Army Air Forces Historical Studies: A

No. 5

INDIVIDUAL TRAINING of BOMBARDIERS

The original of this monograph and the documents from which it was written are in the USAF Historical Division, Archives Branch, Bldg. 914, Maxwell Air Force Base, Alabama.

Prepared by
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HISTORICAL DIVISION

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ARMY AIR FORCES HISTORICAL STUDIES: No. 8

INDIVIDUAL TRAINING OF BOMBARDIERS

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Prepared by
Assistant Chief of Air Staff, Intelligence,
Historical Division
May 1944

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FOREWORD

It is the desire of the President, the Secretary of War, and the Commanding General, Army Air Forces, that a solid record of the experiences of the AAF be compiled. This is one of a series of studies prepared as a "first narrative" in the projected over-all history of the Army Air Forces.

The decision to make the information contained herein available for staff and operational use without delay has prevented recourse to some primary sources. Readers familiar with this subject matter are invited to contribute additional facts, interpretations, and constructive suggestions.

This study will be handled in strict compliance with AR 380-5.

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Readers are requested to forward comments and criticisms, and to this end perforated sheets, properly addressed, are appended at the back of this study.

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Individual Training of Bombardiers

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INTRODUCTION

The modern concept of air power emphasizes bombardment as the essential function of a striking air force. It is only when bombs are released in the target area that a bombardment mission can justify the material and personnel expended on it. Consequently, it is a matter of utmost importance in the accomplishment of the mission of the Army Air Forces that the bombardier be selected with exceeding care and that he be trained to the highest possible point of proficiency.

From a qualitative as well as a quantitative point of view, the accomplishments attained in the training of bombardiers must be evaluated in terms of the production goals established for such training. That is, the quality of the product must be considered in the light of the demands made upon the training facilities. In every type of training in the AAF, especially in the early stage of the training program, there has been the problem of an enormous mission to be performed and few facilities with which to accomplish the mission. At the beginning of the expansion program, early in 1939, there was no bombardier training under the Chief of the Air Corps, and no bombardier schools were established until May 1941, when Barksdale Field began bombardier instruction. In fact, it was nine months later before such training really got under way. In the meantime the United States had entered the war, and the demand for trained bombardiers skyrocketed, as did the demand for every

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category of trained specialists.

The expansion objectives of the air arm have been stated in terms of various "Group Programs", that is, the 25, 41, 54, 84, 115, 224, and the 273 Group Programs. These have been constituted the adopted goals of the AAF training program. Throughout most of the expansion program the requirements for other trained aircrew members have been based on the pilot program, the requirement in each category being a certain percentage of the pilot goal. The ratio of bombardiers to the over-all pilot requirements has generally been one to five. The ratio of bombardiers to combat pilots, however, has been approximately one to three. Bombardier requirements with relation to the various group and pilot programs have been as follows:[1]

Group Program	Pilot Program	Bombardier Requirement
25	1,200	1,093 (bombardier-navigator)
41	7,000	1,800 (approximate)
54	12,000	2,500 (no directive found)
84	30,000	5,590
115	50,000	11,016
224	70,000	14,000
273	102,000	19,400 (by January 1944)

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1. The exact status of bombardier requirements prior to the requirement under the 115 Group Program is difficult to ascertain. Directives and counterdirectives are frequent. Some statements of production goals appear to include the individual training of bombardiers in both the tactical units and the Air Corps schools, while others apply specifically to Air Corps schools only. There is also the complicating factor that some production goals are based on dual bombardier-navigator training. Also, the directives issued to the separate training centers, when compiled, constitute larger goals than do the over-all directives for Air Corps school training. Because of these facts, some of the above data are selected in an arbitrary manner. The 1,093 goal is taken from AAF No. 2, Plans to Training and Operations through (contd)

[redacted]

Probably the most important factor in determining bombardier production requirements has been that of changing aircrew requirements. One of these changes was the decision, resulting from the recommendation of Brig. Gen. James H. Doolittle, to provide each medium bombardment crew with a dually trained bombardier-navigator. This resulted in the inauguration of B-8 bombardier training for gunners and graduate navigators and dead-reckoning navigation for graduate bombardiers, with the necessary establishment of an additional school and a revision of the production schedule. Also, the demand for completely dually trained precision bombardier-celestial navigators for the aircrews of the super-bombers caused another revision of the training objectives.

As the group activation and training program approached its peak in mid-1943, group training (OTU) declined and replacement crew training (RTU) increased. Since more crews are processed through replacement training unit groups than through operational training unit groups, a larger number of all aircrew trainees will be required for operational training. As a result of these changing

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1. (contd)
Executive, Office, Chief of Air Corps, 15 May 1940, in AAG 352.01, Establishment of Schools; the 1,800 figure is based on a general estimate that there would be 3,600 pilot training eliminees available for bombardier and navigator training (see memo, Chief of Air Corps to Chief of Air Staff, 24 May 1940, in AAG 353.9 C, Air Corps Training Directives and Programs). The 2,500 goal is arrived at by means of the 20 per cent ratio of pilots to bombardiers. The succeeding production requirements are more definite and are found in Lt. Gen. B. K. Yount's Project Book, Bombardier Training Program, in files of the Historical Division, AC/AS, Intelligence.

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forces, the demand for bombardiers for the years 1944-1946 has increased tremendously. From November 1940 through October 1943 a total of 21,672 bombardiers (of all types) had been graduated.[2] This study is an account of the experience of the AAF to November 1943, in providing the individually trained bombardiers to meet these requirements.

Bombardier training is conducted in two stages, the period of individual training in the bombardier schools of the Training Command and the period of operational training which is conducted in the tactical units of the four domestic air forces. In the individual training stage the trainee is carried through sufficient training to qualify him as a bombardier according to prescribed standards. The product of such training is an individually qualified specialist, whose experience in teamwork is limited almost entirely to that of pilot-bombardier cooperation and who has had little or no experience in bombing from tactical aircraft and at maximum altitudes. It is in the second stage of the bombardier's training, the operational, that he, with all the other individually trained specialists who will compose the combat team, is trained to perform his special functions in coordination with the other crew members, in tactical type aircraft and under conditions that more nearly simulate actual combat.

This study is confined to the first stage of bombardier training, the training of the bombardier as an individual specialist. Included in the scope of this study are brief accounts of the following: the

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2. See chart following p. 88.

procurement of bombardier trainees; the training conducted in the preflight and advanced bombardier schools; the evaluation of programs of instruction; the problems of personnel (especially instructors and their training) and materiel (airplanes, bombs, and bombsights) encountered in the effort to attain the production goals established for this type of aircrew training; and some of the essential relations between the individual training conducted in the tactical units and that conducted by the Training Command.

