both the pilot and radar observer functions acceptably if given sufficient training. At present, however, very close control from GCI is necessary and the degree of success under certain attack conditions is very limited. As average skills increase, the requirement for extremely close control can be relaxed." [APGC, "Final Report on F-86D Squadron OST (Proj. Lock-ON)," 6 May 1954, HRF 317]

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The straight-line course flown in an attack by the rocket-bearing interceptor was termed a lead-collision course. This attack course was flown as follows.[2] In the F-86D (E-4), during the initial search operations, the scope displayed an artificial horizon and a range trace (a bright vertical line sweeping in unison with the antenna). When the radar was locked onto a target, a steering dot and two concentric circles appeared. The steering dot indicated the azimuth and elevation steering errors. By steering so as to center the dot, the interceptor flew a lead-collision course with the target. The inner circle served as a reference for centering the dot and the outer circle indicated the time-to-go before the rockets would strike the target. At twenty seconds before rocket impact, both circles began to shrink so as to allow more precise steering and to show the seconds before the rockets hit. If the attack were made from a direction other than the side, this phase of the attack continued until the rockets were fired, at which time an X appeared. On a side attack, at four-and-one-half seconds to go the reference circle flattened into a straight line. This indicated that the computer was correcting for asimuth errors and that the pilot had to correct only for elevation errors. As before, an X appeared when the rockets were fired.

The two-man F-94Cs and F-89Ds (E-5 and E-6) operated in exactly the same way except that during initial search operations, only the artificial horizon appeared on the pilot's scope. All other information was displayed on the radar observer's scope. At lock-on, the steering dot and two circles appeared on the pilot's scope.

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One of the most important considerations in this type of attack, of course, was the possibility of collision between the interceptor and the bomber. How a collision would be avoided was explained by the manufacturer of the fire control system, Hughes Aircraft Company, as follows:[3]

> ...the lead-collision course differs from a true collision course only in that it allows for the rockets' traveling several hundred yards ahead of the interceptor and dropping a few yards as a result of gravity before they strike the target. It is by virtue of this relative travel of the rockets that the interceptor clears the bomber it attacks...
>
> The relative travel of the rockets in the direction of the interceptor's velocity is normally about 500 yards. This means that the bomber will cross the interceptor's course at a point about 500 yards ahead of the interceptor...
>
> For a side attack, the bomber will have traveled a considerable distance laterally with respect to the interceptor's course before the bomber comes abeam of the interceptor...For a nose or tail attack, there will be little or no lateral clearance between the interceptor and the bomber since the two courses will very nearly coincide...
>
> Three principal factors affect the vertical clearance between the interceptor and the bomber: (1) the allowance which the fire control system makes for the net vertical drop, (2) the vertical angle between the course of the interceptor and the course of the bomber, and (3) the sum of the pilot's steering errors...
>
> The net vertical drop of an interceptor's rockets depends upon the ballistics of the rockets and the angle of attack of the interceptor. On the basis of currently available data, the fire control computer has been adjusted so that when the interceptor's angle of attack is zero, a vertical rocket drop of about 20 yards will be allowed for...

Conversion to the Rocket-Armed Interceptors

Rocket-bearing aircraft had been scheduled for delivery to ADC as early as the end of 1951. Initially, the F-86D was programmed to arrive in November 1951 and the F-94C and F-89D during January to March 1952.[4] Various production and technical difficulties had by

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mid-1951 pushed these dates back to January 1952 for the F-86D and F-94C and June 1952 for the F-89D.[5] By the end of the year, arrival dates had slipped to May 1952 for F-86Ds and August 1952 for F-94Cs and F-89Ds.[6] The F-86D and F-94C finally arrived in March 1953 (the F-89D was delayed until January 1954), but once started they came in such a torrent that in a little over a year, the great majority of ADC squadrons were equipped with these aircraft.

The first F-94C arrived on 7 March 1953 and was assigned to the 58th Fighter-Interceptor Squadron at Otis AFB, Massachusetts. On 30 March, the first F-86D arrived and was assigned to the 94th Fighter-Interceptor Squadron at George AFB, California. By the close of the year, twenty-eight squadrons had F-86Ds and eight squadrons had F-94Cs.[7] Headquarters USAF termed this "the greatest increase in modernization of the USAF combat force since the end of WW II..."[8]

F-89D delivery began in January 1954 with assignment of these aircraft to the 18th Fighter-Interceptor Squadron at Minneapolis-St. Paul Airport, Minnesota. At the end of September 1954, four squadrons had the F-89D.[9] At the same time, thirty-eight squadrons had F-86Ds and ten were equipped with F-94Cs.

