



## Chapter 17

# INDIVIDUAL TRAINING OF FLYING PERSONNEL

**T**HROUGHOUT the war a distinction was made between individual training, on the one hand, and crew and unit training on the other. The former prepared students in their individual specialties, such as pilot, navigator, or gunner; the latter taught those individuals to work effectively as a team. After July 1940 individual training of flying personnel was chiefly the function of the three Air Corps training centers, operating under the direction of the Office of the Chief of the Air Corps. In February 1942 this function was delegated to a single Flying Training Command, which, it will be recalled, in 1943 was merged with the Technical Training Command to form the Training Command, with headquarters at Fort Worth, Texas. Combat crew and unit training was conducted from early in 1941 by the four continental air forces; training of cargo and ferrying crews was carried on by the Air Transport Command.

### *Pre-Flying Training*

As had been the case in the First World War, when ground schools for air cadets had been established at selected colleges throughout the country, it became necessary to provide for prospective pilots, bombardiers, and navigators extensive preflight instruction previous to their assignment to flying schools. During the interval between the two wars this had not been necessary. The small peacetime air establishment permitted the setting of high educational requirements for selection of cadets, and sufficient time was allowed for military indoctrination in the flying schools. The rapid expansion that began in 1939, however, presented special problems of military training

--557--

---

for prospective officer--leaders of combat crews, and the early necessity of lowering educational standards for admission to cadet programs forced attention to means whereby a minimum level of academic preparation could be assured. The preflight school provided a solution to this two-sided problem.<sup>1</sup>

In February 1941 the War Department authorized establishment of three Air Corps replacement training centers for classification and preflight instruction of candidates for pilot, bombardier, and navigator training. The official designation of "preflight school" was authorized on 30 April 1942, and the term replacement training center was dropped. By that time preflight schools were in operation at Maxwell Field, Alabama; Kelly and Ellington Fields, Texas; and Santa Ana Army Air Base, California. The school at Kelly Field was soon afterwards moved to an adjoining site, designated the San Antonio Aviation Cadet Center.

There was a difference of opinion as to whether pilot and nonpilot candidates should be assigned to the same preflight school. At first, all trainees were included in the same organization, but soon thereafter separate schools were provided. The general rule of separate, though similar, training was followed until April 1944. By that time the downward trend in the number of students called for consolidation, and the Training Command directed that pilot and bombardier-navigator schools be combined. Students thereafter entered preflight schools with only a general aircrew classification and were not assigned to a specialty until near the end of the preflight course. As the war moved to a climax, the unified school proved more adaptable to the shifting demands for each type of aircrew personnel. In November 1944, when the flow of students had been reduced to a trickle, all training was consolidated in one preflight school at the San Antonio Aviation Cadet Center.<sup>2</sup>

Although agreement existed on the need for some kind of pre-flying training, ideas regarding the content of the course were vague when the schools first opened. In announcing the decision to undertake such instruction, OCAC stated that the preflight period would consist of "physical training, military training, supervised athletics and the complete processing of assigned students," as well as "additional instruction and training as may be practicable . . . to further qualify trainees for instruction as pilots, bombardiers, or navigators."<sup>3</sup> Brig. Gen. Walter R. Weaver, commanding the Southeast Air Corps

Training Center, leaned toward military discipline and physical conditioning as the primary aims of preflight, and his view was supported by many officers who viewed the academic program as sub-ordinate. Curricular development, however, followed the direction favored by those who stressed the need for technical knowledge on the part of aircrew members. There was a steady increase in the relative amount of time and recognition given to academic subjects, and this phase of the program became the paramount function of the preflight schools. Military training doubtless suffered from this trend, but the development was a logical response to the increasingly technical nature of air combat.<sup>4</sup>

Four weeks was the standard length of training at the replacement training centers until March 1942, when a nine-week course was instituted. Separate curricula were issued at that time for pilot and nonpilot training; the distinguishing feature of the latter curriculum was greater emphasis upon mathematics, target identification, photography, and meteorology. Until 1943 each preflight school exercised broad discretion in executing the prescribed program. The lack of uniform instruction proved a handicap in subsequent stages of aircrew training, and to correct this situation a single curriculum for all preflight students was published in April 1943. Final developments of the course were incorporated in a revision of May 1944, when the period of training was extended to ten weeks.<sup>5</sup>

Under the various preflight curricula, students spent four to five hours daily in academic training. Many students entering preflight were so deficient in the fundamentals of mathematics and physics that considerable time had to be given to rudimentary drills, with emphasis upon problems related to performance of flying duties. Theory was reduced to a minimum, and matter inapplicable to aviation was progressively screened out of the courses. Since ability to use aeronautical maps and charts was basic to flying operations, an elementary course in that subject was also developed in the preflight schools. The course became increasingly practical as the necessary materials were made available for teaching purposes; a large portion of the allotted hours was reserved for student exercises in simulated operational problems which required use of aeronautical charts.<sup>6</sup>

The subject of aircraft and naval vessel recognition slowly gained acceptance in recognition of its combat importance. Early teaching of planes and ships was largely ineffectual because too much was

attempted with too little time and equipment, but by 1943 the pre-flight recognition program was fairly satisfactory. The time allotted to the course was extended, and the number of visual aids greatly increased. During 1944 and 1945, with an adequate supply of projectors, slides, and screens, the schools were quite successful in training students to recognize, almost instantly, close-up views of the principal American and British aircraft. The scope of naval vessel recognition was gradually restricted to identification of ships by general type, including merchantmen and landing craft, rather than by nationality or individual class.<sup>7</sup>

Pilot trainees, in particular, were unhappy in having to take radio code instruction. It was admittedly a dull subject, requiring concentration and repetition. Student motivation was weakened by the fact that flyers returned from combat generally declared that overseas they had little use for code. Headquarters, AAF, however, repeatedly directed that code be taught, and all preflight students, except those who demonstrated proficiency, had to attend one hour of code daily. By 1944 both sending and receiving of code, by aural and visual means, were taught. The proficiency required was six words per minute.<sup>8</sup>

Of the 175 hours of instruction called for in the official academic program of 1944, 110 were allotted to basic military and officer training. One-half of this time was set aside for close order drill, ceremonies, and inspections; the remainder went to classroom or squadron instruction in customs and courtesies of the service, chemical warfare defense, small-arms familiarization, and related military subjects. The West Point code of cadet discipline and honor was regarded as the model for the preflight schools. The traditional class system, with its more or less stereotyped forms of hazing, was introduced at first, but this practice came under severe public attack, and in spite of its defense by the responsible military authorities, the class system was abolished by order of the Flying Training Command in May 1943.<sup>9</sup> While there may have been disciplinary advantages in the supervision of each lower class by upperclassmen, the hazing associated with the system interfered with the primary mission of the schools and was ill suited to the temperament of the civilian soldier.

Physical conditioning was one of the major purposes of preflight, and after initial uncertainty regarding the nature of such training, a comprehensive and balanced program was evolved. Experimentation

was the rule during the early period, when calisthenics, in varying amounts, were mixed with competitive sports, cross-country hikes, and obstacle courses. In September 1943 a weekly minimum of six hours of physical training was established for all aviation cadets. The trend toward uniform conditioning culminated in November 1949 when the Training Command published a detailed outline of exercises for each stage of aircrew training. This memorandum provided for a steady progression of physical hardening and a specified division of time among standard drills, team games, and aquatic exercises.<sup>10</sup>

The chief problem in developing an effective preflight program was the lack of qualified academic instructors. Because few military personnel were available and they were inadequately prepared as teachers, it was realized that they could not be depended upon exclusively, and in July 1941 authority was granted to hire civilians. Within a year it was recognized that professional training and educational experience were prime requisites of academic instructors, and such men were procured in large numbers. Although these civilians were generally satisfactory, their status as civilians proved troublesome. They were authorized to wear military-type uniforms, but such quasi-military status did not make them feel at home in Army schools. Some of the men, furthermore, were in the process of being drafted by their selective service boards, and others were accepting commissions offered by the Navy. To hold on to these teachers, the AAF in the latter part of 1942 and during 1943 gave direct commissions to civilian instructors at the schools, as well as to several hundred procured directly from colleges, and sent them to the AAF administrative officer training school. Instructors under thirty-five were allowed to enlist and were then assigned to the officer candidate school. Practically all of the men who thus became officers were returned to their preflight teaching positions. In addition, a few instructors who were physically ineligible for commissions remained at the schools as enlisted men, and a small number of civilians were also retained.<sup>11</sup>

Although most of the instructors were experienced college or high school teachers, some had almost no knowledge of some of the subjects they were assigned to teach. In order to deal with this problem, practical in-service training, consisting of classroom observations, individual study of textual materials, and conferences with veteran pre-flight teachers, was given at each school. Attention was limited at first to preparing each instructor in the subjects he was required to

teach, but programs to improve teaching techniques and develop familiarization with the entire curriculum were later developed. In the summer of 1943 these local efforts were supplemented by a special course at the central instructors school at Randolph Field. After a considerable number of teachers had attended the six-week program there, the course for ground-school instructors was dropped in January 1944.<sup>12</sup>

The typical aviation cadet was an eager learner in preflight school. Ground training in any form was viewed with some misgivings by the average cadet, but he responded willingly to preflight instruction. Pilot and navigator students usually showed the highest morale, because their classification most commonly coincided with their first preference. Many of the bombardier students, up to 1943, were eliminees from pilot training who, required to repeat preflight instruction, naturally resented the delay and repetition of subject matter. In 1943 bombardier morale was greatly improved when it was decided that an eliminee from one type of aircrew training, who had completed preflight, would no longer be required to retake that phase of training. As the war neared its end, the attitude of all students be-came less inspired. Delays in the progress of training, caused by curtailments in the aircrew program, proved especially disheartening.<sup>13</sup>

The preflight schools formed an integral part of aircrew training throughout the war. In 1943 an additional phase of pre-flying instruction was introduced: the aircrew college training program, which lasted until July 1994. The college program, to put it bluntly, came into existence not so much to meet an educational need as to hold a backlog of aircrew candidates. As has been previously noted,\* the AAF had found it advisable in 1942 to recruit aviation cadets in excess of its immediate needs and to hold them in an inactive enlisted reserve until needed. By December 1942 approximately 93,000 men were awaiting classification and instruction, and many of them had been in this limbo for six or seven months. Not only did this extended in-active period discourage some of the men, but the pool of idle man-power received increasing notice from selective service boards and the War Manpower Commission. Accordingly, General Arnold proposed to the War Department that these men be called to active duty and given a period of college training designed to make up educational deficiencies.

---

\* See above, pp. [494-97](#).

In January 1943 the Secretary of War, after making certain modifications, ordered Arnold's recommendations into effect. The Services of Supply, then in the process of establishing the Army specialized training program in various colleges, was directed to set up aircrew college training as a separate project. The curriculum was planned to cover a five-month period, and all aircrew candidates were to be assigned from basic training centers to the colleges unless they could pass a special educational test. The relatively few who passed this test were sent directly to preflight schools.<sup>14</sup> Special boards within the Flying Training Command made preliminary selection of colleges for the program, and the contracts for instruction, housing, messing, and medical care were later negotiated by the AAF Materiel Command. Implementation of the project suffered because of the haste in which it was conceived and executed; by April 1943 over 60,000 men were in aircrew college training detachments at more than 150 institutions.<sup>15</sup> Since the AAF viewed the college enterprise primarily as a personnel rather than a training activity, it failed to establish a clear definition of its educational purpose. The educational objectives, as stated by the Flying Training Command, varied from a limited "Preparation . . . both mentally and physically, for intensive ground training in the Preflight Schools" to the broader "attempt to diminish individual differences in educational background for subsequent air crew training."<sup>16</sup>

Academic subjects, taught by college faculty members, included mathematics, physics, current history, geography, English, and civil air regulations. Military indoctrination, the responsibility of the officers of each detachment, consisted of drill, inspections and ceremonies, guard duty, customs and courtesies, and medical aid. Military training was carried into the academic phase by having the students march to and from classes and by insisting upon proper military courtesies at all times. Although there was a great variance in the degree of emphasis upon discipline at the colleges, this phase of the program was probably more valuable than any other, in that it at least helped adapt students to the standard regimen of Army training. Physical conditioning, required one hour daily, included calisthenics, running, and competitive sports.<sup>17</sup>

Perhaps the most controversial phase of the curriculum was the ten hours of flight indoctrination. The AAF did not desire this instruction in the college program; it was prescribed by the War Department

and conducted in cooperation with the Civil Aeronautics Administration. Flying schools located near the colleges provided the training under contract. Since the purpose of this flying was only familiarization, operations were restricted to simple maneuvers in light aircraft, under dual control by instructor and student. AAF observers criticized the training as of little value, charging that the students were "merely riding around for 10 hours." A study conducted in 1944 showed that the indoctrination course helped students materially in the regular primary stage of flying training but gave them no appreciable advantage in later stages. Whatever its long-range value, the course was a morale booster for men who had waited months to learn to fly.<sup>18</sup>

As early as November 1943 moves were made toward liquidating the college program. By that time sufficient aircrew personnel were in the training pipeline, and the backlog of men on inactive status was relatively small. The Training Command took the view that the college program was not essential and that it was creating an unfavorable public attitude by holding combat-age personnel in colleges while fathers were being drafted into military service. In January 1944 entrance of aircrew students into college was cut almost in half, and contracts with many institutions were terminated. In March, as a consequence of the general manpower shortage, the AAF was directed to return to the Army Ground Forces and Army Service Forces all personnel recruited from those branches who had not reached the preflight stage of aircrew training. This order resulted in large withdrawals of students from the college detachments and sealed the fate of the program. Shortly thereafter, the Secretary of War approved its final liquidation by July 1944; since procurement of aircrew candidates had been suspended, there appeared to be insufficient personnel in the backlog to sustain the program beyond that time.<sup>19</sup>

Although the number of enlisted reservists awaiting training had been greatly diminished by the middle of 1944, the general problem of backlogs, or personnel pools, was by no means ended. During the year requests from combat theaters for aircrew personnel declined sharply; entry of students into the flying stages of training was accordingly reduced, and this had created pools in intermediate stages of the training sequence. The Training Command concluded that the best solution to the problem was to distribute personnel from the pools to flying fields for on-the-job instruction. AAF Headquarters

accepted the recommendation and authorized the beginning of on-the-line training, with a dual objective: to provide storage

and training of delayed students and to alleviate the growing shortage of regularly assigned personnel at the airfields. On-the-line training was first put into effect in February 1944, and after termination of the college program in July, it became the principal holding device for pre-flying personnel pools.<sup>20</sup>

Higher headquarters provided little guidance in the development of an instructional program for on-the-line students. The Training Command advised only that "trainees will be given duty assignments with aircraft maintenance and servicing where they will get more practical training for their future instruction." Responsibility for implementing the program was left almost entirely to individual station commanders, and this fact resulted in considerable variation in the training. Some commanders reasoned that the students would shortly be returned to the normal sequence of aircrew instruction and gave them slight attention; others saw the possibility of a longer period of delay and devoted a great deal of consideration to their training, work, and recreation.