Chapter I

PROCUREMENT AND PREFLIGHT TRAINING OF BOMBARDIERS

Securing Bombardier Trainees

The present scientific program for the selection and classification of personnel for the various categories of aircrew training was launched at a belated hour.[1] It was in May 1941, approximately a month after the graduation of the first class of cadet bombardiers, that a directive was issued which authorized an investigation of the "aptitudes of bombardier and navigator trainees".[2] Before July 1943, however, little or no significant correlation between the classification tests and the aerial performance of bombardiers had been discovered.[3] In the absence of any successful procedure for securing candidates for bombardier training, the principal sources of such trainees were enlisted men and cadets eliminated from pilot training. Only 4 or 5 per cent of the men who applied for cadet training preferred bombardier training.

In choosing bombardier trainees the only selection exercised prior to the development and use of the aviation cadet tests and aptitude scores was that effected by giving preference in bombardier

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1. For the detailed record of the AAF policies and procedures relative to the selection and classification of students for the various categories of training, consult the studies prepared by AFHRI.
2. "Annual Report" (fiscal year 1942) of the Psychological Div., Office of the Air Surgeon, 13 Aug. 1942.
3. "Circular Error as a Measure of Bombardier Proficiency", prepared by Psychological Unit, Office of the Surgeon, AFFTC, 15 July 1943, in AFHRI files.

training to men with certain educational qualifications.[4] As the demand for bombardier production under the expansion program increased, however, the policy of selection on the basis of educational qualifications was abandoned, and the only educational requirement retained was that of graduation from an accredited high school and ability to pass the General Classification, Physics, and Mechanical Aptitude tests. If he could meet these requirements, the applicant was accepted for training in a replacement training center "for Bombardier-Navigator training only".[5]

The 4 or 5 per cent of cadet applicants who preferred bombardier training, plus the eliminated pilots who were assigned to such training, did not produce the required flow into bombardier training. As a result, the AAF launched a publicity campaign to procure candidates for bombardier and other non-pilot training.[6] Even this did not produce sufficient trainees, and in order to meet quota requirements men were assigned to bombardier training contrary both to aptitude scores and preference. Some men were assigned to such training with stanine[7] scores of "1" and "2". The elimination rate among the men with such low scores was very high — 33 per cent among the men with a score

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4. Asst. C/AC to Commanding Generals of the training centers, 16 June 1941, in AAG 353.9, Specialized Training.
5. R&R, C/AS to C/AC, 24 Oct. 1941, in ibid.
6. Station Commanders' News Letter No. 3, 14 Nov. 1941; R&R, AC/AS, A-1, 17 Dec. 1941, in AAG 353.9, Specialized Training; author unknown, WD Public Relations Bureau to Col. Arthur I. Ennis, 24 Apr. 1942, in ibid.
7. Based on the weighted scores made on the aviation cadet examinations, each cadet is given a composite score ranging from "1" to "9" for each category of aircrew training — bombardier, navigator, and pilot. This aptitude score, or rating, is known as a "stanine" score.

of "1."[8]

The most mooted question relative to securing bombardier trainees has been that of utilizing men eliminated from other types of airerew training. The approximate required ratio of bombardiers to pilots has been 1 to 8, whereas the ratio of applicants for these types of training has been about 1 to 18. Consequently there has been no alternative to the policy of training eliminees as bombardiers. Nevertheless, there has been decided and recurring opposition to the policy from the time the first cadet bombardiers were trained under the Chief of the Air Corps.[9] So completely did the Air Corps depend on eliminated pilots as bombardier trainees that the production goal for bombardiers under the 7,000 pilot program was set up on the basis of the anticipated percentage of pilot eliminees who would volunteer for bombardier training.[10] This policy was modified somewhat, however, when the new policy of classifying cadets for airerew training rather than just for pilot training was adopted.

The policy of utilizing eliminees as bombardier trainees has been opposed at various times by the Training and Operations Division of the Office, Chief of Air Corps,[11] the Directorate of Military Require-

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8. "Research Bulletin No. 128," 20 June 1945, Psychological Br., Office of the Air Surgeon.
9. Asst. CO, AC Technical School, Denver, Colo. to C/AC, 3 Oct. 1940, in AAG 353.9, Specialized Training.
10. Memo for Chief of Staff by C/AC, 24 May 1940, in AAG 353.9 C, AC Training Directives and Programs.
11. R&R, P40 to Military Personnel Div. 12 Aug. 1941, in AAG 353.9, Specialized Training.

ments,[12] the Directorate of Bombardment,[13] the Air Inspector,[14] and commanding officers at schools conducting bombardier training.[15] The only progress made in this direction, however, has been that of preventing eliminees with low aptitude scores from taking other types of training.[16]

Preflight Training of Bombardiers

Prior to July 1940 all bombardier training, including the preliminary phase, was the responsibility of the General Headquarters Air Force, which performed such training in its tactical units. The expansion program had not advanced far, however, until it became apparent that the individual training of the non-pilot aircrew members constituted an overload on the tactical units and that this training should be assigned to the Office, Chief of Air Corps. No sooner had the individual training of non-pilot aircrew specialists begun in the Air Corps schools than plans were instituted to establish special training facilities for conducting the basic training of combat crew members. On 17 October 1940 the Training and Operations Division proposed such a school.[17] This proposal was approved, for planning purposes, on

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12. Daily Diary, Director of Military Requirements, 20 March 1942, in AAG 319.1-3, Daily Diaries.
13. Daily Diary, Director of Individual Training, 19 June 1942, in ibid.
14. Memo for Maj. Gen. H. H. Arnold by Air Inspector, 19 Aug. 1941, in AAG 352.01 D, Establishment of Schools.
15. Asst. CO, AC Technical School, Denver, Colo. to C/AC, 3 Oct. 1940, in AAG 353.9, Specialized Training.
16. Daily Diary, AFFTC, 23 July 1942, in AAG 319.1-3, Daily Diaries.
17. R&R, T&O to Executive through Plans, 17 Oct 1940, in AAG 353.01 C, Establishment of Schools.

9 November 1940. In addition to relieving the tactical units of the responsibility for individual training, there was also the demand to provide basic military and some primary training preparatory to the advanced specialized training.