The sudden conversion to new, highly complex aircraft, while creating a potentially more lethal force, brought almost overwhelming problems. All of the difficulties usually associated with a changeover to new weapons -- supply shortages, insufficient numbers of skilled maintenance personnel, crew inexperience, etc. -- were multiplied many-fold. The experiences of the 93rd Fighter-Interceptor

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Squadron at Kirtland AFB, New Mexico, which received F-86Ds in the fall of 1953, as related by the 34th Air Division, illustrate the situation:[10]

> Upon receipt of F-86D aircraft in the 93rd FIS, the following conditions existed.
>
> a. Approximately fifty (50) pilots were assigned. Twenty-five of these had been checked out in the F-86D at ATRC bases, but only five of these had over ten hours in the aircraft and over 500:00 total flying experience.
>
> b. Only a very limited amount of ground handling and test equipment was available.
>
> c. Maintenance personnel, although for the most part qualified on jet aircraft, were not qualified on the F-86D.
>
> d. Adequate logistic support was not available for the aircraft or the fire control system.
>
> Other factors bearing on the extended transition periods were the numerous groundings of the F-86D for Safety of Flight Tech Order compliance, lack of training material and experienced instructors to train maintenance personnel and the lack of a flight simulator to train the pilots in the use of airborne radar equipment and the intercept problem.

The 34th Air Division also pointed out that the 15th Fighter-Interceptor Squadron at Davis-Monthan AFB, Arizona, which was equipped with F-86Ds early in 1954, had identical experiences, "the only difference being that they came later due to the later conversion..."[11]

Both the F-86D and the F-94C were exceedingly difficult to maintain. Between mid-1953 and mid-1954, the in-commission rate of the F-86D averaged no higher than fifty percent and of the F-94C about sixty percent.[12] During this period, both of these aircraft were grounded many times for short periods for modifications and parts changes. The F-86D was grounded for over a week in November for rework of the fuel system. At the end of December, all F-86Ds were

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grounded for a major modification of the fuel system.[13] This modification required considerable work by factory specialists and all F-86Ds were not released for flight until the first week of March.

The simple fact was that during this painful transition period, the problems of which were magnified by the suddenness with which the interceptor force was switched to the new aircraft, ADC's capability was considerably reduced. That this would be the situation was recognized before the first rocket-armed interceptor arrived, but the increased potential which these aircraft would give made it necessary that the risk be taken. ADC's Vice Commander, Major General Frederic H. Smith Jr., pointed this out to the WADF Commander, Major General Walter E. Todd, when the latter expressed concern over the impending all-out conversion and suggested leaving a few proven aircraft in each squadron. General Smith rejected the proposal, stating that:[14]

> squadrons with a proven aircraft as a back-up would be prone to rely on these aircraft rather than concentrating on the F-86D and F-94C, delaying the development of the capability of the new aircraft. I don't think we can emphasize this too strongly. The increased capability of the new AI interceptors over our present day aircraft, warrants an all out effort to bring these units up to a combat ready status at the earliest date. With this in mind, we are prepared to accept a calculated risk during this critical period.

Despite this statement, a modified version of General Todd's idea was put into effect. One of the complicating factors in the transition to the new aircraft was that their arrival coincided with the increased alert schedule applied at the beginning of each spring and continued through the summer months -- the period considered to be the most

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advantageous for an attack on the United States. The problem of maintaining an increased alert was partially alleviated by leaving a few of the old aircraft in possession of the squadron to stand alert or by assignment of older model aircraft to newly activated squadrons for this purpose.

At the end of the critical summer period, as had been the policy in the past, the alert schedule was lowered. This time, however, it was reduced to a somewhat lower level than before.[15] As noted by ADC, "the reductions in alert commitments...do not reflect a change in the intelligence situation but are considered advisable to facilitate conversion and training."[16] ADC further reduced its alert requirements on 1 December so that almost full time could be devoted to conversion. ADC ordered that, "during December, January, and February command wide effort will be concentrated on solution to training problems induced by unit equipment changes and low skill levels in air and ground crews. An added degree of risk...will be accepted in order to facilitate your training in this period."[17] In addition to the lowered alert, ADC left fulfillment of the unit proficiency directives to the discretion of the field commanders, noting that any waiver must be made in "realization that we must aim for peak readiness by next spring."[18]

<u>Armament Maintenance</u>

Proper functioning of the fire control system was never before so vital as in the rocket-armed interceptors. The split-second timing of the lead-collision course attack required precision operation of all components of the system. As pointed out by the commander of the Yuma center, the fire control system simply had to be in correct working order:[19]

> In aircraft equipped with fire control systems designed for the use of machine guns, the proficiency of the combat crew was of prime importance and while the systems maintenance personnel, charged with the maintenance of the fire control system itself, were important, the fire control system allowed the pilot several alternatives for the accomplishment of his mission in the event that any part of the fire control system was not functioning properly. This situation no longer exists in utilization of the E-4 and E-5 fire control system.