Some stations offered a few elementary academic courses, but attendance was voluntary; a formal thirty-day mechanic course was established at stations of the Western Flying Training Command. At every field, however, student training consisted chiefly of apprentice experience in aircraft maintenance. Because of the increasing shortage of regularly assigned enlisted personnel, permission was eventually granted to use trainees for administrative and nontechnical duties, as well as on the flight line. Such permission tended to draw students ever closer to enlisted and further from cadet status. As progressive cuts in the aircrew program continued, large numbers of aircrew candidates were transferred to regular enlisted status and classified in their appropriate military occupational specialties.<sup>21</sup>

In no other stage of aircrew training was the problem of morale so serious as in on-the-line training. Lack of an explicit program was partially responsible, but delay and uncertainty concerning the students' future were of primary importance. Each step in curtailing the aircrew program was an added blow to morale. Although many of the trainees eventually reached flying schools, large numbers remained in the pools; by the end of 1944 some men had been in pre-aircrew status for almost a year. Higher headquarters showed concern over

--565--

---

the attitude of such students and explained each curtailment of air-crew training quotas as the result of unexpected combat success. To young and ambitious men this explanation was hardly satisfying; as they moved toward enlisted status, many experienced bitter disappointment and sense of failure.<sup>22</sup>

### *Pilot Training*

Although the importance of other specialties was increasingly recognized during the war, the pilot remained the principal object of Air Corps training. While each member of the aircrew was essential to performance of assigned missions, the general success and safety of the crew depended mainly upon the pilot, who was the aircraft commander. Although the AAF made a substantially successful effort to give all flying personnel due recognition, it properly put flying training in top priority.

Development of a military pilot required a succession of training stages, for it was not feasible to train a man to fly a powerful combat or service airplane without preparation in simpler and less specialized aircraft. During the 1920's and 1930's pilots had received a total of twelve months' instruction, divided into three stages. After 1931 the primary and basic stages were given in an eight-month combined course at Randolph Field, Texas; a four-month advanced course, providing specialization in bombardment, pursuit, observation, or attack aviation, was taught at Kelly Field, Texas. This peacetime system of training was successful in producing a small number of graduates who were both skillful pilots and highly qualified junior officers.<sup>23</sup>

In July 1939 the total instructional time was reduced from twelve to nine months. In the following May, with the war pressure mounting across the Atlantic, the period was cut to seven months. Although the introduction of preflight training in the following year compensated somewhat for the loss of time allotted to flying schools, the seven-month period, which allowed only ten weeks each for primary, basic, and advanced flying, was considered insufficient by existing standards. But national danger required unprecedented steps, and shortly after Pearl Harbor the time for each stage was forced down to nine weeks. In March 1944 each stage was lengthened to ten weeks, and after V-J Day to fifteen weeks. The post-hostilities schedule raised the time for individual pilot training to a level approximately that of the 1930's.<sup>24</sup>

--566--

---

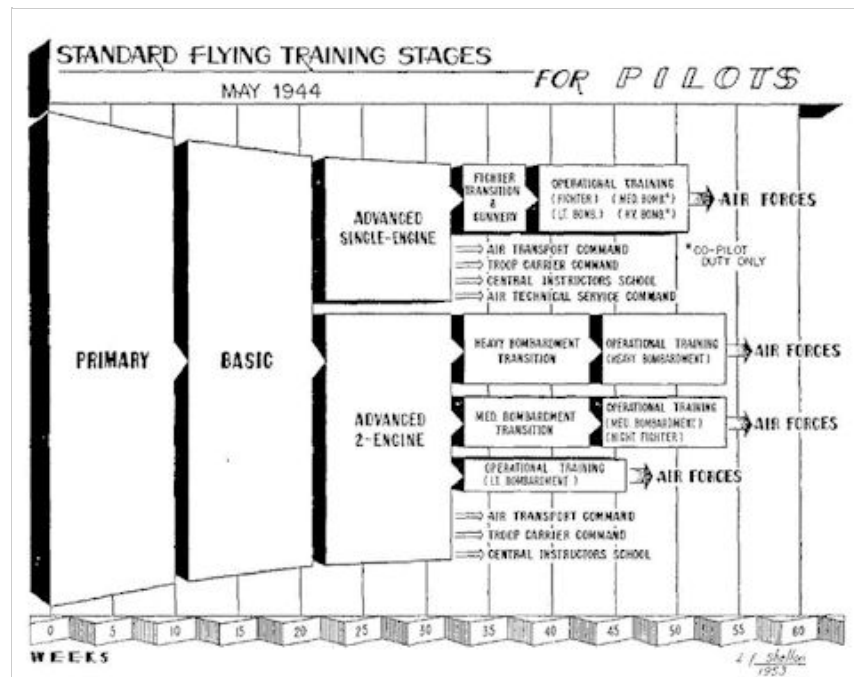
The three stages--primary, basic, and advanced--were common to the training of all Air Corps pilots, and upon graduation from advanced, students received their wings and bars. This step, however, did not signify the end of their training; the new pilots were given additional periods of specialized instruction suited to their military assignments. Such instruction included in all cases a period of transition flying.

The term "transition" was applied generally to a pilot's learning to operate an unfamiliar plane; thus all students underwent several brief transition phases as they progressed through the normal stages of pilot training. In primary they learned to fly a small aircraft of low horsepower; in basic they transitioned to a heavier plane with more complex controls; in advanced they learned to fly a still more powerful machine which approximated the characteristics of combat aircraft. Transition to combat planes, which generally did not occur until after a pilot had earned his wings, was a larger undertaking than previous transitions to training planes. It involved not only learning to fly a complex, high-performance aircraft, but also the acquisition of flying techniques, preliminary to operational unit training. In order to make adequate provision for this step, a special stage, called transition, was evolved in the major pilot programs.

When the Air Corps' expansion began in 1939, transition to combat aircraft was a function of the GHQ Air Force and units in overseas departments; the four continental air forces took over this job and carried it on until 1942. By that time the program had become too large for the air forces alone to direct in addition to their operational unit training. Consequently, transition of pilots to heavy and medium bombardment aircraft was assigned to the Flying Training Command, the agency primarily responsible for individual flying instruction. Light bombardment and fighter transition, however, remained a function of the continental air forces' operational units.<sup>25</sup>

The time allotted to pilot transition to combat planes varied throughout the war, but by May 1944 it was stabilized at ten weeks for bombardment transition. Fighter pilots received five weeks of transition on obsolescent combat types before being assigned to operational units, where they were given transition on current fighter types prior to tactical training. Transition to the specific aircraft to be flown in combat was the last stage of a pilot's individual training. Upon completion of this stage, he was ready to start training as a

member of an aircrew and a combat unit. Crew and unit indoctrination normally required about twelve weeks, after which the aerial teams were sent to staging areas to prepare for movement overseas. Even though the time for primary-basic-advanced training of pilots was reduced during the war to seven months or less, a pilot was not ready for combat until a year or more after he started flying instruction.<sup>26</sup>



Until July 1939 primary training, as well as other phases of pilot training, had been conducted exclusively at Air Corps stations by military instructors. Thereafter, as described above,\* the Air Corps depended increasingly upon civilian schools working under contract to provide primary instruction to air cadets; by May 1943 there were fifty-six contract primary

schools in operation. At each school the AAF maintained a small military contingent whose services were gradually expanded, but the military element in the activity of these schools was subordinated to the task of learning to fly.<sup>27</sup> The termination of contracts began with the curtailment of pilot training in

---

\* See above, pp. [456-61](#).

--568--

---

1944, and by the end of the war the responsibility for primary training had been returned to regular AAF establishments.<sup>28</sup>

The instruction given at the contract schools was an adaptation of the primary phase formerly taught at Randolph Field. Although the number of weeks allotted to primary training was sharply reduced, the number of flying hours remained almost constant after the original requirement of sixty-five hours had been trimmed to sixty in March 1942. In that year an unsuccessful attempt was made to add instrument, night, and navigation instruction to the curriculum, but otherwise the program remained virtually the same during the war. As given at the height of the effort, primary flying training was divided into four standard phases. In the pre-solo phase students became familiar with the general operation of a light aircraft and achieved proficiency in forced landing techniques and in recovering from stalls and spins. In the second, or intermediate phase, pre-solo work was reviewed, and precision of control was developed by flying standard courses or patterns, known as elementary 8's, lazy 8's, pylon 8's, and chandelles. The third, or accuracy, phase demanded high proficiency in various types of landing approaches and landings; the fourth, or acrobatic, phase required ability to perform loops, Immelmann turns, slow rolls, half-rolls, and snap rolls. The ratio of dual to solo hours was flexible within the limitation that a minimum of 40 per cent and a maximum of 50 per cent of the total time was to be dual. Each student in primary was required to make at least 175 landings.<sup>29</sup>

It was the mission of the basic schools to make military pilots out of primary graduates; hence, these schools were completely controlled and operated by the military. Although basic flying was conducted by a few private contractors, on a trial basis, from 1941 to 1943 and the experiment met with some success, AAF officials questioned the ability of civilians to teach military flying techniques, and by the end of 1943 curtailment of the pilot program removed any necessity for using private agencies in basic training. The student at basic learned to operate a plane of greater weight, power, and complexity than the plane which he had mastered in primary. In addition, the student was introduced to new aspects of airmanship, learning to fly by instruments, at night, in formation, and cross-country. The military instructors emphasized precision and smoothness of airplane operation, and a large portion of flying time was devoted to repetition of maneuvers to develop proficiency.<sup>30</sup>

--569--

---

After 1939 the basic stage was accomplished in from 70 to 75 hours of flying, as compared with the 100 hours required before that time. It was divided into a transition phase, involving familiarization with the plane and fundamental operations, and a diversified phase, which included accuracy maneuvers and acrobatics, and formation, instrument, navigation, and night flying. Reduction in training time was at first effected by eliminating navigation and formation flights and decreasing slightly the hours allotted to other portions of the diversified phase. In 1940 formation and day navigation flights were restored to the curriculum, and Link trainer instruction was added. Soon after Pearl Harbor, in response to observed combat requirements, increasing emphasis was placed upon the diversified phase, but the change was unsatisfactory, because it allowed too little time for fundamental transition exercises. The root of the difficulty lay in the fact that the nine weeks given to basic from 1942 to 1944 were not enough to permit satisfactory development of proficiency in both phases of training. Since it was impracticable to accomplish the full objective, there was a serious controversy over which phase should receive principal emphasis. During 1943 the curriculum was modified to favor transition at the expense of diversified training and, as might have been expected, graduates showed greater proficiency in the so-called flying fundamentals but were weak in formation and instrument flying. Criticisms of this weakness from combat units brought a change in basic curricular requirements in May 1944, at which time the length of training was extended to ten weeks. Although the hours allotted to flying were held constant, there was a shift of hours within the diversified phase, instrument time being increased at the expense of acrobatics.<sup>31</sup>

Instrument training was doubtless the most important part of the basic curriculum. Experience in combat underlined the necessity of flying at night and under all weather conditions, and such missions required operation of aircraft by instruments. The nature and extent of the instrument indoctrination given to pilots at basic schools were insufficient until late in 1943, partly because of the traditional peace-time attitude of training officers who subordinated instrument work to

conventional visual maneuvers. Another reason for this deficiency was the acute shortage of instructional time and equipment; more-over, the system of instrument flying used by the AAF before June 1943 was not the most efficient. The AAF system relied almost exclusively

--570--

---

upon the three rate instruments: the needle, or rate-of-turn indicator; the ball, or bank indicator; and the airspeed indicator. Gyroscopic instruments were practically ignored. During 1942 the Navy developed an improved method of instrument flying, the full-panel system, which relied chiefly upon the directional gyroscope and the artificial horizon. AAF instructors who observed the new method found it to be more accurate than the traditional one; hence, the full-panel system was introduced at basic and advanced pilot schools in June 1943. Assistance in establishing the new system was given by officers from the central instructors school (instrument pilot), which had been activated in March 1943 as a means of strengthening the AAF instrument program. During the succeeding year a substantial improvement in the instrument proficiency of basic graduates was achieved; this resulted from standardized employment of the more efficient system, proper training of instructors, procurement of adequate equipment, and allocation of more flying hours to instrument work.<sup>32</sup>

The traditional basic curriculum had always been confined to training on single-engine aircraft; differentiation of students for single-engine or two-engine instruction did not normally occur until advanced training. But during 1943 and 1944 an attempt was made, in the interest of improving the proficiency of multiengine pilots, to begin two-engine training for them in basic. Although the majority of students continued to receive the standard single-engine curriculum, small numbers were entered into one of two experimental curricula. The first of these was a combination course; after transitioning on the single-engine basic trainer, the student received familiarization instruction on a two-engine plane. The second course was conducted exclusively with two-engine aircraft. Although the experimental curricula showed some promise, they were abandoned in 1945. The combination course allowed too little time for the student to gain more than familiarization with either type of plane; the second course proved impracticable because of the shortage of appropriate two-engine aircraft. The experiment indicated, however, that if adequate numbers of satisfactory trainers were planned for and provided, differentiation of instruction at the basic stage would prove more efficient than the conventional curriculum.<sup>33</sup>

Although twin-engine training did not become a permanent part of the basic curriculum, one of the responsibilities of the basic schools

--571--

---

was the selection of students for single- or two-engine advanced training. Assignment was based upon a combination of factors--current requirements for fighter and multiengine pilots, the student's aptitude, his physical measurements, and preference. After the middle of 1944, however, student choice was generally disregarded. Preferences for fighter training exceeded the demand, and there were not enough men with the requisite physical qualifications who desired bombardment. Some schools found it necessary to assign all men with the required physique to advanced two-engine schools.