As a result of these demands, the Air Corps Replacement Centers were established, in which a 12-week course of instruction was conducted. The principal aim of the replacement training centers, however, was the preliminary training of pilots. As there was not adequate provision for preliminary training for bombardiers and navigators, on 12 June 1941 the commanding officer at Maxwell Field was instructed to establish a reconnaissance school for this purpose. Training in the reconnaissance school was to be an eight-week course for eliminated pilots and "selected civilians". The program of instruction was to consist of the following subjects: maps and charts, photography, communications, meteorology, naval forces, ground forces, air forces, military administration, and military training. Upon completion of this course, trainees were to be sent to a five-week gunnery course and then to advanced bombardier or navigator schools.[18]

In the following September (1941) the three Air Corps Replacement Centers were redesignated Air Corps Replacement Training Centers (Airerew).[19] This action reflected the increasing emphasis being given to the training of the non-pilot members of the airerew. Plans also

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18. [redacted] to CG, GHQAF, 24 March 1941; 1st Ind., CG, GHQAF to C/AC, 25 April 1941; 2nd Ind., [redacted] to CG, Southeast Air Corps Training Center, 29 Apr. 1941, in AAG 353.9 B, Training, General; CG, SEACTC to CO, Advanced Flying School, Maxwell Field, 12 June 1941, in AAG 353. Training, General.
19. AG 320.2 (MR-M-AAF), 30 Sep. 1941.

were made to open a bombardier-navigator center at Ellington Field in addition to the one at Maxwell. Training at Ellington was scheduled to begin on 11 October 1941 for the navigators who would go to Kelly Field for their advanced training and for the bombardiers who were scheduled to remain at Ellington for advanced training.[20] There was thus established the equivalent of the later preflight bombardier-navigator schools.

Effective 30 April 1942 the replacement training centers were redesignated "Preflight" schools, and Maxwell, Ellington, and Santa Ana became the bombardier-navigator preflight schools.[21] On 22 October 1942 the bombardier-navigator preflight school at Maxwell was moved to Monroe, La.[22] When this school was transferred it conducted preflight bombardier training for only a month after which time it became a preflight school for navigators only,[23] leaving only Ellington and Santa Ana as preflight schools for bombardiers. Advanced bombardier training at Ellington had been discontinued in December 1941. In January 1942 the preflight course of instruction had been shortened from 12 weeks to 10, and in the following month a nine-week course was adopted.[24]

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20. Asst. C/AC to CG, CGACTC, 16 Sep. 1941, in AAG 353.9 C, Training General.
21. AG 320.2 (3-24-42) MR-M-AF, 30 Apr 1942.
22. AG 320.2 (10-21-42) OB-I-AF-M, 22 Oct. 1942.
23. History of Selman Field, Monroe, La., 15 June 1942-31 Dec. 1942, 15.
24. Commanding Officers' Official Bulletin No. 12, 16 Jan. 1942; CG, AFFTC to CG's of the three training centers, 6 Feb. 1942, in AAG 353.9 I, Aviation Pilot Training.

The purpose of the preflight schools was to provide the basic academic and military training requisite for the instruction offered in the advanced schools. In the preflight stage, however, there was very little that was peculiar to the bombardier's training. The authorized preflight programs of instruction for bombardiers and navigators were identical, the only variations being those made by the individual schools. Furthermore, after February 1943 the same course of preflight instruction was given to pilots, bombardiers, and navigators. It appears, also, that even prior to this date there was little difference in the instruction given to these three categories of personnel in preflight training. Authorized programs of instruction embodied only the minimum requirements, however, and the individual school was free to change the program by offering additional training and to vary instruction in particular courses. For example, the preflight school at Santa Ana gave more instruction in mathematics for navigators than was required and more instruction in physics for bombardiers than was required.

The program of instruction for bombardiers in preflight training as of July 1943 included the following:

1.	Code (radio and visual)	48 hours
2.	Physics	24 "
3.	Mathematics	20 "
4.	Maps, charts, and aerial photographs	18 "
5.	Identification and tactical functions of aircraft	18 "
6.	Identification and tactical functions of naval vessels	15 "
7.	Ground forces and military subjects	10 "
8.	Chemical warfare defense	12 "
9.	First aid and field sanitation	8 "
10.	Altitude indoctrination and testing	3-1/4 hours(in chamber
11.	Physical training	54 "
12.	Military training	113 "

Although students differed in their educational attainments, until April 1943 every student, regardless of his background and training in preflight subjects, was required to take the entire preflight course. This was also true of the eliminees from other types of aircrew training. A new policy, inaugurated in April 1943, provided that "Any student officer attending Pre-Flight School (Bombardier-Navigator) whose proficiency in Ground School and Military Training warrants his advancement to specialized school at the end of six (6) weeks training may be so advanced". Also, any aircrew trainee who had been eliminated from one type of training, after having accomplished the preflight stage, and who was reclassified for another category of aircrew training could be sent to the advanced stage of such training without taking the preflight course again.[25] This latter policy was the logical outgrowth of a step taken in February 1943 when the training in all preflight schools was standardized. The preflight program of instruction for pilots was made the preflight program for all preflight schools, including bombardier-navigator schools.[26]

From October 1941, when the first preflight bombardier program was inaugurated, to 1 October 1943 a total of 1,451 students were eliminated from training and 23,430 graduated. This constituted a long-term elimination rate of 5.83 per cent in preflight training. The rate of elimination, however, was not uniform, or even nearly uniform in the two preflight schools which did virtually all of this type of training. The elimination rate at Ellington was only

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25. TC Memo 50-23-3, 21 Apr. 1943.
26. TC Memo 50-23-1, 19 Feb. 1943.

3.61 per cent, while the rate at Santa Ana was 7.86 per cent.[27] This wide divergence in the elimination rate in the two schools raises a number of questions to which satisfactory answers have not yet been found. Were the standards of proficiency at Santa Ana higher than those at Ellington? Was the instruction at one school decidedly better than at the other? Does the record made by the graduates of these schools in the advanced bombardier schools indicate that those trained in preflight in one school were better trained than those in the other? Were the classification and assignment procedures and policies administered uniformly in the training centers? These are questions which demand a more thorough study.[28]

Prior to 5 July 1942 only 2,281 bombardier students had graduated from preflight training. From July to October this total increased to 4,843; by the end of December it was 8,732; the first three months of 1943 saw the total rise to 14,088; and by 30 September 1943 the cumulative total had reached 23,430. The advanced schools were unable to enter students at a rate equal to the graduation rate of the preflight

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27. The data used here are taken from the Consolidated Flying Training Report issued monthly by the Statistics Div. of AFFTC.
28. The elimination rate in preflight bombardier training, by quarters, was as follows:

Period	Elimination Rate
Prior to July 5, 1942	6.76%
July 5 to Sept. 28, 1942	6.75%
Sept. 28 to Dec. 31, 1942	11.33%
Jan. 1 to March 31, 1943	6.00%
April 1 to June 30, 1943	4.51%
July 1 to Sept. 30, 1943	4.60%

R&R, Statistical Control Div., Management Control, to AFIHD, 15 Oct. 1943, in AFIHI files.