During 1953, the only rocket firing accomplished was for familiarization and equipment checks. Perhaps this was just as well, for during this time and far into 1954, parts, test equipment, and personnel were inadequate to maintain the equipment on the level required for actual record firing. A picture of the situation was given by the 4707th Defense Wing located at Otis AFB, Massachusetts, in August 1953:[20]

> The radar and fire control systems are difficult to adjust and maintain. Maintenance crews have difficulty in correcting malfunctions. The system does not operate very long once adjusted... The fire control system did not arrive with maintenance or operational technical orders or a parts replacement schedule. In addition, special tools, test equipment and required power were not available. Certain items are still lacking. Maintenance technical orders have only recently arrived in the operating unit and the table of supplies is still incomplete...
>
> Personnel of the caliber needed to maintain the fire control system have not been available to this command in numbers great enough to maintain the equipment. Units of this command have not had enough trained personnel to even determine whether or not the system can be maintained in an acceptable combat-ready condition.

Fire control system test equipment such as mock-ups, range calibrators, and tube testers was severely short. For example, ADC had a total of twenty of the very important range calibrators, AN/UPM-11A, in October 1953 to meet the requirement of seven in each squadron.[21] These calibrators were still in short supply at mid-1954 with barely a minimum requirement on hand in each squadron.[22] Power supplies for bench mock-ups, not available initially, were eventually secured through local purchase in late 1953.[23]

Probably the greatest problem, however, was the shortage of skilled fire control system maintenance personnel. This was a chronic, Air Force-wide situation, as was discussed in connection with gunnery training, resulting from such factors as long training periods and a continuous turnover of airmen. In response to a request for more people, higher headquarters pointed out in October 1953 that little could be done since ADC manning was as high as that of any command. The world-wide average for five level (skilled) airmen was 79.2 percent and for ADC 81.1 percent.[24] For the seven level (advanced) airmen, the ADC average was 85.3 percent compared to the world-wide of 83.9 percent. It was up to ADC to raise the level of its airmen by on the job training, USAF continued:

> Shortages in the higher airmen skill levels prevail throughout the Air Force. This condition must necessarily be shared by all commands. The upgrading of airmen to the higher skill levels is a responsibility of the major commands and is being accomplished through vigorous training programs in the commands... In view of the worldwide shortage of personnel in critical areas, Air Defense Command is being provided with officer and airmen personnel to the fullest extent possible without adversely affecting the capabilities of other commands.

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To supplement the fire control system training provided by ATRC's Technical Training School at Lowry AFB, Colorado, ADC distributed an OJT "package" training program containing reference materials, course outlines, and training aids.[26] During this period, the Defense Forces, particularly EADF, instituted very thorough fire control system OJT programs.[27]

As late as the fall of 1954, however, there were still too few highly skilled fire control system maintenance people and an excess of apprentice level airmen. ADC advised USAF Headquarters in September 1954 that there were over 900 apprentice level (30) E-4, E-5, and E-6 fire control system maintenance people in the command for an authorization of less than 200; and at the same time that there were just over ninety airmen of the highest skill levels (70 and 71) for an authorization of nearly 500.[28]

The authorization for fire control systems maintenance people as well as weapons mechanics (the people who took care of rocket storage, loaded and unloaded rockets, etc.) was raised in 1954 at the request of ADC. The latter asked for more people after discovering through experience that the tables of organization, which were drawn up over a year before (January 1952) the first rocket-bearing aircraft arrived, did not allot enough men.[29] The number of weapons mechanics proved to be especially short and ADC asked than an additional fifteen be authorized each squadron which would bring the total to twenty. This was the minimum required to have a crew of four on duty at all times.

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USAF consented to an increase, although not as large as ADC wanted, and pending a T/O change, authorized eleven more people effective for January 1954.[30] New T/O's were issued in February 1954 for F-94C squadrons, in March for F-89 squadrons, and in September for F-86D squadrons. By these, the F-86D and F-94C squadrons were authorized sixteen weapons mechanics each.[31] The F-89, with its much greater load of rockets, was authorized thirty-seven men for this function. These same T/O's also increased the number of fire control systems maintenance personnel from twenty-nine to thirty-three for F-86D squadrons and to thirty-five for F-94C and F-89 squadrons.

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