The differentiation of single-engine from two-engine training in the advanced stage was not effected until the spring of 1942 although planning for the change dated back to October 1940.<sup>34</sup> As it had evolved by 1944, the single-engine curriculum consisted of seventy hours of flying instruction, compared with seventy-five hours in 1939. It included five phases--transition, instrument, navigation, formation, and acrobatics; Link trainer time was also required. Instrument operation was a continuation of the methods learned in basic; the transition, navigation, and formation phases all required night flights. In response to the lessons of war, increasing emphasis was placed on formation flying, especially at high altitudes and using the close, three-plane V-formation. Acrobatics included all conventional combat maneuvers within the performance limits of the advanced trainer.<sup>35</sup> Although some of the graduates of the advanced single-engine school eventually were assigned as noncombat pilots or were sent to bombardment operational training units for service as co-pilots, the principal mission of the school was to prepare students for subsequent flying in fighter aircraft. To achieve this end, the advanced schools stressed the handling of maneuverable, speedy training planes and the development of instantaneous control reactions in students.

But besides expert flying ability, the fighter pilot needed skill in fixed aerial gunnery. Hence, during the course of advanced training the more promising students, those who were to become combat fighter pilots, were assigned to a fighter-transition and gunnery stage. This preparation for operational unit training consisted of some twenty hours of fixed gunnery practice in the standard advanced training plane and about ten hours of transition in an obsolescent combat type (P-40 or P-39). Development of proper techniques and equipment for fixed gunnery training came slowly, although gradual improvement



was noted after 1942 when better teaching methods and use of

-572---



DUAL FLIGHT INSTRUCTION



FORMATION FLIGHT, FOSTER FIELD,  
TEX.  
ADVANCED TRAINING



ALERT NET PROBLEM AT FOSTER  
FIELD, TEX.



INSTRUCTOR AND CADET IN NOSE  
OF AT-11

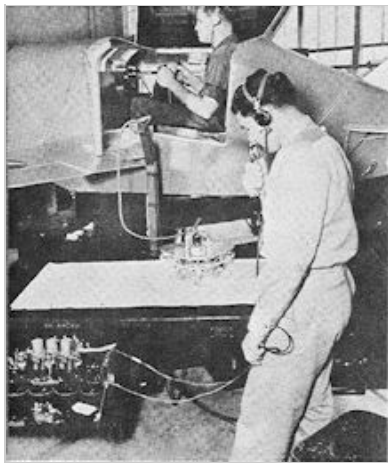


ENLISTED MEN PREPARE FOR  
BOMB-SPOTTING FLIGHT

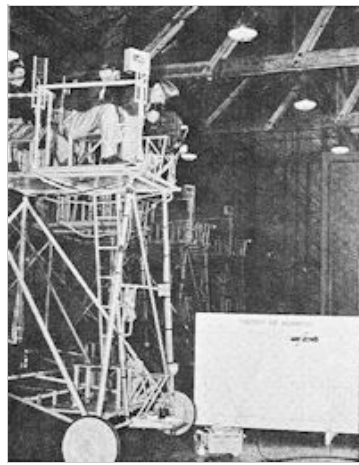
BOMBARDIER TRAINING



NAVIGATOR TRAINING AERIAL  
CLASSROOM



For Pilots: Link TRAINER



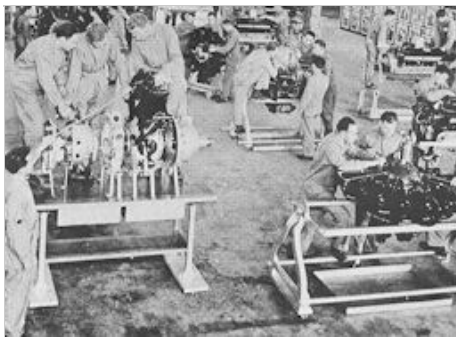
For Bombardiers: A-2 BOMB  
TRAINERS  
SYNTHETIC TRAINING AIDS



For Navigators: HAGNER  
PLANETARIUM



FLEXIBLE GUNNERY TRAINING



ENGINE MECHANIC CLASS, RANDOLPH FIELD, TEX.

---

synthetic trainers and the gunsight-aiming-point camera had been instituted. In 1944, as the pressure for numbers of graduates eased, the gunnery and fighter-transition phase were made into a separate course to be taken after graduation from advanced. This change lengthened by five weeks the over-all period for training fighter pilots.<sup>36</sup>

Although advanced two-engine training did not begin until the spring of 1942, it expanded rapidly thereafter in response to the growing demand for multiengine pilots. All students, except a few chosen to become night or two-engine fighter pilots, were marked for assignment to bombardment-type aircraft. The number of hours and types of flying instruction were the same as in the advanced single-engine course. The principal difference in the two-engine course was the absence of training in acrobatics and the greater emphasis on instrument work; all flying was conducted in two-engine planes.<sup>37</sup>

Upon graduation from advanced two-engine schools, pilots were assigned to transition training on specific combat types. Beginning in 1942, transition for medium and heavy bombardment was conducted by stations of the Flying Training Command; the Third Air Force continued to provide transition for light bombardment as a part of operational unit training.

Separate schools were established for each type of airplane; the first of these, for B-17 transition, opened in March 1942. Initial attempts to conduct full combat-crew training at these schools were abandoned in August 1942, and instruction thereafter was confined to transition of first pilots only. An independent program for co-pilot transition was carried on at selected gunnery and technical schools of the Training Command from 1944 to April 1945.<sup>38</sup>

Until the fall of 1942 entrance into bombardment transition was restricted to pilots with at least one year's flying experience. When it became necessary to train recent graduates of advanced schools, the instructional period had to be doubled in length; by May 1944 it amounted to ten weeks. Although some differentiation for each type of aircraft was found to be desirable, the flying curricula, each of which prescribed about 100 hours of flying, were generally similar. Instrument, navigation, and high-altitude training received increasing attention in the four-engine schools; formation flying was emphasized in two-engine transition. Toward the end of the war, closer liaison was developed with the combat air forces in order to adapt instruction to the changing requirements of the air war.<sup>39</sup>

Ground training, from primary through transition, was an essential

--573--

---

aspect of the instruction received by AAF pilots, instruction designed to prepare the student for successful performance of flight duties. Although air and ground indoctrination were inadequately coordinated at first, a satisfactory integration was achieved by 1944 through more careful planning of the curriculum and frequent conferences between the teaching staffs of the air and ground departments. Mutual understanding was advanced by encouraging familiarization flights for ground instructors and classroom observations by flying instructors.<sup>40</sup>

When the accelerated training program was begun in 1939, the ground curricula at the various stages of instruction consisted of a large number of short courses. For several years thereafter, directives from the higher commands remained vague as to requirements, and each school consequently had a more or less individual curriculum. Continuity of subject matter from one stage to the next was lacking, and considerable duplication between stages prevailed. Gradually, a more orderly sequence of ground training was developed,<sup>41</sup> and by May 1944 the program had become relatively well stabilized at each stage of individual training. Five major courses, calling for a total of ninety-six hours, were given at the primary schools. Almost half of this time was devoted to the aero-equipment course, which was devoted to the principles and workings of the various operating systems of an aircraft. Navigation, the next most extensive course, was a continuation of the maps and charts course taught in the preflight schools and emphasized planning for cross-country flights. A course in principles of flight consisted of elementary applied physics, with special reference to airplane structures and flight behavior. Continuation training in aircraft and naval recognition, as well as in radio code, was also provided. In all courses theory was held to a minimum, emphasis being upon teaching the student how to perform necessary operations.

Pilot trainees received their first instruction in weather during the basic stage. They were also then introduced to the principles of instrument flight, because it was in the basic schools that students learned to fly at night and under all weather conditions. Radio communication procedures were taught at this stage, and the sequence of training in aircraft and naval recognition aimed at achieving proficiency in identifying relatively distant views of the principal planes and vessels.

Ground school at the advanced stage was similar for both single-engine and two-engine trainees. It included the same amount of instruction

--574--

---

in weather, taking up the subject where it was left at the end of the basic stage. Further ground training on flight instruments was also given to both types of students, as well as a course in flight planning. The chief difference in the two curricula was in the aeroequipment course, which, since the two-engine was more complex than the single-engine trainer, was given more time at the two-engine schools. Single-engine students, on the other hand, received training in armament and fixed gunnery, which was not required for two-engine pilots.

Technical instruction did not end when students received their wings and were assigned to transition on specific combat airplanes. Both fighter and bomber pilots, while undergoing transition to their combat planes, received appropriate ground instruction in equipment and practical maintenance. Intensive training in armament and fixed gunnery was given only to fighter pilots; the multiengine pilots received special instruction in weather, radio equipment, aircraft weight and balance, bombing-approach procedures, and duties of the airplane commander.<sup>42</sup>

Although graduates of its pilot schools were officers as well as flyers, in the wartime pressure to produce pilots rapidly the

AAF paid but scant attention to their military training. The atmosphere of the civilian-operated primary schools was not conducive to the development of rigid discipline, and too little time was available for military instruction at all the stages of pilot training. What instruction there was, over and above the regimen of Army life, was restricted largely to marching, ceremonies, inspections, and military customs and courtesies. The vigorous physical conditioning which began in preflight schools was, however, continued and intensified during flying training.<sup>43</sup>

The method of teaching men to fly military aircraft remained fundamentally the same from 1939 through 1945. The sequence was this: explanation by the instructor of each new maneuver, actual demonstration by the instructor, supervised student performance, correction of student errors, and then practice. Progress checks by supervisors were made at specified intervals; final checks, toward the end of each stage of training, tested the ability of the student to operate the airplane under all required conditions. The student, so far as practicable, was taught by the same instructor through all the lessons of a particular training stage. Departure from this "all-through"

--575--

---

system was tried experimentally during 1943 as a possible means of accelerating training. Under the new plan, the flying curriculum at a given training stage was divided into a series of phases, with instructors assigned each to a particular phase. The student could advance individually through the progressive phases as rapidly as his proficiency would permit, and he had a different teacher for every phase. The advantage of the plan was that it permitted the instructor to concentrate on teaching a limited number of maneuvers, with a resultant increase in his teaching skill. The principal disadvantage came from the fact that frequent change of instructors made it difficult for both students and teachers to develop the mutual understanding which facilitates learning. It was finally decided to abandon the experiment, chiefly because it caused serious scheduling difficulties and required a higher ratio of instructors and airplanes to students than the standard "all-through" plan.<sup>44</sup>

Ground-school instruction depended primarily upon classroom lectures, demonstrations, and discussions. Some courses, such as radio code and aircraft recognition, consisted mainly of aural or visual drill. Training aids were used as available, but during the early period of the war these were limited almost entirely to what could be produced locally. After 1943 the situation was considerably improved, and the Training Command produced and distributed manuals and handbooks for both instructors and students. Special emphasis was placed upon mock-ups of operational equipment, and standard sets of such aids were prepared. During 1944 and 1945 increasing numbers of effective training films, slides, and charts were also made available.<sup>45</sup> The most important synthetic device used in instruction of pilots was the Link trainer--a machine in which students could simulate blind flying by means of instruments; it was regulation equipment at every school where instrument flying was taught.<sup>46</sup>

Indoctrination of new teachers, as well as in-service training for experienced teachers, proved to be a continuing necessity in the pilot-instruction program. In the early period the individual schools provided training of a sort for instructors, but by the close of 1942 each subcommand of the Flying Training Command had established a single instructor school for personnel within its jurisdiction. It will be recalled that, in the interest of standardizing training methods and content throughout the command, these regional schools were supplanted in 1943 by one central school at Randolph Field, where various instructor programs aimed to establish and demonstrate stand

--576--

---

and instruction for the various phases of student training. Courses corresponding to each of the regular stages of pilot training were given to flying instructors; they consisted of both classroom and air indoctrination. Special courses for ground-school instructors and military training officers were also conducted. Some attention was given also to general teaching methods, psychology of learning, and analysis of flying maneuvers, but these courses were not very effective. The major weakness of the central instructors school appeared to be its inability to secure and retain the best qualified personnel as staff instructors. Soon after the Randolph Field courses were started, a second central school for the exclusive training of instrument-flying instructors was established at Bryan, Texas. In addition to these two central schools, supplementary instructor-training programs were conducted at the individual pilot schools until the end of the war.<sup>47</sup>

The principal item of equipment in pilot training was, of course, the airplane itself. Almost all of the schools were hard pressed by the shortage of trainers until after 1943, and it was necessary to use some models which were hardly satisfactory but, being the only ones available, had to be used. Full conversion to the most appropriate models was not accomplished until the spring of 1945.<sup>48</sup> Among primary training planes, the Stearman PT-13 was eventually selected to replace all other primary trainers. A biplane, and thus different from later trainers and combat types, the PT-13 had the special virtue of

ruggedness, a quality not to be despised in a plane that had to take the punishment inflicted by a novice.<sup>49</sup> During most of the war period, the Vultee BT-13, a low-wing monoplane of medium horsepower, served as the standard trainer for basic flying. Regarded by many as altogether too easy to fly, it was being replaced during the latter part of the war by the AT-6, a low-wing monoplane already in use as the standard trainer for advanced single-engine instruction.<sup>50</sup> No suitable training plane became available for advanced two-engine flying until late in the war, when the B-25 was modified for the purpose. Theretofore, the Cessna AT-17 and UC-78, the Beech AT-10, and the Curtiss AT-9 were used, with the last considered the most satisfactory.<sup>51</sup> In the transition stage, combat models, which could not always be the latest, were usually stripped down and flown without full fighting equipment.