29. The monthly flow and cumulative totals of graduates of preflight (contd)

schools, and by October 1942 there was a backlog of preflight bombardier graduates,[30] just as three months later there was a surplus of bombardier graduates of the advanced schools.

By the end of October 1942 the backlog of preflight graduates had become such that remedial action had to be taken by the Flying Training Command. On 31 October the Command issued a directive which cancelled for the next two months the shipment from the three training centers of all cadets classified as navigators. All bombardier-navigator graduates who were physically qualified and whose records indicated that they desired pilot training were to be transferred and given priority of assignment to the next pilot class. Those who could not be reclassified as pilots were to be given advanced training in

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29. (contd)
bombardier training were as follows:

Period	Graduates During Period	Cumulative Total
Prior to May 4, 1942	1,062	1,062
May 4 to June 3, 1942	207	1,269
June 3 to July 5, 1942	1,012	2,281
July 5 to Aug. 15, 1942	579*	2,860
Aug. 15 to Sept. 28, 1942	1,983	4,843
Sept. 28 to Oct. 31, 1942	1,817	6,871**
November 1942	861	7,732
December 1942	1,000	8,732
January 1943	1,881	10,613
February 1943	1,721	12,334
March 1943	1,754	14,088
April 1943	1,202	15,290
May 1943	1,981	17,271
June 1943	1,773	19,044
July 1943	1,818	20,862
August 1943	1,655	22,517
September 1943	913	23,430

B&R, AFMSC to AFIHD, 15 Oct. 1943, in AFIHI files.

* There is an apparent error in the report for this period. The report indicates 607 graduates, but this number appears to have been corrected in subsequent reports.

** The number of graduates from Maxwell Field is corrected from 23 to 234 on this report.

30. Daily Diary, AFFTC, 23, 27 Nov. 1942. SECURITY INFORMATION

the order of their graduation, and furloughs were authorized when neither of the above alternatives was possible. Where practicable, qualified preflight graduates were to be utilized "as assistant ground school instructors or appointed as drill masters in the Military Department". Furthermore, authority was given temporarily to discontinue classification of men for preflight bombardier-navigator training "except when mandatory".[31]

With the flow of bombardier trainees from preflight exceeding the capacity of the advanced bombardier schools, it was decided, in July 1942, to send men assigned to bombardier training to flexible gunnery prior to entrance into preflight schools.[32] In the following December, however, the policy was adopted of sending bombardier-navigator preflight graduates to flexible gunnery prior to entrance in the advanced bombardier schools instead of prior to preflight.[33] The capacity of the gunnery schools, however, was not sufficient to accomodate all of the preflight graduates because of a priority given to career gunners, and a quota for graduates of the preflight bombardier-navigator schools was established at the gunnery schools.[34]

Factors affecting preflight training of bombardiers were by no means in a settled state by late 1943. The advisability of a uniform program of instruction for pilots, bombardiers, and navigators was questioned in some quarters. There was a possibility that the increased emphasis given to military training in all stages of training

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31. Ibid., 23 Nov. 1942.
32. AFRIT to CG, AFFTC, 27 July 1942, in AAG 353.9 B, Bombardiers, Gunners; Daily Diary, AFFTC, 4 Aug. 1942.
33. Daily Diary, AFFTC, 11 Dec. 1942.
34. AFRIT to CG, AFFTC, 10 Feb 1943, in files of AFACT-2.

might result in changes in the preflight program. And it was obvious that the academic training provided in the College Training Program would affect the academic phase of preflight instruction.

Chapter II

ADVANCED TRAINING IN TACTICAL UNITS

Prior to Establishment of Specialized Schools

Before July 1940 the individual training of bombardiers was one of the missions of the tactical units under the GHQAF. This type of training continued to be performed by the tactical units, even after such training became one of the responsibilities of the Chief of the Air Corps. In fact, at the end of 1943 individual training was still conducted in the domestic air forces, but after the end of 1942 it was at a minimum because the specialized schools were able to supply most of the required individual training. The individual training conducted in tactical units was dictated by expediency, and the records available on it are rather fugitive.[1]

As early as April 1939 it was suggested to Maj. Gen. Henry H. Arnold, Chief of the Air Corps, that the individual training of bombardiers could be performed better in a school than in the tactical units and that relieving those units of this responsibility would

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1. The Directorate of Individual Training and the Directorate of Bombardment attempted without success to secure a record of these activities performed during the years 1939 to 1942 in the First through Seventh Air Forces. BAR, No. 2, AFRIT to AFRDB, 1 Dec. 1942; and No. 3, AFRDB to AFRIT, 2 Dec. 1942, in files of AFACT-2, 353, Bombardier Training.

"greatly facilitate unit training."[2] In the following September the Plans Division of the Office, Chief of the Air Corps recommended that the Training and Operations Division take steps to initiate the preliminary ground training of bombardiers at Lowry Field.[3] This plan called for a 16-week program of instruction for only the preliminary ground school period of training, air training remaining the responsibility of the tactical units. Classes of 38 students each, entering every four weeks, were to begin on 6 November 1939. The training was scheduled in such a manner as to produce 644 bombardiers by July 1941 -- the scheduled demand of the tactical units.[4]

In the meantime, it appears that the Chief of the Air Corps had requested the opinion of the Commanding General, GHQAF on the advisability of establishing a "bombardment" school at Lowry Field. Maj. Gen. Delos C. Emmons, Commanding General of the GHQAF, indicated that while he had recommended such a school "about two years ago," he did not at this time approve such an establishment. It was his opinion that the Air Corps had "been confronted with an expansion program and the mission of creating tactical units, with priority given to pilot training for the first two years." A "bombardment" school would require personnel and equipment which General Emmons felt could not be spared for two years. Meanwhile this type of training could be given "coincidentally" in the tactical units.[5] The tactical units of the

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2. Memo for Gen. Arnold by Col. D. B. Netherwood, 7 Apr. 1939, in AAG 353.9 A, Denver, Misc. Training.
3. M&R, Plans to C/AC through T&O, 6 Sep. 1939, in ibid.
4. Ibid.
5. CG, GHQAF to C/AC, 7 Sep. 1939, in ibid.

GHQAF continued to conduct all bombardier training until such training was begun at Lowry Field in July 1940.