A total of 193,440 pilots was graduated from AAF advanced flying schools between 1 July 1939 and 31 August 1945. The number under instruction increased very rapidly from 1939 until 1943; the

--577--

---

peak was reached in December 1943 when over 74,000 students were in the various stages of individual pilot training. By contrast, the total number remaining in August of 1945 was only about 5,000.<sup>52</sup>

Successful completion of pilot training was not easy. During the period from 1939 until V-J Day more than 124,000 students failed to complete the primary, basic, or advanced stage of pilot instruction. This figure, which included fatalities, amounted to almost 40 per cent of the number that entered the flying course. The proportion of students eliminated, as would be expected, was highest in primary training and lowest in advanced. No fixed elimination rate was ever imposed from above; a variety of factors determined the number of failures in a given class at a given school. One determinant, of course, was individual differences in the aptitude and motivation of students; another was the varying quality of instructors and training facilities. One of the most important causes for variation in the elimination rate was the fact that judgment of flying proficiency had to be subjective. Teachers and supervisors established differing criteria of proficiency, and no truly objective form of measurement was developed during the war period. But the aptitude of the students and the quality of instruction did not alone cause the elimination rate to fluctuate--the training establishment was also sensitive to the attitudes of higher authority. The Army Air Forces desired pilots of the highest skill consistent with the demand for numbers and the supply of eligible young men. Whenever substantial backlogs of trainees accumulated and the personnel requirements of combat units appeared to be stabilized, higher headquarters stressed rigid maintenance of proficiency standards. When, as a result of this policy, the over-all pilot elimination rate rose to a point considered excessive, higher headquarters impressed upon all training establishments the necessity of reducing manpower wastage. This policy constituted a realistic, if crude, means of compromising the conflicting needs for quality and numbers of pilots.<sup>53</sup>

The students eliminated from pilot training were not lost to the AAF, since most of them were reassigned to other types of instruction or service. The majority of those who had the qualifications were sent to bombardier or navigator schools. If not so qualified, they were assigned to other combat-crew positions, which normally required courses in flexible gunnery and one of the various companion specialties, such as airplane mechanics.<sup>54</sup>

--578--

---

### ***Bombardier Training***

While the Air Corps had a splendid heritage of experience to build upon in the wartime training of pilots, it had no such advantage in developing instruction for bombardiers. Before 1940 the training of bombardiers was limited to on-the-job instruction in operational bombardment groups, both in the United States and at overseas bases. A small number of the trainees were pilots, but the majority were nonpilot enlisted men. Plans had been under way as early as 1939 for the establishment of a specialized school for individual bombardier training, and a course for instructors was established at Lowry Field, Colorado, in July 1940. It was not, however, until late in 1941 that training of students in specialized bombardier schools began. At first the effort was made to conduct this training at fields where advanced pilot training was being given, but by the end of 1942 it was generally agreed that it was more satisfactory to conduct only one kind of training at one station. Specialized schools were established as rapidly as facilities would permit, and they expanded to meet the rising flow of students during 1942 and 1943. The students, who had received air-crew preflight training before entering these bombardier schools, were given a twelve-week course until the middle of 1943; as soon as combat requirements for bombardiers declined, the course was lengthened to eighteen weeks. By 1945 it was possible to provide twenty-four weeks of advanced individual training.

In addition to this specialized instruction, bombardier students from 1942 on were required to take a regular six-week

flexible gunnery course. This training was received either before or after the bombardier course, depending upon when it could best be scheduled by the gunnery schools. Upon completion of training in gunnery and bombardiering, the students, who had become rated officers upon graduation, were assigned to one of the continental air forces for crew and unit training. When there was a shortage of bombardier graduates coming into the operational units, the continental air forces completed their crews with enlisted men who had received individual bombardier training in their own units. This program distracted from the primary mission of the air forces, which was unit training, and it was generally considered to be less efficient than the individual instruction conducted in regular specialized bombardier schools.<sup>55</sup>

Although most of the bombardiers who were trained up to the middle of 1943 were qualified only in that specialty, plus flexible gunnery,

--579--

---

plans persisted for dual bombardier-navigator training. It was believed more efficient to carry as part of the bombardment team a man who was both navigator and bombardier, and the crews specified for the very heavy bombers (B-29 and B-32) called for two fully qualified bombardier-navigators. The chief obstacle to this training goal during the early part of the war was the chronic shortage of men trained in one or the other of the specialties, and it proved difficult to keep for supplementary instruction a man already qualified and needed elsewhere. Another hindrance was the difficulty of securing men who were capable of being trained in both bombardment and navigation. As a result of these major deterrents, the AAF repeatedly postponed inauguration of its dual training plans, which had been in existence since September 1941. Insistent demands continued to be made, however, for some type of bombardier-navigator course. During 1942 small numbers of qualified navigators were given an abbreviated course on the D-8 (low-altitude) bombsight and were then assigned to medium bombardment units as "navigator/D-8 bombardiers." In the early part of 1943 a short supplementary course in dead-reckoning navigation was given to a small number of qualified bombardier graduates. Complete dual training--to produce "precision bombardier/ celestial navigators"--was initiated in January 1943 and was continued on a limited scale. In July the regular bombardier curriculum was enlarged to include dead-reckoning navigation; this change appeared to be the most feasible answer to the demand for some form of dual training.<sup>56</sup>

One of the principal criticisms of early training was the lack of attention given to analysis of the causes of bombing errors. Bombardier graduates appeared in general to be deficient in knowledge of their equipment and inaccurate in making fundamental computations. Shortages of qualified instructors and proper equipment, and lack of training time were considered to be the chief causes for the deficiency.<sup>57</sup>

After numerous conferences, a standard eighteen-week course was adopted in June 1943 and continued in effect, with minor variations, until the end of the war. The ground instruction, which was the foundation for air exercises, consisted of some 425 hours. The largest portion of this time was given to critiques of air missions and preflight inspection of bombing equipment. Other parts of the ground training dealt directly with bombing and bomb equipment. The most important

--580--

---

of these were on basic theory and bombsights; students became acquainted with the forces acting upon a falling projectile and with the principles of a bombsight. Both Norden and Sperry sights were studied until 1944, but beginning in that year instruction was limited to Norden equipment. Another subject was bombing accessories, which included the study of bomb racks, fuzes, aerial cameras, and radio. Separate courses were given on flight instruments and the elements of bombsight maintenance and calibration. In the course on bombing procedure most of the student's time was spent on a synthetic bomb trainer which served as a device for transition from ground to air training. A special course was also devoted to the C-1 automatic pilot which the bombardier normally operated during actual bombing runs. Analyzing results of practice bombings and explaining scoring methods made up the bombing analysis course, and the basic AAF doctrines of employment of air power were expounded in a course called bombardment aviation. In addition to the subjects related only to bombing, some dealt with elementary navigation. Training was given in pilotage, dead reckoning, and computers; the graduate bombardier was therefore qualified in elementary navigation as well as in his primary specialty. Several courses common to the preparation of other aircrew members--weather, flight planning, oxygen indoctrination, aircraft and naval recognition, and continuation practice in radio code--rounded out the ground-school curriculum. Military instruction and physical conditioning were practically the same as in pilot training.<sup>58</sup>

Air training, eagerly anticipated by the bombardier students, did not begin until after three weeks of preparatory ground instruction. It consisted of a total of some 120 hours and was divided into two parts: the instructional and qualification stage, and the combat stage. On his first several flights the student learned the feel of the bomb-sight in the air. He made

several dry runs over simulated targets without having any bombs in the plane. For about a week he flew over practice ranges, developing his ability to sight by aiming at various ground objects--bridges, farmhouses, roads, factories, and the like. Practice bombs were then dropped, under close supervision of the instructor. If the student's progress was considered satisfactory, he was permitted to bomb for record and qualification; otherwise he was subject to elimination or further preparatory training. Ordinarily, about 100 bombs were dropped during the qualification phase of the

--581--

---

bombardier's training. At least seven record missions, four by day and three by night, were required; in order to qualify for the combat stage, the student's average circular error for these missions could not exceed 230 feet (when converted to an altitude of 12,000 feet). Bombing runs during the qualification phase were generally from two to three minutes in duration.

The combat stage of training tried to improve bombing proficiency and to simulate the diverse conditions which could be expected in combat. Some sixty bombs were generally dropped during this phase, thirty of them without the instructor present in the airplane, and all releases were scored for record. Circular error was the basis for scoring until early in 1943, when the method was changed to counting only hits and misses. It was believed that the latter method provided a stronger incentive for the student to strive for the greatest possible accuracy. The required standard of proficiency, established in 1943, was a minimum of 22 per cent hits. Combat training missions were exacting; continuous evasive action by the pilot of the aircraft was required within a ten-mile radius of the target, and final approaches had to be straight and level and could not exceed sixty seconds.<sup>59</sup>

Most combat missions were flown with the aid of the C-1 automatic pilot, a device for keeping the aircraft on a set course. The bombardier, as he prepared to make his run, engaged a clutch on his bombsight which gave him control of the plane's direction. As he made adjustments on the sight in order to hold the hairline on target, the aircraft was automatically guided to the required course. A certain number of manual missions were also flown. These were accomplished with the aid of the pilot's directional indicator, which was first zeroed by the bombardier when the plane was lined up on a collision course with the target. The pilot then made the necessary adjustments of stick and rudder to hold the indicator on zero. Not until 1944 did it become possible to provide enough cameras to permit all scoring to be done by photographic record.<sup>60</sup> During 1943 and 1944 interest was stimulated by bombing contests among the several schools.<sup>61</sup>

The bombardier schools had difficulty, as did practically every military training program during the war, in procuring adequate training staffs. Instructors were needed for ground classes as well as for the air phase of training; some military personnel with flying experience were made available for these assignments, but most of the instructors were commissioned directly from civilian life or were

--582--

---

drawn from the ranks of graduating classes at the schools themselves. Equally as important as the instructors were the bomb-approach pilots. The effectiveness of the bombardier was dependent in large measure upon the proficiency exercised in piloting the airplane; this held true not only when the pilot controlled the plane manually, but even when the automatic pilot was used. In both instances the pilot needed to understand the bombing problem and how to operate the equipment successfully. A general policy was developed of rotating experienced bomb-approach pilots to operational units and replacing them with new graduates of advanced two-engine pilot schools.<sup>62</sup>

Training manuals, books, films, and mock-ups were produced with considerable success in the bombardier program. Most of these materials, as well as ground school teaching outlines, were at first prepared locally; during the latter part of the war numerous aids were produced at higher headquarters for distribution to the schools. One of the most generally used mock-ups was a device to demonstrate bombing theory; it showed the influence of airspeed, altitude, drift, and other factors upon the course of a falling projectile. While devices such as this one had the advantage of arousing student interest, many instructors believed that the same principles could be taught as easily by using the blackboard or other simple techniques. Instruction on particular items of equipment, such as the C-1 automatic pilot, was generally conducted on working models of the equipment involved. Giant-sized mock-ups were sometimes built, so that large groups of students could be taught simultaneously.<sup>63</sup>

The most important synthetic device used in the bombardier program was the A-2 bomb trainer. This consisted of a steel scaffold about twelve feet high. It was mounted on wheels and could be electrically propelled across the floor of the hangar, where the trainers were usually kept. The top of the structure represented the bombardier's compartment of an airplane, including the actual bombsight, and was large enough to accommodate the instructor, a student bombardier, and another

student who acted as bomb-approach pilot. A third student sat in the lower section of the scaffold and operated a movable "bug" (an electric motor on wheels), at which the bombardier aimed his sight. The "bomb" released was a small plunger that struck a paper target on the "bug," thereby registering the student's accuracy.<sup>64</sup>

--583--

---

As in the pilot program, the need was recognized for training of instructors in desired techniques. Eventually a central instructors school (bombardier) was established at Carlsbad Army Air Field, New Mexico, and later moved to Midland Army Air Field, Texas. It conducted advanced courses for regular bombardier instructors and refresher courses for bombardier returnees, some of whom were assigned to teaching duties. Although some attention was given to teaching methods, the principal part of these courses treated the subject matter of the standard bombardier curriculum. The work of the central school was supplemented throughout the war by local training courses at the bombardier schools.<sup>65</sup>

The standard bombardier trainer during the war was the Beech AT-11, a two-engine, low-wing, all-metal monoplane. It carried an adequate bomb load, and its flying characteristics were suitable for use of the Norden sight and the C-1 autopilot. Major deficiencies of the AT-11 were its altitude and range limitations. A further draw-back was the fact that the trainer did not respond in flight as would a heavy bomber; graduates of the bombardier schools therefore had to make a considerable adjustment in technique when they were assigned to the heavy bomber units.<sup>66</sup> The AAF bombsight, rather than the training plane, was the cardinal item of equipment in bombardier schools, and it was required both for air and ground instruction. Several types of sights were used: the Norden M-1 and Sperry S-1 precision sights, and the D-8 and T-1 nonprecision types, but the Norden was the sight in most general use.<sup>67</sup> Although several kinds of practice bombs were used, the type most commonly dropped was the 100-pound, sand-filled M38A2. Bomb targets were of various outline shapes until 1944, when all except circular targets were discontinued.<sup>68</sup>