Bombardier training was conducted not only in the tactical units within the United States but also in the units outside continental United States. An example is the training conducted in the Hawaiian Department. It was found there that a thorough basic course required a minimum of two months, for either commissioned or enlisted personnel. The first basic course for enlisted bombardiers at Hickam Field was of two months' duration, 1 November to 31 December 1939, and included both ground and air training. The course of training at this field included:

1.	Theoretical	14 hours
2.	Bomb trainer practice and instruction	7-1/2 hours
3.	Aerial tracking mission	1-1/2 "
4.	Bombing (60 bombs) average	32-1/2 "

This course was much briefer than the one that later became standardized in the bombardier schools under the Chief of the Air Corps. The bombardier training experience at Hickam Field led to the significant conclusion that carefully selected men of high school education could "be trained in [the] art of bombing, and [could] be expected to measure up to the usual standards set by officer-bombardiers."[6] This conclusion was not reached until much later in the specialized schools.

Lack of uniformity and organization characterized almost all phases of bombardier training in the tactical units. Each unit,

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6. CG, 18th Wing, Hickam Field, Hawaiian Department, to C/AC, 8 Feb. 1940, in AAG 353.9-1A, Bombsight Training.

it appears, conducted its own training program very largely in its own way. There was no complete manual at the beginning of the training, and varying amounts of time were devoted to the several phases. In March 1940 in the tactical units the ground phase of individual bombardier training was assigned as a function of the group, while the flying training phase was conducted by the squadron. In the absence of a completed training manual, the available portions of "Tentative Training Manual" No. 2170-105 were used, and other parts of training were conducted in accordance with instructions issued by Headquarters, GHQAF, to the wing commanders. Ground training was allotted 135 hours in the program of instruction. Aerial training consisted of releasing a minimum of 150 bombs, 10 bombs on each of 15 missions. The ground school phase consisted of the following:[7]

1.	Bombs, bomb racks, fuses, releases, etc.	20 hours
2.	Theory of bombing — ballistics, bomb trajectories, trail and cross trail	40 "
3.	Bombsights	40 "
4.	Bomb trainer	10 "
5.	Bombing instruments	12 "
6.	Theory of camera obscura	3 "
7.	Low altitude bombing	10 "

The September 1939 training plans contemplated the training of only enlisted bombardiers in the tactical units. However, the training of bombardiers in specialized schools under the Chief of the Air Corps began so late and the demand for bombardiers was so large that the tactical units felt compelled to train not only enlisted men but also officers and cadets. The first requirement

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7. Chief of Staff, GHQAF to C/AC, 22 March 1940, in AAG 353.9, Training, Bombers, Gunners.

for bombardier production, it appears, was the 1,800 rate under the 41 Group (7,000 pilot) Program, approved in the summer of 1940 before any bombardiers were trained by the Chief of the Air Corps. About 1 July 1940 the Commanding General, GHQAF, had asked the Chief of the Air Corps for permission to train flying cadets as bombardiers.[8] On 15 August the plan for this training was explained more fully to the Chief of the Air Corps. It contemplated training men as bombardier-gunners in the tactical units to which they were to be assigned. Since the number of bombardiers required was 179 and an elimination rate of 20 per cent was expected, the plan called for 214 men to be entered in such training. It was desired to continue the training of the officers who were then undergoing training, but thereafter to train only non-pilot cadets as bombardiers "as a permanent substitute for pilot bombardiers in tactical units" until such requirements could be met by the "centralized bombardier school." The Chief of the Air Corps was asked for information as to when graduates of the bombardier schools could be expected; the GHQAF needed to know this so that it could cease training in time "to avoid duplication of effort."[9] The Chief of the Air Corps replied that the expected flow of graduates from the specialized bombardier schools would be as follows:[10]

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8. Executive, OCAC to CG, GHQAF, 15 July 1940, in AAG 353.9, Specialized Training.
9. 1st Ind. (Executive, OCAC to CG, GHQAF, 15 July 1940), Chief of Staff, GHQAF to OCAC, 15 Aug. 1940, in ibid.
10. 2nd Ind. (Executive, OCAC to CG, GHQAF, 15 July 1940), OCAC to CG, GHQAF, 29 Aug. 1940, in ibid.

May 24, 1941	107
July 5, 1941	252
August 9, 1941	252
September 20, 1941	252
October 25, 1941	252
December 6, 1941	252

Obviously, the GHQAF could expect few, if any, individually trained bombardiers for its tactical units for approximately a year and in the meantime it must train its own.

Problem of Training in Dual Agencies

Despite the existence of the specialized schools, it was necessary to continue the training in tactical units. With the exception of 122 bombardier instructors graduated from Lowry Field between 1 November 1940 and 15 March 1941, only 34 bombardiers had been graduated by 24 May 1941, although 107 had been expected. In fact, by the end of 1941, when the training rate required by the 30,000 pilot program was 3,300 officer bombardiers and 4,800 enlisted bombardiers, and when the projected total was 1,367 graduate bombardiers from the specialized schools, only 206 students had graduated from Lowry, Barksdale, and Ellington, the three schools in operation during that year.[11] Another factor which tended to increase the individual training performed by the tactical units was the fact that the bombardier training done in the bombardier schools was in "relatively short and intensive" 10-week courses, and the graduates had to be given further individual training in the tactical units. Regarding training in the bombardier schools, the Chief of the Training and Operations Division indicated to the Commanding General, GHQAF on 24 March 1941 that

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11. Training Report: Flying Training—Non-Pilot (Reports for 1940 and 1941), in AFFTC files.

> It is obvious that this instruction will not by any means prepare this personnel to the extent that would enable them to undertake the responsibility that would naturally be assigned to them in combat units, and that a considerable amount of individual training would necessarily be required in the tactical organizations.[12]

Consequently, the GHQAF relied very little on the bombardier schools and in May 1941 indicated that in view of the shortage of bombardiers it did "not desire to process any of its men through the bombardier schools." Neither was it desired that any of the enlisted men in combat units be selected for bombardier training in the training center schools.[13]

A number of problems arose out of this system of training in dual agencies, that is, tactical units in specialized schools. Not only did bombardier instruction in the various tactical units lack uniformity, but also, after bombardier training was begun by the Chief of the Air Corps, there were differences between the instruction given by these two training agencies. There was, therefore, a need to coordinate the programs and standards of bombardier training in the tactical units and in the specialized bombardier schools in the training centers. Too, the number of graduates from the preflight bombardier schools was inadequate for both of the training agencies. Again, there were problems growing out of the commissioning of the bombardiers trained in the tactical units.

The problems of standardizing instruction and rating upon graduation were inseparable. In May 1942 the Directorate of

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12. AAG 353.9 B, Training, General.
13. 1st Ind. (T&O to CG, GHQAF, 7 May 1941), CG, GHQAF to C/AC, 14 May 1941, in AAG 353.9, Bombing Training, Gunners.

Individual Training requested that the Flying Training Command establish requirements to be met by the group bombardier schools in the air forces in order that graduates could be rated as "bombardiers." The following requirements were requested: (1) qualifications of instructors and the instructor-student ratio; (2) qualifications to be met by students entering the group schools; (3) the program of instruction to be offered. It was emphasized that the graduates of the group schools should be as proficient as the graduates of the Air Corps bombardier schools.[14]

The Flying Training Command insisted that the equivalent of bombardier training in the Air Corps schools could not be given in the group schools, but indicated that group school personnel could be qualified as non-rated first, second, or third-class bombardiers. The recommended requirements for qualification of the group school personnel were: (1) instructors should be graduates of the specialized bombardier schools with an instructor-student ratio of one to four; (2) minimum qualifications for trainees entering the group schools should be the same as outlined for aviation students in AR 650-150; (3) the length and content of the course of instruction should be the same as in the Air Corps bombardier schools.[15] This information was forwarded to the Directorate of Bombardment and thence to the tactical units for their use in conducting the group

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14. AFRIT to AFFTC, 22 May 1942, in AAG 353.9-1B, Bombsight Training.
15. 1st Ind. (AFRIT to CG, AFFTC, 22 May 1942), CG, AFFTC to AFRIT, 30 May 1942, in ibid.

schools.[16]

On 6 June 1942 the Directorate of Individual Training directed the Flying Training Command to select 150 preflight bombardier graduates to be transferred to Tucson, Arizona to be given advanced training by the Second Air Force. These men were to be trained in four groups, 30 to begin training on 9 June and 40 on each of the following dates: 30 June, 21 July, and 11 August. Upon completion of training in the Second Air Force, these men were to be commissioned as officers in the same manner as if graduated from Air Corps advanced bombardier schools.

This policy of assigning preflight bombardier graduates to the tactical units for advanced individual training immediately encountered the objection of the Flying Training Command, which offered many reasons why the policy was inadvisable. Upon receipt of the instructions relative to sending the 150 men to the Second Air Force, the Command registered its nonconcurrence, pointing out that "by the time this personnel would be trained as competent bombardiers, approximately 700 graduates of our bombardier schools would be available to combat units." It was felt at the time, however, that the quota of preflight graduates for the Second Air Force would not upset the quotas for the advanced bombardier schools.[17] Plans were soon made to assign students to the Third Air Force as well as to the Second Air Force. By the time the July group was scheduled to go th the Second Air Force,

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16. R&R, AFRDB to CG, 3d AF, 12 Sep.1942, in ibid; Daily Diary, AFRIT, 8 July 1942, in AAG 319.1-3, Daily Diaries.
17. Daily Diary, AFFTC, 8 June 1942.

however, there were insufficient preflight graduates to meet the assignment without leaving the bombardier schools with unfilled classes. Accordingly, the Flying Training Command requested that all individual bombardier training be performed in its schools and submitted the following reasons: (1) The graduates of the bombardier schools over a two-year period were admittedly of high quality. (2) "Confining such training to the bombardier schools would result in the maximum utilization of training personnel and materiel." (3) The Flying Training Command's methods of instruction were both established and flexible. (4) Restriction of all individual bombardier training to the Command's schools would insure uniformly well-qualified bombardiers for the combat units. (5) "The increased production of bombardiers in the Command schools required the capacity output of the preflight schools. In case of any excess of such preflight graduates, they should be given their training in flexible gunnery prior to going to the advanced specialized schools." (6) Advanced schools, operating at full capacity, "would graduate bombardiers sufficiently in excess of the expected flow to more than offset the number which would be trained in the group schools." It was expected that the production rate of the advanced schools would exceed the requirements of the 70,000 program. (7) "The group schools in the Air Forces should be used to provide the urgent need for the combined training of pilots, bombardiers, and navigators."[18]

The Directorate of Individual Training did not concur in these

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18. CG, AFFTC to AFRIT, 17 July 1942, in AAG 353.9-1B, Bombsight Training.

views, and the practice of training bombardiers in the group schools continued. In order to meet the demand for preflight graduates, the Flying Training Command was instructed to enter the maximum number of students in the preflight schools. Upon graduation, those who could not be accomodated in the Command schools were to be sent to the first four air forces. And in case a surplus still existed, such men were to be sent to gunnery schools. It was pointed out, however, that the training done in the air forces was to be "supplemental to, and not in replacement of, that conducted by the Flying Training Command schools."[19] The Flying Training Command continued to insist that all advanced bombardier training be given in the Command schools,[20] but the shortage of bombardiers, either apparent or real, prompted individuals in AAF Headquarters who were responsible for the training function to direct that advanced training in the domestic air forces continue. On 28 September the Assistant Chief of Air Staff, A-3 stated the situation to the Chief of the Air Staff:

> The training facilities of the four domestic Air Forces are not being fully utilized due to a shortage of qualified personnel. At the same time the capacity of AAF schools is not great enough to provide individually trained personnel. Therefore, any overflow of personnel from the various schools should be assigned to the four Air Forces in the number and in the category for which training facilities are available. . . .
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> As the capacity of the AAF Schools increases, the need for "on-the-job" training by the four Air Forces will decrease. It is not believed that the schools should function at less than

19. Daily Diary, AFRIT, 27 July 1942, in AAG 319.1-3, Daily Diaries.
20. Ibid.

> peak capacity in order to fully utilize training facilities of the four Air Forces, since the individually trained school graduate is believed to be superior to the individual who is trained "on-the-job." Also, the function of the four Air Forces is not individual training of combat units. However, these Air Forces must continue to train qualified individuals available from normal personnel sources.[21]

In order to clarify the policy relative to individual training in the training commands and the air forces, AAF Regulation 50-15 was published on 20 August 1942. This regulation provided that the facilities of the training commands

> will be utilized when they are available without the establishment of parallel facilities in the Air Forces. The school requirements of the Training Commands will be given priority in the allocation of equipment developed for the purpose of individual training, in the accomplishment of this policy. Duplicate facilities for training of individuals will only be established by special authority of these Headquarters in each and every case. Parallel facilities will not be established except wherever the training required cannot be accomplished within the Training Commands or within the facilities available to the Training Commands.