The number of students assigned to specialized bombardier instruction in the Flying Training Command increased rapidly from 1941 until the middle of 1943; following a slump in enrollment for several months, the number moved up again to a wartime monthly peak of over 2,000 students in training in September 1944. After that time the number in training declined sharply until the end of the war. During the entire period a total of over 45,000 bombardiers was graduated; this figure does not include several thousand who were given instruction outside the Training Command in operational training units.<sup>69</sup>

--584--

---

Procurement of qualified trainees was one of the most difficult problems in the bombardier program. Hardly any of the applicants for aircrew training, most of whom desired to be pilots, wanted to become bombardiers. In order to rectify this unbalanced situation, the AAF conducted a publicity campaign to glamorize the position of bombardier and other members of the combat crew; the role of the pilot was de-emphasized. By means of press releases, books, films, and radio broadcasts the campaign produced favorable results by 1943. In the meantime, however, eliminees from pilot training were the principal source of students. These men, most of whom had been washed out in primary flying, were offered the option of entering bombardier instruction. Although this policy was necessary in order to fill training quotas, it was strongly criticized by many Air Corps authorities. The pilot eliminee often was a serious morale problem because of failure to attain his first goal, and because he was inclined to regard his new status with resentment. By the time this student reached operational training, he had usually become adjusted to the role of bombardier, but his efficiency in training was lessened because of the initial attitude.<sup>70</sup>

No rigid policy for elimination of unsatisfactory students was established in the bombardier schools. The principal cause for elimination was unsatisfactory performance in the qualification stage of air training; students who were deficient in ground instruction, but who could bomb well, were usually held over at the school for additional ground classes. The method of measuring bombing proficiency was more objective than was that for flying proficiency in the pilot program. Various factors, including the immediate demand for graduates, influenced the elimination rates in bombardier training. They fluctuated from a low of 3.3 per cent for one class to a high of 26.1 per cent for another. The average rate for all graduating classes during the war was about 12 per cent.<sup>71</sup>

### *Navigator Training*

Before 1933 instruction in navigation was given only as part of pilot training. After 1933, though some specialized instruction was provided in combat units, the small number of long-range aircraft in the Air Corps required only a few specialized navigators. Even in 1939 plans called for only about 500 officers to be trained in that classification. In drafting



training of navigators would be conducted in specialized Air Corps flying schools, but no such organizations were in operation until 1941. Meantime, besides continuing training in combat units, the Air Corps sent students to Coral Gables, Florida, for specialized instruction by the Pan American Airways System. Navigation training was also started on a temporary basis at Barksdale Field, Louisiana, in November 1940. Toward the close of 1943 individual navigator training by the AAF was consolidated in four specialized schools of the Central Flying Training Command, and after September 1944 the contract with Pan American Airways was discontinued.<sup>72</sup>

Beginning in 1942 navigator trainees were given flexible gunnery instruction in addition to their specialized training. On occasion, the quotas for both bombardiers and navigators at gunnery schools had to be canceled, however, because the facilities were required for career gunners.\* By early 1943 gunnery school capacity had been expanded so that the flow of navigation trainees to gunnery schools could be stabilized, and by the middle of 1944 gunnery instruction was provided for all students before their entry into navigation schools.<sup>73</sup>

Before April 1943 special instruction had been limited to fifteen weeks, but at that time an eighteen-week curriculum was placed in effect. Another two weeks were added in December 1944.<sup>74</sup> The directive establishing the program of April 1943 was the first to prescribe uniform instruction in all navigation schools, including the Pan American contract school. The stated objective of navigation training was to qualify students as precision dead-reckoning navigators with basic proficiency in pilotage, radio, and celestial navigation. Dead reckoning was a method of navigation which involved charting a given course, noting the required directional bearings, and computing the airplane headings and airspeeds necessary to fly the charted course. Pilotage involved holding a course by following approximate compass headings while observing certain terrain features used as checkpoints. Radio navigation depended upon signals received from selected ground stations, while celestial navigation was the technique of holding to a course by reference to the stars. To insure the greatest possible accuracy, the navigator was trained to use all available information.<sup>75</sup>

The overwhelming proportion of training time was given to

---

\* For this term, see below, p. [590](#).

ground instruction, with some 500 hours devoted to teaching the several methods of navigation. Theory was reduced to a minimum in the effort to teach the cadets how to do a job and do it well. Students were first introduced to the basic principles of navigation and were then taught to use the fundamental tools: the compass, drift-meter, altimeter, plotting sheet, logbook, and other devices. Problems were then presented for solution. In the final stage of ground instruction the cadet participated in flights, with critiques of his performance as navigator. Instruction on weather and instrument calibration, together with standard aircrew military and physical indoctrination, rounded out the ground program.<sup>76</sup> Air training was carried on concurrently with ground instruction, beginning usually in the fourth week of the course. Some 20 navigational flights were scheduled, adding up to a total of approximately 100 hours. Rendezvous, search, and patrol problems, in addition to straight flights, were included in missions flown by night as well as day. Each plane normally carried three trainees, their instructor, and the pilot. One student navigated to direct the pilot, as a regular navigator would do; the other two usually followed the pilot, recording on their charts the actual course being covered. Upon completion of a flight, the planned course of the first navigator was then checked against the recorded course. Each of the three students rotated into the position of first navigator on succeeding flights. Experience showed a close correlation between the ground and air performances of navigation trainees, although some students proved unable to adapt to air conditions.<sup>77</sup>

Probably no other aircrew program was started with so few qualified instructors, and the shortage lasted longer than in other programs. The demands of the operational air units for navigators far exceeded the supply of qualified specialists during the first year of war; as a result, practically no experienced personnel could be spared for teaching, and reliance had to be placed upon new graduates of the navigation schools. Though not classed as instructors, pilots assigned to fly the planes used in navigation training were important for its success, and there was also a serious shortage of this type of personnel--a shortage aggravated by the policy of rotating such pilots, as well as navigation instructors, to combat organizations.<sup>78</sup> The several schools provided their own indoctrination of teachers until late in 1943. At that time a central instructors school (navigator) was established at Mather Field in California. Soon transferred

to Selman Field in Louisiana, this school served not only to supply needed instructors but to help in standardizing the methods of instruction.<sup>79</sup>

The AAF failed to provide standard textbooks, syllabi, and training aids until mid-1944. Before that time the individual schools supplied students with a variety of materials. Maps and charts of all types were procured from standard sources; reference handbooks for navigators were prepared by the instructors themselves. In June 1944 a standard work, the Air Navigation Textbook, a comprehensive and satisfactory manual, was produced for distribution to the schools. Numerous films on navigation were made available, large-scale mock-ups of the navigator compartments of medium and heavy bombers were fabricated, and instruments and instrument mock-ups were widely used as training aids.<sup>80</sup> Various types of synthetic trainers were tried as a means of simulating navigation flights, but none of these proved very successful; the first to be obtained in considerable numbers was the G-2 dead-reckoning trainer. It was built like the navigation compartment of an airplane, was similarly equipped, and was mounted on rollers. A number of these devices were usually installed in one room. The G-2 instrument readings for airspeed, altitude, wind direction, and other factors affecting navigation could be changed at will by the instructor from a control desk. The students, who operated the electrically driven trainers, noted the changing instrument data and set courses for the G-2's to follow across the floor of the room. By the time these trainers could be distributed in sufficient numbers, the supply of aircraft at the navigation schools had become adequate, and the need for substitute devices accordingly declined. The G-2 trainer, furthermore, was unduly complex for practical purposes.<sup>81</sup>

A variety of airplanes were used during the early months, but the Beech AT-7 became the standard trainer after the middle of 1942. The principal shortcoming of the AT-7 was its limited passenger capacity and the lack of sufficient range for long navigation missions; during 1945 a number of C-47's, the work horses of the AAF, were converted for use on long flights. After V-J Day it was recommended that four-engine planes, preferably C-54's, be substituted for the C-47's then in use at navigation schools.<sup>82</sup> Until 1945 it continued to be difficult to get the navigational instruments needed for proper instruction of cadets. The competition between the requirements of combat units and the needs of the schools became especially

acute in the recently developed items in a field marked by rapid technological progress. It was often necessary to train the navigator without the equipment he would use upon assignment to a combat unit.<sup>83</sup>

Early in 1942, in accordance with a growing emphasis on heavy bombardment and with the demands of operational commitments that were literally global in their extent, the AAF revised upward its previous estimates of requirements for navigators. The training program was expanded still more rapidly in 1943, and in late 1944 the monthly number of cadets receiving navigation instruction reached a peak of over 2,500. By V-J Day more than 50,000 students had graduated from the specialized navigation schools.<sup>84</sup>

Since mathematical ability was one of the most important qualifications of a successful navigator, in determining navigator stanines the heaviest weight was assigned to the scores on arithmetical reasoning, dial and table reading, and general reading comprehension. Only those students with the highest scores in these areas had a good chance of completing their training successfully, so that their selection became more restrictive than that for either pilots or bombardiers. Although fewer young men desired navigation training than pilot training, no special difficulty was experienced after 1942 in procuring a sufficient number of qualified candidates. The morale of these students was in general good, and many of them looked forward to using their training after the war as navigators for civilian airlines.<sup>85</sup>

The chief reason for failure of students in the navigation schools was inability to meet basic proficiency requirements on air missions. The trainee had to demonstrate his ability to navigate by day within a course error of 11 degrees and a time error of 1 # minutes per hour of flight; he had to navigate during darkness by celestial means, over distances up to the full range of the training aircraft, to within fifteen miles of his objective. The average rate of attrition in specialized navigator training was approximately 20 per cent.<sup>86</sup>

### *Flexible Gunnery Training*

Every member of the combat crew had a vital responsibility in executing the aircraft's mission. When a bomber was under attack by hostile fighters, it was the aerial gunner who defended the lives of his teammates; on the skill he had developed rested the fate of the crew.

those for any other flying specialty. As in the navigation program, the Air Corps had virtually no background of experience in this type of instruction. Equipment shortages were extreme, and the problem of procuring qualified instructors unusually serious. Finally, it was several years before an adequate sighting and firing system was evolved, and a practicable means of simulating actual combat firing was not developed before the end of the war. As a result, the performance of flexible gunners in battle was not so efficient as desired, and the training program was a subject for continual criticism and controversy.<sup>87</sup>

Although plans had been under consideration for some time before Pearl Harbor, no specialized school for flexible gunnery was in operation when the United States entered the war. Construction was being completed, however, at Las Vegas Army Air Field, Nevada; Harlingen Army Air Field, Texas; and Tyndall Field, Florida. Students were assigned at once to these fields for instruction with whatever equipment was available. Construction at other sites was soon begun, and by the middle of 1944, when the number of students in training reached its highest point, seven specialized gunnery schools were functioning.<sup>88</sup>

Men entered the gunnery program from a variety of military backgrounds, and the basis for selection was continually changing. Until December 1942 training was open only to volunteers, but after that time certain categories of specialists were automatically eligible for selection. All of the enlisted members of bombardment crews were required to have flexible gunnery training; some were designated career gunners and had no other specialty, but for most of the crew members--armorers, airplane mechanics, radio operator mechanics, or other specialists--gunnery was a secondary specialty. Of the officer members of the bombardment crew, only the pilot and co-pilot were exempt from gunnery instruction; the navigator and bombardier were given the training when facilities permitted.<sup>89</sup>

The total number of officers and men who graduated from gunnery schools--more than 297,000 during the war period--was larger than that for any other Air Corps specialty except aircraft maintenance. Physical qualifications for admission were successively modified; the age limit was raised to 35 years, height to 6 feet, and weight to 180 pounds. Officers attending the gunnery schools received training in whatever grade they held upon entrance, but the policy

regarding enlisted men varied. Beginning in 1943 graduates who had previously completed a course of specialized technical training were awarded the grade of sergeant; those who had not were made privates first class and were promoted to sergeant upon completing a technical specialty. The morale of gunnery students was frequently poor. Attempts to induce volunteers through widespread publicity campaigns brought in many men who did not understand the nature of the training and the real demands of the position. During the course of the transition from the voluntary to a selective system for student procurement, many men were resentful when assigned to gunnery instruction. A considerable number of these involuntary trainees proved unable to perform their duties satisfactorily, while others requested elimination on the grounds of fear of flying. Elimination rates for all causes varied considerably as a result of changing methods of student procurement, relaxation of physical standards, and lack of a standardized instructional program. The rate for each class ranged from under 1 per cent to nearly 20 per cent; the average per class was less than 10 per cent.<sup>90</sup>

The standard gunnery course\* as developed by the year 1944 consisted of six weeks of familiarization with equipment, ground firing, and air training, as well as the usual military and physical training.<sup>91</sup> Familiarization, which required about 125 instructional hours, introduced the student to machine guns, turrets, and sighting procedures. Although various weapons were studied from time to time, machine-gun instruction was concentrated upon the .50-caliber aircraft model, which became standard equipment on American bombers and which the students were required to strip and reassemble while blindfolded. Instruction was given also in the maintenance and manipulation of turrets, but shortages of the proper types were a persistent handicap. Beginning in 1943 the schools evaded this problem by adopting a policy of specialized training on certain types of turrets. Instruction in sighting procedures went through more changes than any other phase of gunnery indoctrination. During 1942 the student had to become familiar with as many as ten different kinds of sights. Various methods were employed for estimating range and lead in

---

\* All except the career gunners received training in radio, armament, maintenance, or some other specialty in the AAF technical schools. Since this training was identical with that given to the corresponding ground technicians, it need not be

deflection shooting, but they were generally too complicated. The use of tracer ammunition as a partial substitute for ordinary sighting methods was tried out experimentally. It was discovered, however, that observation of tracer trails often gave an erroneous impression of the true course of the bullets, and the tracer method did not gain wide acceptance. In October 1943 the schools adopted the position firing sighting system, a method adapted from but considered more accurate than the British zone system. Basically, the system involved aiming behind the attacker, instead of in front of him, as was true in deflection shooting, in order to compensate for the effect on the bullets of a bomber's own forward motion. In 1944 automatic compensating and computing sights were replacing the old iron ring and the newer optical ring sights. The automatic devices mechanically calculated proper allowances and made it necessary for the gunner merely to keep the enemy plane in his gunsight. The compensating sight was the one most generally used during 1945.

Synthetic trainers were employed from the beginning to teach turret manipulation and sighting. The simplest of these trainers was a device consisting of a hand-operated spotlight and a large concave surface. While an instructor moved the spot of light across the surface through patterns such as ovals and figure 8's, the student practiced tracking, framing, and triggering from his turret-mounted machine gun. A more elaborate device, originally called the "Jam-Handy," had two motion-picture projectors. The student, seated behind a mock machine gun, observed pictures projected on a wall by one of the machines. Actual combat films were shown, including fighter approaches, attacks, and breakaways as photographed from a bomber. The student estimated the range of approaching aircraft, as shown by the film, and "fired" at 600 yards. The film's sound track gave the noise of gunfire if the target was in range; if not, a continuous bell. The second projector was synchronized with the first so as to cast a spotlight on the wall which showed the correct point of aim to hit the target. The spotlight could be turned on at will, and the student could see whether he was aiming at the proper point. Other devices, even more elaborate and more difficult to maintain, were in limited use. They proved fairly successful so long as the equipment functioned properly and good films, showing the latest combat maneuvers, could be obtained.<sup>92</sup>

Actual firing on the ground supplemented the manipulation of

weapons and synthetic trainer exercises. Many varieties of ranges were constructed, including the B-B gun ranges for .22-caliber rifles or machine guns. In the moving-base range, especially popular with students, several trucks equipped with turrets proceeded at intervals around a track, the wheels of the trucks deflecting wires which set off traps. The students fired at the targets as they were thrown up at various angles from the traps. Another popular type was the moving-target range. This varied in form but generally involved the use of a driverless jeep on a fixed track, carrying targets on high poles. The jeeps themselves were hidden by a revetment while the students fired at the targets from pedestal-mounted machine guns. Some sixty-five hours were assigned to ground range exercises of all types.<sup>93</sup>

From the beginning of flexible gunnery training, air-to-air firing was considered essential and was included in all the curricula. But the types of aircraft at first available were ill suited to the purpose. Various types of trainers and combat aircraft were employed; the Lockheed AT-18, equipped with Martin turrets, proved the most successful until B-17's and B-24's could be obtained. Targets, usually of the sleeve or flag type, were towed by a variety of utility aircraft. In 1944 it was prescribed that air training consist of twelve two-hour missions. Performance of at least six missions was a requirement for graduation. The basic criticism of conventional firing exercises, up to the year 1944, was that they did not simulate actual attacks by fighters against bombers. Students who fired from an airplane at a target towed by a plane on a more or less parallel course were doing something which would hardly be repeated in a combat situation. What was needed was a practicable means of firing, or simulated firing, against fighter planes as they executed typical combat attacks. The best answer to the problem seemed to be the camera gun, which came into general use during 1944 and 1945. A special type of motion-picture camera was installed in turrets on bombardment airplanes, and students "fired" these "guns" as fighter-type planes flew normal pursuit curves toward the bombers. While the theory of the camera gun was generally lauded, practical difficulties arose in procuring and developing the film and in assessing the results for each student. By July 1945 nose cone attacks by fighters were included in camera-gun missions in addition to the established beam and stern approaches.<sup>94</sup>

A method of training even more realistic than the camera gun was introduced in February 1945. This was the frangible-

bullet method, the product of experiments which had begun in June 1942. The frangible bullet, made of a combination of lead and plastic, splattered into powder when it struck the target. Specially built planes, Bell RP-63's protected by armor plate, made conventional fighter attacks against bombers, while gunner trainees fired frangible ammunition against them. The RP-63's were equipped with radiosonic devices which registered hits on a meter in the pilot's compartment and at the same time flashed a wing lamp to show the gunners that they had scored. Although the schools were enthusiastic about the realism of the frangible-bullet exercises, numerous difficulties prevented their general adoption before the end of the war. Frangible bullets had only one-third the powder, two-thirds the weight, and one-half the speed of regular bullets; these ballistic differences necessitated special adjustment of gunsights. Excessive quantities of carbon accumulated in the guns while firing frangible ammunition, causing frequent malfunctions. Furthermore, the RP-63's were pierced by bullets which struck inadequately armored surfaces, and the coolant radiators were damaged by particles of bullets entering the airscoops. In view of the desirability of the frangible-bullet project in principle, strenuous efforts were made to overcome these practical limitations.<sup>95</sup>

Almost all of the instruction at gunnery schools was performed by enlisted men retained for the purpose from each class of new graduates. The selection was at first more or less arbitrary, but later the desires and ability of the men were considered. The greatest single problem affecting the instructors' morale was their low rank; during 1942 the majority were privates or corporals. In the following years most instructors reached the grade of sergeant, but the problem of insufficient rank persisted throughout the war. There were two basic systems of instruction in flexible gunnery, the flight and specialist methods. In the former, one teacher took charge of a small flight of students and carried it through all phases of the course. In the specialist system the instructors concentrated on a specific subject, and students had a different instructor for each course. Practice varied at the several schools, although the Training Command in 1943 directed uniform acceptance of the specialist system.

Closely related to the problem of retaining proficient instructors

--594--

---

was that of obtaining satisfactory pilots. Pilots generally preferred combat work or instructing in pilot schools to gunnery assignments, and the better pilots were usually given their preference. The gunnery schools, consequently, appeared to be dumping grounds for inferior pilots. Efforts were made to raise the morale and performance of these pilots by impressing upon them the importance of their function, but the results were only partly successful. The central school for flexible gunnery, which took final form at Laredo, Texas, not only indoctrinated teachers but became a focal point for research and development in the gunnery program. Various types of instructional courses were established, and the research and engineering divisions of the school turned their attention to solving the theoretical and practical problems which were obstacles to more efficient training.<sup>96</sup>

Of the various special programs provided by the Training Command schools, one of the most interesting was the B-29 gunnery course. Although difficulties in obtaining parts and equipment impeded training at first, by the spring of 1945 a satisfactory program was in operation. The original curriculum lasted twelve weeks, but experimentation with a six-week program showed that the shorter course accomplished equivalent results. A distinctive feature of the B-29 course was the system of training gunners in crews of five. Each team included an officer bombardier who acted as "gun captain" and operated the forward turret; a remote control turret mechanic gunner; two waist gunners, one of whom was an armorer and the other an electrical mechanic; and a tail gunner, who was not a technical school graduate. Since most of these individuals had previously received instruction in the standard flexible gunnery program, the B-29 course was in the nature of conversion training. In addition to refresher courses on weapons and auxiliary equipment, the curriculum included study of the B-29 central fire-control system, exercises on special B-29 ranges, and air training in the Superfortresses.<sup>97</sup>

### ***Flight Engineer Training***

The B-29 was the only bomber employed by the AAF during the war whose operation required a third pilot--a special member of the crew, known as the flight engineer, who controlled the plane's mechanical functioning while the regular pilot and co-pilot controlled the plane's direction and altitude. Seated before a complex

--595--

---

panel, just behind the co-pilot, the flight engineer observed his instruments and made necessary mechanical adjustments. By movements of the levers and switches on the panel he regulated electrical, hydraulic, fuel, lubrication, and oxygen systems, and detected and corrected malfunctions. He was also responsible for inspection of the operating systems before each flight

and for computing cruise-control data.<sup>98</sup>

When instruction began in April 1943, only officer graduates of maintenance engineering courses and a small number of experienced mechanics were accepted. To meet the demand for greater numbers, engineering prerequisites were modified, but even so the supply of officer students was inadequate. Training was therefore opened to enlisted mechanics in March 1944, but these men were not selected carefully, and the number of properly qualified individuals in this category also proved insufficient. As an expedient, a plan was tried to utilize rated pilots in the flight engineer program. The results of this attempt were most discouraging, since the majority of pilots had little liking for the job. At last, early in 1945, the position of flight engineer was placed on the same basis as the position of pilot, bombardier, or navigator; aviation cadets and aviation students were enrolled in a program which led to the rating of flight engineer and commissioning as second lieutenant or appointment as flight officer. This arrangement was generally accepted as the most satisfactory method of flight engineer procurement. Of the students who entered from all categories, approximately 7,800 were graduated from advanced training. The elimination rate varied greatly, depending upon the qualifications of the different groups of students. In 1945 the over-all rate was about 9 per cent<sup>99</sup>

Flight engineer instruction, following aircrew preflight school, was divided into a basic and an advanced stage. Upon completion of the course the graduates were normally assigned to a B-29 transition school, where they learned to fly the Superfortress as part of the pilot-co-pilot-flight engineer team; following this transition they entered full combat-crew training. The nineteen-week basic curriculum, as developed by May 1945, provided instruction in B-29 first and second echelon maintenance. It also included explanation of the flight characteristics of the airplane, routine and emergency flight procedures, engine operation, power settings, and fuel consumption. Eight of the instructional days were marked for actual flying. The basic course was taught at Amarillo Army Air Field,

--596--

---

Texas; advanced training was developed at Lowry Field, Colorado, but was later transferred to Hondo Army Air Field, Texas. The curriculum in 1945 was of ten weeks' duration and consisted of three principal phases. The mechanic-training phase emphasized inspections and correction of malfunctions in flight, as well as familiarization with emergency equipment and emergency control of the various operating systems. The cruise-control phase was considered to be the heart of the advanced curriculum. All of the factors affecting power output and fuel consumption, such as atmospheric conditions, speed, loading, and altitude were explained. Following this introduction, students were taught the use of cruise-control charts, which showed the fuel requirements of a mission when distance, altitude, and atmospheric conditions were known. Methods of correcting this estimate of fuel requirements for a variety of smaller determinants were then explained. The final phase of the advanced course consisted of four weeks of flights in which the students applied what they had learned about cruise control.<sup>100</sup>

Instructors for flight engineer training were obtained initially from a school operated by the Lockheed Aircraft Corporation for the commercial airlines. As the Air Corps' program expanded, the body of graduates became the chief source of instructors; most of the individuals retained as teachers were enlisted men. Shortage of equipment was the chief handicap to training before 1945; no B-29's were available at the flight engineer schools. Hence, B-24's were modified and used as improvised substitutes, several flight engineer stations including operating instrument panels being installed in each plane. To provide realistic practice in cruise control, the controls and instruments of all stations were interconnected, and several students could observe the effects while the instructor or a student manipulated the controls at any one of the stations. By 1944 adequate numbers of "weary" aircraft and one B-29 had been obtained for ground instructional purposes, but until 1945 lack of B-29 parts hampered the construction of mock-ups. Several flight engineer synthetic trainers were built by local station personnel, and at the end of the war the training aids available were considered excellent.<sup>101</sup>

## **Radar Observer Training**

Training of radar specialists was one of the most important pro-grams in the AAF. Instruction, which began just before Pearl Harbor, was changed almost continuously up to V-J Day. By September

--597--

---

1944 the program consisted of a large number of courses for radar mechanics and ground officers, described in the chapter on ground technicians and service personnel,\* and several courses for flying radar observers. The most important of the flying specialists was the "radar observer-bombardment," who was trained to direct bombing through overcast (BTO). Three other types of radar observers were also trained for sea search, night fighter operations, and radar countermeasures.

Location of targets and bombing by electronic devices was one of the most significant developments in air war. BTO training was initiated in October 1943 at Boca Raton Army Air Field, Florida, and within a year it became the dominant course of the radar program. In September 1944 the course was restricted to pilots, but two months later the AAF decided to train bombardiers and navigators, rather than pilots, for BTO duties. Bombardiers were given a ten-week course in radar techniques, and navigators received the same training plus four weeks of nonradar bombing instruction. The radar phase of the course consisted mainly of instruction and practice in the operation of standard airborne radar equipment, such as the AN/APQ-23 (used in the Pacific) and the AN/APQ-15 (similar to equipment used in Europe). The chief obstacle to training was the shortage of radar-equipped aircraft. Despite this handicap, about 7,600 radar observers-bombardment were graduated from AAF schools during the war; they were assigned to heavy bomber or B-29 operational units. Heavy bomber lead crews each carried a BTO operator in addition to its regular personnel, while each B-29 crew included one radar observer-bombardment.<sup>102</sup>

Radar observer courses for sea search, night fighter operations, and radar countermeasures were also started in October 1943. Students for the sea-search program were selected from graduates of the standard radio-operator mechanic courses. The radar training for these men consisted of five weeks of practice in operation and first echelon maintenance of the electronic search devices, which they subsequently used on long-range patrol missions. Eliminated aviation cadets formed the source of trainees in the night fighter radar course. Over 1,000 of these students graduated from the nine-week course and received commissions or appointments. During training they

---

\* See below, pp. [639-41](#).