In mid-July the Flying Training Command had been instructed to enter 100 additional trainees in the preflight school at Ellington who were to receive advanced training in the Third Air Force. The Command advised the Directorate of Individual Training that this would not leave "sufficient trainees for Bombardier-Navigator Advanced Flying Schools" and again requested that all such training be performed in the Command Schools.[22] This request was not concurred in, however, and

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22. Daily Diary, AFFTC, 22 July 1942, in AAG 319.1-3, Daily Diaries.
21. AAG 353.9-1B, Bombsight Training.

plans were made to assign these students to the Third Air Force on 12 October.[23] Twelve days before these men were to go to the Third Air Force, the Flying Training Command called to the attention of the Directorate of Individual Training the fact that the Command schools were then adequate for all such training, and stated that this assignment would be in violation of AAF Regulation 50-15, and asked for a decision on the matter.[24] As a result, it was decided not to train these men in the Third Air Force "at present."[25]

On 22 June 1942 the four domestic air forces were requested to submit a report on the status of individual training in each. On the basis of the data secured, a report dated 15 July and corrected on 14 September as a result of additional data from the Third Air Force, indicated the following status of bombardier training in the First, Second, Third, and Fourth Air Forces: (1) on hand and trained but not trained in the training commands, 32 enlisted men and 175 officers; (2) in training, 392 enlisted men and 182 officers; (3) number that could be trained with existing facilities, 233 in the First, Second, and Fourth Air Forces.[26] In addition to this training, 110 of the 150 bombardier cadets scheduled to be trained by the Second Air Force were in training in that air force.[27]

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23. R&R, AFRIT to AFRDB, 22 Sep. 1942, in files of AFACT-2, 353, Bombardiers.
24. CG, AFFTC to AFRIT, 1 Oct. 1942, in ibid.
25. 1st Ind. (CG, AFFTC to AFRIT, 1 Oct. 1942), AFRIT to CG, AFFTC, 5 Oct. 1942, in ibid.
26. Memo for Col. Bradley by Military Personnel Div., Directorate of Personnel, 15 July 1942; memo for Gen. Arnold by C/AS, 23 Sep. 1942, in AAG 353.9-18, Bombsight Training.
27. Daily Diary, AFRIT, 23 Aug. 1942, in AAG 319.1-3, Daily Diaries.

Requests continued to come from the air forces for permission to conduct this type of training. In November the Fourth Air Force indicated a shortage of 111 bombardiers and asked permission to train enlisted men in this capacity,[28] and in January 1943 the Twelfth Air Force asked permission to establish a "provisional Bombardier Training Squadron" for the purpose of training enlisted bombardiers.[29] The disposition of the request of the Fourth Air Force has not been ascertained, but the request of the Twelfth was denied with instructions to return any enlisted personnal in excess of the authorized Table of Organization "to the United States to undergo bombardier training."[30] It is difficult to see the need for these two requests. The average monthly rate of bombardier production in the training command schools for the last six months of 1942 was 725, and in January 1943 approximately 1,700 bombardiers were graduated. Of the January production, the Third Air Force took none and the Second Air Force only 200, leaving a surplus of about 1,500.[31] After this time there was an actual surplus of bombardier graduates from the Flying Training Command schools. It appears that by the end of 1942 individual bombardier training in the air forces was largely confined to the Third Air Force, where the second stage of dual training was given to some men, for example, B-8 bombardier

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28. CG, 4th AF to CG, AAF, 8 Nov. 1942, in files of AFACT-2, 353, Bombardiers.
29. CG, 12th AF to the Commander in Chief, Allied Force Headquarters, 4 Jan. 1943, in ibid.
30. 1st Ind. (CG, 12th AF to Commander in Chief, Allied Force Hq., 4 Jan. 1943), AC/AS, Training to CG, 12th AF, 11 Feb. 1943, in files of AFACT-2, 353, Bombardiers.
31. R&R, AFRIT to AFDMR, 19 Feb. 1943, in AAG 352.11 A, Courses of Instruction.

training to graduate navigators and dead-reckoning navigation to graduate bombardiers. It seemed probable the latter type of training would soon cease, or virtually cease, since all future bombardiers were to be trained also as dead-reckoning (DR) navigators.

Evaluation of Training in Tactical Units

It is pertinent here to attempt an evaluation of the individual training of bombardiers performed by the combat units. Relative to the training of their own personnel, enlisted men and some officers, this study offers no basis for an evaluation, though there appears to be a general opinion to the effect that bombardiers trained in the Flying Training Command schools were better trained than those receiving training in the group schools. But relative to the training of bombardier cadets assigned to combat units from the bombardier preflight schools, the evidence seems to be overwhelmingly in favor of the instruction given in the specialized schools.

Conditions which prevailed in the Second Air Force may be representative. After 70 of the 150 cadets who were to be trained by the Second Air Force were in training, the Flying Training Command was instructed to have the director of training at one of the bombardier schools contact the Second Air Force to see that the instruction there paralleled that given in the Training Command schools. Uniform instruction was needed in order for the cadets to be commissioned upon completion of the course. Accordingly, Capt. George A. Gilbert, acting director of flight training at

Albuquerque bombardier school, was sent on temporary duty to Ft. George Wright, Washington, for this purpose. Captain Gilbert reported to the commanding officer at Albuquerque that he had found two non-rated officers, assisted by three bombardier instructors, running the school for the 70 students. Part of the students had been sent on 9 June and the others on 30 June, but he was informed that it would be impossible to begin bombing missions before 1 August and that it might require five or six months to accomplish their training. There was an obvious and acute need for both instructors and bomb trainers. The Second Air Force held that its operational training had to come first, and the cadets would have to wait, in spite of the fact that the air force had requested permission to train the men. Consequently, Captain Gilbert returned to Albuquerque.[32]

After the last group of 40 (of the 150 to be trained by the Second Air Force) arrived for training, the Directorate of Bombardment informed the Directorate of Individual Training that the Second Air Force was unable to train them and advised that they be sent to flexible gunnery schools.[33] Because of the lack of training facilities, the Second Air Force finally placed the group of 70 cadets as "secondary bombardiers under [the] supervision of commissioned bombardiers."[34] The last group of 40 were, as late as

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32. Capt. George A. Gilbert to CO, Albuquerque Bombardier School, 27 July 1942, in files of AFACT-2, 353, Bombardiers.
33. Daily Diary, AFRIT, 23 Aug. 1942, in AAG 319.1-3, Daily Diaries.
34. Ibid., 11 Sep. (or 12), 1942.

15 September, "still sitting at [the] 2nd AF which [was] unable to train them." The gunnery schools were then full, and the Directorate of Individual Training instructed the Flying Training Command to assign them to the bombardier schools to await the next class.[35] Obviously, neither the personnel, materiel, nor essential functions of the domestic air forces lent themselves to the individual training of bombardiers.