--598--

---

were indoctrinated in the employment of airborne radar devices for detecting enemy bombers at night and directing the aim of the night fighter's guns against the unseen targets. Graduates of the standard officer communications course were selected for training in radar countermeasures; only about 500 officers were enrolled in this program, which required fifteen weeks of instruction. After completing the course, these men were assigned to special duty with operational units. On combat missions they flew with bomber formations and helped direct jamming of enemy ground detectors.<sup>103</sup>

--599--

---

[Table of Contents](#)  
[Previous Chapter](#) (16) \* \* [Next Chapter](#) (18)

---

### NOTES TO CHAPTER 17

- [1.](#) Maj. Gen. B. K. Yount, "Building the AAF: Part 1 , Pre-flight Toughens 'Em," *Aviation* (Aug. 1943), p. 124, in AHS-48, Preflight Training in the Army Air Forces, 1939-1944, p. 1.
- [2.](#) TC Memos 35-17, 14 Apr. 1944; 50-23-1, 23 May 1944; and 50-27-1, 12 May 1944.
- [3.](#) Ltrs., OCAC to CO SETC, 1 and 2 Oct. 1940.
- [4.](#) FTC Memos 50-1-1, 21 Apr. 1943; 50-23-1, 19 Feb. 1943.
- [5.](#) TC Memo 50-23-1, 23 May 1944.
- [6.](#) Hist. SAAAB, 7 Dec. 1941-31 Dec. 1942; Hist. SAACC, May-June 1944, p. 18.
- [7.](#) Memo for Maj. Gen. B. K. Yount from Col. K. P. McNaughton, 16 Nov. 1942; Hist. EFTC, 1942, pp. 390-91.
- [8.](#) Hist. EFTC, 1942, p. 360; Hist. SAAAB, 1942, p. 210, and Jan.-Feb. 1944, pp. 38-39.
- [9.](#) TC Memo 50-27-1, 12 May 1944 and 13 Apr. 1945; Hq. AFTRC, Conf. on Preflight Training, 10-11 July 1944.
- [10.](#) AAF Reg. 50-14, 23 Sept. 1943; Hist. SAAAB, 1943, pp. 144-45; TC Memo 50-21-10, 9 Nov. 1944.

- [11.](#) AG 201.1 (21 Jan. 1942) RB-A, 26 Jan. 1942; AC/AS, A-1 to CG AFFTC, 31 July 1942.
- [12.](#) Hist. EFTC, 1942, pp. 363-64; Hist. WFTC, 1943, pp. 597-98; Hist., Randolph Fld., 1931-44, p. 235.
- [13.](#) WFTC Tng. Memo 26, 24 Mar. 1943.
- [14.](#) Memo for AC/S G-1 from Maj. Gen. G. E. Stratemeyer, 13 Dec. 1942; AAF to AAFFTC, 17 Jan. 1943; memo for CG AAF, 7 Jan. 1943, in Hist. of AAF Tng. Comd. and Pred. Comds., 1939-1945, pp. 400-404.
- [15.](#) TWX, AFTRC to AAF, 1 Dec. 1944; Daily Diary, Hq. AAFFTC, 23 Apr. 1943.
- [16.](#) Hq. AAFFTC, Flight Table "E," (rev. 23 Jan. ,943; 11 Feb. 1943); FTC Memos 50-25-1, 24 Feb. 1943, and 25 Nov. 1943; interviews, Maj. C. H. Dabezies, A-3 Div., Hq. AFTRC, 22 Jan. 1945; Col. P. C. Potter, A-3 Div., Hq. AFTRC, 25 Jan. 1945; Maj. P. M. Ferguson, A-3 Div., Hq. WFTC, 3 June 1943.
- [17.](#) Hist. CFTC, 1943, pp. 1064-65; interview, Lt. T. H. Greer, Preflight School, SAAAB, 2 Feb. 1944.
- [18.](#) Memo for CG AAF from Col. T. J. Dubose, 10 Jan. 1943; Dabezies interview cited in n. 16; Hist. WFTC, 1943, pp. 1057-59; TWX, AAF to AFTRC, 12 Jan. 1944; memo for C/S from Hq. AFTRC, A-3, 17 Jan. 1944.
- [19.](#) Memo for C/S from Hq. AFTRC, AC/S, 24 Nov. 1943; TWX, AFTRC to 3 FTC's, 1 Jan. 1944; memo for C/S, G-3 from CG AAF, sub.: Elimination of AAFTC Prog., 30 Mar. 1944; memo for CG AAF from OC/S, 31 Mar. 1944.
- [20.](#) Interviews, Maj. F. P. Dunne, A-1 Div., Hq. AFTRC, 17 Sept. 1945; Lt. Col. D. E. Ellett, OC/S Hq. AFTRC, 24 Sept. 1945, in TC Hist., pp. 429-31.
- [21.](#) AFTRC to EFTC, 27 Jan. 1944; Ellett interview cited in n. 20; Hq. AFTRC, Table, Rpt. of Flying Training Students, Dec. 1944, p. 2; AAF to AFTRC, 4 Dec. 1944; Hist. CFTC, Jan.-June 1944, p. 751; Hist. WFTC, Nov.-Dec. 1944, pp. Iq6-q7; AFTRC to EFTC, 23 Sept. 1944.
- [22.](#) AFTRC to AAF, 17 Oct. 1944; Brig. Gen. K. P. McNaughton, C/S AFTRC to Brig. Gen. W. W. Welsh, AC/AS Training, 20 Dec. 1944; AFTRC to EFTC, 13 Mar. 1945; Dunne and Ellett interviews cited in n. 20.
- [23.](#) Hist. CFTC, 1 Jan. 1939-7 Dec. 1941, I, 10-11; 111, 220-21.
- [24.](#) TC Memo 50-9-1, 11 Oct. 1945; TC Hist., pp. 547-49.
- [25.](#) AHS-18, Pilot Transition to Combat Aircraft, pp. 1-2, 37-39, 58-67.
- [26.](#) Hist. AAF Tng. Comd., pp. 600-601, 671.
- [27.](#) Hist. EFTC, 1 Jan. 1943-31 Dec. 1943, I, 276-77; Hist. WCTC, 7 Dec. 1941-31 Dec. 1942, IV, 971-72; Med. Hist., CFTC, 1940--44, p. 160; Hist. of 1st FTD, Santa Maria, Calif., 1 Mar. 1944-30 Apr. 1944, App.; and TC Memo 50-8-2, 30 May 1944.
- [28.](#) Hq. AFTCC, Progress Rpt., Dec. 1943; tables, Rpt. of Flying Training Students, Dec. 1944, Aug. 1945.
- [29.](#) Program of Instruction: Elementary Flying Training, revisions of 6/1/19 and 5/22/40; ACID, Hemet, Calif. to WCACTC, 25 Mar. 1941; Program of Instruction: Elementary Flying Training, 15 Jan. 1943; TC Memo 50-8-1, 9 May 1944.
- [30.](#) TM 1-212, Basic Flying, 20 Jan. 1942, pp. 1-2; *Hearings* on H.R. 4124, 25 Mar. 1941, before the Senate Subcommittee of the Committee on Appropriations, 77 Cong., 1 Sess., p. 34; R&R, Hq. AAF, Management Control Sec. to C/AS, 19 May 1944; Hist. WCACTC, 8 July 1940-7 Dec. 1941, II, 275-85; Hist. EFTC, 1 Jan. 1943-31 Dec. 1943, II, 376-79.
- [31.](#) Hist. CFTC, 1939-41, III, 214-16; C/AC to GCACTC, 25 Oct. 1940; interview, Col. James H. Price, DAC/S, A-3 Div., Hq. AFTCC, 16 Nov. 1944; III Bomber Comd. to 3d AF, 8 June 1942; FTC Memo 50-9-1, 21 Apr. 1943; TC Memo 50-9-1, 8 May 1944.
- [32.](#) Proceedings of a Board of Officers Convened for the Purpose of Investigating Instrument Flying and Instrument Flying Training in the AAF [late 1942]; WCAAFTC to AFFTC 10 Oct. 1942; SEAAFTC to AFFTC, 30 Oct. 1942; GCACTC Tng. Memo 151, 12 Dec. 1941; Tech. Note 66-42, BuAer., Navy Dept., 21 Aug. 1942; TWX, AFTCC to WFTC, 26 Feb. 1944.



- [33.](#) TC Memo 50-9-2, 1 Oct. 1943; TC Memos 50-9-1, 50-9-2, 50-9-3, 8 May 1944; Hist. CFTC, 1 Sept. 1944-31 Oct. 1944, II, 220; TC Memos O-2D, 24 Apr. 1945; 50-9-1, 20 Apr. 1945.
- [34.](#) OCAC to TC's, 12 Oct. 1940.
- [35.](#) AC/AC to GCACTC and SEAL TC, 7 July 1941; AFRIT to 1st, 3d, and 4th AF's and AFFTC, 1 Apr. 1942; Hist. CFTC, 1942, IV, 435; Hist. Moore Fld., 1941-44, pp. 24-26.
- [36.](#) FTC Memo 50-10-1, 15 May 1943; 2d ind. (AFRIT to AFFTC, 14 June 1942), AFFTC to GCAAFTC, 15 July 1942; TC Memos 50-10-4, 1 May 1944; 50-10-4A, 19 May 1944 50-2-7, 10 Aug. 1944; Hist. EFTC, 1942, II, 465-69; Hist. WCTC, 1942, II, 347; Hist. CFTC, 1942, IV, 467-69; AFRIT to AFFTC, 2 Nov. 1942; FTC Memos 50-10-1, 21 Apr. 1943, and 50-10-8, 19 May 1943.
- [37.](#) Program of Instruction, Advanced Flying Tng., Two-Engine; TC Memo 50-10-2, 19 Apr. 1944.
- [38.](#) Hist. EFTC, 7 Dec. 1941-31 Dec. 1947, III, 789-94; interview, Col. W. H. Blanchard, A-3 Div., Hq. AFTRC, 5 Oct. 1943; AAF to AFFTC, 26 Aug. 1942; AAF to AFFTC, 25 Sept. 1942; AFTRC to AAF, 5 Feb. 1944; Hq. AFTRC, Progress Rpt., Jan. 1944; AFTRC to WFTC, 22 Oct. 1944; interview, Lt. Col. A. J. Perna, A-3 Div., AFTRC, 30 Apr. 1945; AFTRC to EFTC, 26 Apr. 1945.
- [39.](#) Hq. AFFTC, Project Outline, 8 Sept. 1942; Daily Diary, Hq. AFFTC, A-3 Div., 2 Oct. 1942; FTC Memo 50-2-1, 14 Apr. 1943; Hist. EFTC, 1943, II, 585-96; TC Memo 50-2-3, 7 Jan. 1944; TC Memo 50-2-3, 21 Apr. 1944; AFTRC to 3 FTC's, 16 May 1944; TC Memo 50-2-3B, 27 July 1944.
- [40.](#) TC Memo 50-26-12, 11 May 1944; Hist. CFTC, Sept. 1944-31 Oct. 1944, pp. 208-9; Hist., EFTC, Jan.-June 1944, I, 246, 529.
- [41.](#) Hist. CFTC, 1939-41, III, 227, 390-92; Proceedings of a Board of Officers Convened for the Purpose of Investigating Instrument Flying and Instrument Flying Training in the AAF [late 1942]; FTC Memo 50-1-1, 1 Feb. 1943; Hist. CFTC, 1942, IV, 443, 492; Hist. EFTC, 1942, II, 525-26, 557-60, 596-99, 645-47, 748, 750.
- [42.](#) TC Memo 50-26-12, 11 May 1944, Addendum No. 1.
- [43.](#) R&R, OCAC, T&O Div. to Mil. Pers. Div., 31 July 1941; TC Memos 50-27-7, 22 July 1943, 50-27-16, 2 Oct. 1944, and 3 May 1945; FTC Memo 50-1-1, 21 Apr. 1943; TC Memo 50-27-1, 12 May 1944 and 13 Apr. 1945; interview, Maj. A. J. Perna, A-3 Div., Hq. AFTRC, 22 Dec. 1944; Hist. WCTC, 1942, II, 692-93; III, 693.
- [44.](#) Hist. of EFTC, 1943, II, 398-403, 566-67.
- [45.](#) Hist. CFTC, 1942, IV, 420-21; Hist. WFTC, 1 July 1944-31 Aug. 1944, I, 189, 570.
- [46.](#) Air Tng. Comd., Evaluation of Individual Training in the Army Air Forces, 1946, p. 21.
- [47.](#) Hist. WCTC, 7 Dec. 1941-31 Dec. 1942, III, 572; Hist. EFTC, 1 Jan.-30 June 1944, I, 297; WFTC Memo 50-9-1, 23 June 1944; Hist. WCTC, 1942, III, 577; memo for Col. W. R. Carter from Lt. Col. James H. Price, Hq. AFFTC, A-3 Div., 18 Aug. 1942; AFFTC to AAF, 27 Nov. 1942; Hist. CFTC, Jan.-June 1944, V, 827; Mar.-Apr. 1945, pp. 492-93; 1 July-31 Aug. 1945, pp. 312-13; TC Memo 50-1-3, 5 July 1945; Hist. Randolph Fld, 1931-44, pp. 229-33, 240-43, 246; FTC Memo 37-2, 19 Apr. 1943; Hist. CIS, Mar.-May 1944, p. 33.
- [48.](#) Evaluation of Individual Training in the Army Air Forces, p. 19.
- [49.](#) Hist. WCACTC, 1940-41, II, 229-30; Hist. WFTC, 1942, II, 308-10; Hist. EFTC, 1942, II, 463, IV, 1480-81; 1943, I, 345-47, IV, 1459-61; Hq. AFTRC, Progress Rpt., July 1944, p. 29; Hist. CFTC, Nov.-Dec. 1944, IV, 126-29.
- [50.](#) Hist. WFTC, 1943, I, 239, 574-76.
- [51.](#) Special War Dept. Monthly Report on Airplanes, July 1942; Hist. EFTC, 1942, III, 768, 770-72 and app., chap. XL, p. 2 1943, IV, 1465-69; Hist. WCTC, 1942, II, 369-70; 1943, II, 295-96; Hist. CFTC, 1943, II, 434-35; interview with Col. Walter S. Lee, A-4 Div., Hq. AFTRC, 6 May 1944; SEACTC to OCAC, 1 Apr. 1942; memo for AFRIT from OCAC, AFRDB, 5 July 1942; AFRIT to AFRDB, 8 July 1942; Daily Diary, Hq. AFTRC, A-3 Div., 21 July 1943; 8 Aug. 1943; Tables, Report of Flying Time of Aircraft and Personnel, Hq. AFTRC, Dec. 1944-May 1945.
- [52.](#) AAF Stat. Digest, tables 46-47.

- [53.](#) *Ibid.*, tables 47-48; interview, Col. Norman L. Callish, A-3 Div., Hq. AFTRC, 16 Nov. 1944; Price interview, in Hist. AAF Tng. Comd., pp. 571-74.
- [54.](#) Hist. EFTC, 1943, App., chap. IX, doc. 3, and pp. 537-38.
- [55.](#) AHS-5, Individual Training of Bombardiers, pp. 1, 18-34, 42; interview, CWO T. J. Kelly, A-3 Div. AFTRC, 5 Mar. 1946; Hist. Lowry Fld., 1 Jan. 1939-7 Dec. 1941, II, 180-90, in Hist. AAF Tng. Comd., pp. 877-85.
- [56.](#) R&R #1, C/AS to C/AC, 26 Sept. 1941; Daily Diary, AFRIT, 23 Sept. 1942; AFFTC, Consolidated Flying Training Report, Dec. 1942, Jan., Feb., and July 1943; memo for Col. T. J. Dubose from Maj. E. H. Herzog, 22 Dec. 1942; R&R, AFMSC to AFII-ID, 15 Oct. 1943, in AHS-5, pp. 58-88.
- [57.](#) AFFTC to GCAFTC, 16 Apr. 1942; AAF to all Air Forces and AAF Comds., 28 July 1942; 2d ind. (4th AF to AAF, 3 Nov. 1942), AAFFTC to AAF, 11 Dec. 1942; AAF to AAFFTC, 15 May 1943.
- [58.](#) TC Memo 50-11-1, 16 June 1943, 20 Aug. 1943, 29 Sept. 1943, 30 June 1944; interview, Maj. P. P. Dawson, A-3 Div., Hq. AFTRC, 22 Mar. 1946; FTC Memo 50-11-2, 19 Apr. 1943; Hist. WCTC, 1942, II, 447-48, 898-99, 910-15.
- [59.](#) FTC Memo 50-11-2, 19 Apr. 1943; FTC Memo 50-11-1, 16 June 1943; TC Memo 50-11-1, 20 Aug. 1943, 29 Sept. 1943, 18 Feb. 1944, 30 June 1944; AHS-5, pp. 53-56.
- [60.](#) TWX, AFTRC to CFTC and WFTC, 10 May 1944; AAFFTC to GCTC, 13 Jan. 1943; TC Hist., pp. 904-5.
- [61.](#) TC Memo 50-11-5, 6 Aug. 1943, 2 Feb. 1944; AFTRC to CFTC and WFTC, 29 Mar. 1944.
- [62.](#) AHS-5, pp. 89-114.
- [63.](#) TM 1-250, 7 Mar. 1941; Min. Bombardier and Navigation Conf., Hq. AFTRC, 25 Oct. 1945; Hist. Kirtland AAF, 1 July-31 Aug. 1944, pp. 216-17; interview, CWO T. J. Kelly, A-3 Div., Hq. AFTRC, 25 June 1944; AFTRC to CFTC, 1 Mar. 1944; Daily Diary, Hq. AFTRC, A-3 Div., 22 Apr. 1944.
- [64.](#) Hist. Big Spring AAF, Nov.-31 Dec. 1944, pp. 87-88.
- [65.](#) AFTRC to AAF, 12 Aug. 1943; FTC Memo 50-11-6, 5 July 1943; AAF FTC to AAF, 2 July 1943; AHS-5, pp. 99-110.
- [66.](#) Daily Diary, Hq. RC, A-4 Div., 30 Sept. 1943; Hist. Big Spring AAF, 1 Nov.-31 Dec. 1944, p. 178.
- [67.](#) Daily Diary, Hq. AFFTC, 20-21 June 1942, 13 Jan. 1943; General Yount's Project Book, Bombardier Training, 20 Aug. 1943; memo for Lt. Col. E. H. Herzog from Capt. H. O. McTague, 13 Aug. 1943.
- [68.](#) Daily Diary, Hq. AAFFTC, A-4 Div., 18 Apr. 1943; TWX, AFTRC to AAF, 23 Sept. 1944; Hist. Kirtland AAF 1 July-31 Aug. 1944, p. 95.
- [69.](#) Stat. Control Sec., Hq. AFTRC, Chart, Bombardier Graduates, 1946.
- [70.](#) R&R, ACFTC to Asst. for Pers., Hq. AAF, 21 Feb. 1942; memo for Maj. W. S. Lee, Bombardier Sec., OCAC from Capt. E. C. Plummer, 17 Jan. 1942; Daily Diary, AFFTC, A-3 Div., 20 Oct. 1942; Daily Diary, AAFFTC, A-3 Div., 19 May 1942.
- [71.](#) AFFTC to TC's, 26 May 1942; Min. Bombardier and Navigation Conf., Hq. AFTRC, 25 Oct. 1945; Chart, Bombardier Graduates, cited in n. 69.
- [72.](#) AFTRC to WCTC, 16 Aug. 1943; Maj. Gen. C. L. Tinker, Hq. Hawaiian AF to C/AAF, 24 Feb. 1942; AHS-27, Individual Training of Navigators in the AAF, pp. 173-75.
- [73.](#) AHS-27, pp. 186-87.
- [74.](#) *Ibid.*, pp. 181-82.
- [75.](#) *Ibid.*, p. 185; FTC Memo 50-12-1, 15 Apr. 1943 and 22 July 1943; interview, 1st Lt. W. A. Bennett [rated navigator], AFSHO, 16 Jan. 1947.
- [76.](#) CG AFFTC to AFRIT, 12 Jan. 1943, in AHS-27, pp. 82-83, 182-83; TC Hist., p. 820.

- [77.](#) Hist. EFTC, 1 Jan. 1943-31 Dec. 1943, III, 792-97, 819; AHS-27, pp. 84, 183.
- [78.](#) R&R, C/AC to C/AAF, 15 Sept. 1941; R&R, AFRDB to AFRIT, 3 Feb. 1943; Daily Diary, AFFTC, A-1 Div., 5 Oct. 1942; Daily Diary, AFTRC, A-1 Div., 23 Dec. 1943; AHS-27, pp. 135-48, 158-60.
- [79.](#) Hist. WFTC, 1943, II, 486-87; AFTRC to WFTC, 21 July 1943; memo for C/Non-pilot Sec., A-3 Div. from Hq. AFTRC, Maj. J. H. Kusner, A-3 Div., 16 Nov. 1943; TC Hist., pp. 862-76.
- [80.](#) AHS-27, p. 186; AAF to AFTRC, 26 Nov. 1943; AAF to AFTRC, 8 Nov. 1943; AFTRC to CFTC, 21 Nov. 1944; AFTRC to CFTC, 15 Dec. 1943; 3d ind. (AAF Nav. Intr. School (N), Selman Fld., La., to AFTRC, 24 Apr. 1944), AFTRC to CFTC, 14 May 1944; AFTRC to FTC's, 2 Aug. 1943; TC Hist., pp. 848-55.
- [81.](#) Dawson interview, in TC Hist., pp. 859-60.
- [82.](#) TWX, ACFTC to GCAFTC, 7 June 1942; Hist. CFTC, Mar.-Apr. 1945, I, 215; TC Hist., pp. 855-57.
- [83.](#) R&R #1, AFRDB to AFRBS thru AFRIT, 9 Sept. 1942; R&R #7, AC/AS MM&D to AC/AS Training, 6 Apr. 1944; Rpt. of AAF Board, Project No. (M-4) 537, 5 May 1944; CG AFFTC to AFRIT, 26 Feb. 1943, in AHS-27, pp. 168-72.
- [84.](#) Chart, Navigator Graduates, in TC Hist., p. 846.
- [85.](#) Psych. Sec., Office of the Surgeon, Hq. AFTRC, Table VI, September 1944 Test Battery; Dawson interview cited in n. 81; interview, Capt. A. R. Kooker, Hist. Off., Hq. AFTRC, 17 Oct. 1944.
- [86.](#) TC Memo 50-12-1, 22 Nov. 1943, in AHS-27, pp. 84-85; Chart, Navigator Graduates, in TC Hist., p. 846.
- [87.](#) Lt. Gen. H. H. Arnold and Col. I.C. Eaker, *Winged Warfare*, p. 45; Gen. H. H. Arnold to AAFFTC, 29 June 1943; TC Hist., pp. 978, 1018.
- [88.](#) R&R, OCAC, Maj. Lee to C/Tng. Div., Nov. 1941; Table, Flexible Gunnery Training Schools, in TC Hist., pp. 981-83.
- [89.](#) Memo for General Perrin from Brig. Gen. R. W. Harper, 3 Sept. 1943; C/AS to CG's all AF's, Comds., etc., 1 Dec. 1942; Brig. Gen. R. W. Harper to CG AFFTC, 27 Apr. 1943; Brig. Gen. R. W. Harper to CG AFTRC, 3 Aug. 1943, in AHS-31, Flexible Gunnery Training in the AAF, pp. 13-16.
- [90.](#) Chart, Flexible Gunnery Graduates, in TC Hist., p. 985; AAF Stat. Digest, tables 47, 50; Hq. AFTRC, Project Book; TWX, GCAFTC to AFFTC, 18 Apr. 1942; AAF Reg. 35-17, 10 Feb. 1943, in TC Hist., pp. 984-89.
- [91.](#) TWX, AFTRC to EFTC, 26 Oct. 1943; Gunner's Information File (AAF Manual 20), rev. Feb. 1945, in Hist. EFTC, 1 Mar. 1945-30 Apr. 1945, I, 372, 1047-49; AHS-31, pp. 100-101.
- [92.](#) Hist. EFTC, 1942, III, 983-84; 1943, III, 871-72; Rpt. of Conf. on Flexible Gunnery, 6 June 1942; Col. L. W. McIntosh, Rpt. of Training Inspection of AFTRC Flexible Gunnery Schools, 11 Aug. 1943, in TC Hisc., pp. 999-1000.
- [93.](#) Hist. Kingman AAF, 1943, p. 48; Hist. EFTC, 1942, III, 962, 965-66, 986-89; 1943, III, 880-83; Col. L. W. McIntosh, Rpt. of Tng. Inspection of AFTRC Flexible Gunnery Schools, 11 Aug. 1943.
- [94.](#) 94. AAF to AFTRC, 31 Aug. 1944; Hist. of EFTC, Nov.-Dec. 1944, I, 389; Hist. WFTC, Mar.-Apr. 1945, II, 254-55; May-June 1945, I, 138-39, 1054-55; AHS-31, pp. 63-71.
- [95.](#) AFTRC to AAF, 1 Dec. 1943; AAF to AFTRC, 4 Dec. 1943; AFTRC to EFTC and WFTC, 30 Aug. 1944; memo for Gen. H. H. Arnold from Hq. AFTRC, 12 Dec. 1944; interview with Lt. H. D. Shearn, Frangible Bullet Off., Laredo AAF, 29 Oct. 1945; Daily Diary, Hq. AFTRC, A-4 Div., 4 Aug. 1945, 5 Aug. 1945, in TC Hist., pp. 1056-58.
- [96.](#) Hist. EFTC, 1942, III, 953-55; 1943, III, 863, 892-93, 903; AFRIT to AAFFTC, 15 Feb. 1943; memo for Col. Harding from Maj. R. F. Worden, Hq. AAFFTC, 17 Oct. 1942; FTC Memo 50-13-3, 7 Feb. 1943; TC Memos 50-13-1A, 31 Aug. 1943; 50-13-2, 19 Aug. 1944; Hist. Laredo AAF, Jan.-Feb. 1945, III, 99-100; interview, Capt. A. H. Payne, Jr., CSFG, 30 Oct. 1945.
- [97.](#) TWX, AAF to AFTRC, 6 Mar. 1944; Hist. Buckingham AAF, , Nov.-31 Dec. 1944, II, 17-20; 1 Mar.-30 Apr. 1945, II, 58-74, 107; memo, Hq. AFTRC, Rpt. of Conf., 9 Oct. 1944; Daily Diary, Hq. AFTRC, OD/FG, 25 Apr. 1945, Hq. AFTRC, A-1 Div., 28 July 1945; AFTRC to EFTC, 22 May 1945.

[98.](#) AAFFTC to AAF, 23 Feb. 1943.

[99.](#) Sheppard Fld., Texas, to AAFTTC, 12 May 1943; AAF to AFTRC, 9 Oct. 1943; AAF to AFTRC, 9 Mar. 1944; AFTRC to AAF, 13 Apr. 1944; AFTRC to AAF, 7 Feb. 1945; Stat. Control Sec., Hq. AFTRC, Special Rpt., 18 Jan. 1945.

[100.](#) Hist. Amarillo AAF, May-June 1945, III, 101-2; TC Memo 50-32-8, 7 July 1944; Course Outline for B-29 Flight Engineer Course, Lowry Fld., Colo., 1 Nov. 1944.

[101.](#) WTTC to AFTRC, 8 Feb. 1944; Lowry Fld., Colo., to WTTC, 26 Aug. 1944.

[102.](#) Hist. Boca Raton AAF, 1 May-30 June 1944, App. B, Item 12; AFTRC to ETTC, 16 Sept. 1944; AFTRC to WFTC, 20 Sept. 1944; AFTRC to AAF, Dec. 1944; AFTRC to WFTC, 22 Dec. 1944; AAF Stat. Digest, table 50.

[103.](#) Hist. Boca Raton AAF, 7 July 1943-1 Mar. 1944, app. B, Items 8-10; Radar Standardization Bd., Chart, AAF Radar Tng., in Monograph on Communications Training, 1 Jan. 1939 to 31 Dec. 1944 (rev.), pp. 46-63.

---

[Table of Contents](#)

[Previous Chapter](#) (16) \* \* [Next Chapter](#) (18)

---

---

*Transcribed and formatted for HTML by Terry Welshans for the HyperWar Foundation*