35. Ibid., 15 Sep. 1942.

Chapter III

ADVANCED BOMBARDIER TRAINING IN AIR CORPS SCHOOLS

Trial and Error, July 1940 to January 1942

The record of experience of advanced bombardier training in the specialized schools under the jurisdiction of the Chief of the Air Corps from July 1940 until the fall of 1942 is much like that of other AAF functions under the stress of the expansion program. It is the record of an almost frantic effort to accomplish constantly rising objectives in the face of acute shortages of all the means necessary for the fulfillment of the assigned missions. As the AAF expansion program advanced, training objectives followed one another in rapid succession, but there were neither training establishments, training materiel, nor instructor personnel with which to train the thousands of men required in each category of specialized training. Shortages of personnel and facilities were especially acute in the training of non-pilot airerew members. The first specialized school for bombardier training, Barksdale Field, La., was not opened until two years after the beginning of the expansion program in early 1939. And it was still another year before bombardier training can be said really to have got under way with the closing of Barksdale and Ellington as advanced bombardier schools and the initiation of such training at Albuquerque, N. M. and Midland, Tex. in early 1942.

The first bombardier training conducted by the Chief of the

Air Corps was done at Lowry Field. It was felt that the most immediate need was for bombardier instructors, and the first three classes of bombardiers at Lowry were enlisted men who were trained for that purpose. The first of these classes started on 16 July 1940, and the third class finished training about 15 March 1941. A total of 122 men graduated from these bombardier instructor classes, which were followed by one "test class" of cadet bombardiers from which 54 men graduated. The training of the bombardier instructors was originally planned as a 12-week course but was extended to 16 weeks, while the course of instruction for the test class of cadets was limited to 10 weeks.

Weather conditions at Lowry were not suitable for flying training, and after the graduation of the four classes, instruction was transferred to Barksdale Field. Training began at Barksdale on 5 May 1941, the first class of 32 graduating on 11 July 1941. Three additional classes were graduated, the last two on 28 November 1941. A total of 144 graduated in the four classes. From the very beginning of training at Barksdale it was obvious that the climate there was little, if any, better suited for flying training than at Lowry, and plans were drawn to establish bombardier schools in Texas where weather conditions were more conducive to the flying phase of bombardier training. Accordingly, Ellington Field was selected, and instruction began on 4 October 1941, with the first class graduating on the following 27 December.[1] Again, however, the site proved to be poor for bombardier

1. Preflight bombardier-navigator training was begun at Ellington on 11 Oct. 1941. Asst. C/AS to CG, GCACTC, 16 Sep. 1941, in AAG 353.9 C, Training, General.

training. Weather conditions were unsuitable, and only the one class of 26 was trained at this school. Thus, by the end of 1941 three schools had been experimented with, the quantitative results being 122 bombardier instructors and a total of 204 cadet bombardiers graduated. It could hardly be said that the program for bombardier training was even well begun, though some expensive lessons had been learned.

Training Goals and Establishment of Schools

In mid-1940 the annual production rate requirement for bombardiers was approximately 1,800, and in December 1941 training to correspond with the 30,000 pilot program was initiated. The annual production rate called for by this program was 5,590 bombardiers. It was obvious that new schools would have to be opened and located in the southwestern part of the country where weather conditions would be conducive to flying training. The decision was made to discontinue all bombardier training at Barksdale and to confine training at Ellington to the preflight phase. In December 1941 Albuquerque Air Base, Albuquerque, N. M., was transferred from the jurisdiction of the Air Force Combat Command to the West Coast Training Center and opened as an advanced bombardier school. The schools at both Barksdale and Ellington were transferred to Albuquerque until the new bombardier school at Midland, Tex. was opened in February of 1942. The personnel that had been at Ellington was moved to Midland to constitute the original group at that school.

During the remainder of 1942, as the training program advanced to the 30,000 pilot program (11,016 bombardiers) and then to the

70,000 pilot program (14,000 bombardiers), bombardier training facilities were greatly expanded. The bombardier school at Victorville, Calif. opened and began instruction about March, and in June schools were opened at Roswell, N. M. and Higley, Ariz. In the following September, schools were opened at Big Springs, Tex., San Angelo, Tex., and Hobbs, N. M. In October a D-8 bombardier school was opened at Carlsbad, N. M., and in December the school at Deming, N. M. began instruction. A Central Bombardier Instructors school was established at Carlsbad in January 1943, and the next month a bombardier school opened at Childress, Tex.

With the opening of new training establishments in 1942, bombardier production showed a rapid increase. The number of bombardiers graduated, by periods, follows: 1 March to 3 June, 671; 4 June to 28 September, 1,931; 29 September to 31 December, 3,079 — a total of 5,681, or a monthly average of 568. By the latter date there was an actual surplus of individually trained bombardiers. In January 1943, when 1,697 bombardiers were graduated, the requirement of the air forces for that month was only 200.[2] The bombardier schools had finally reached the point where they could more than supply the needs of the operational training units. The production figures more than doubled during the first half of 1943, when a total of 7,928 graduated — an average monthly rate of 1,321. By 31 October 1943 the bombardier schools had graduated a cumulative total, since May 1941, of 19,058, not in-

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2. See Chap. I.

cluding 891 B-8 bombardiers.[3]

Program of Instruction in Advanced Bombardier Schools

--Ground Training

One of the important phases of the history of bombardier training is the evolution of the program of instruction used in the advanced stage. The program of instruction used at Lowry in the bombardier instructors' course was the first one used in Air Corps schools in the training of bombardiers. This program was prepared, it appears, in the early summer of 1940 for use in instructing the first class, which entered training on 15 or 16 July. About a month before instruction began at Lowry, the Chief of the Air Corps requested the commanding officer at that school to forward a "breakdown of the academic work required" in the course. The information sought was to be used in preparing the curriculum for the advanced bombardiers' course in the specialized schools which were to be opened. It was the opinion of the Chief of the Air Corps "that the course for the bombardiers should be the same as the course for the instructors, except for the time allotted to each subject."[4]

In compliance with this request, the Assistant Commandant at Lowry forwarded the following tentative program of instruction

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3. U.S.AAF Graduates from Non-Pilot Flying Training Schools, 17 Apr. 1943, prepared by AFMSC, in AFIHI files; Consolidated Flying Training Report (Monthly), AFFTC, in AFIHI files; cf., chart following p. 88.
4. C/AC to CO, Lowry, 8 June 1940, in AAG 353.9-1A, Bombsight Training.

for the 16-week course:[5]

a. Six weeks ground instruction to include the following:
   (1) Theory of bombing — 32 hours
   (2) Gyroscopes — 16 "
   (3) Electricity — 16 "
   (4) Trainer study — 8 "
   (5) Clock — 8 "
   (6) Bomb ballistics, forms and regulations — 32 "
   (7) Bombsights — 128 "
b. One week on bombing trainer — 10 "
c. Eight weeks of air training
   (1) 34 missions of 3 hours each
      (a) 2 dry runs
      (b) 32 bombing missions -- 4 bombs per student per mission, or a total of 128 bombs per student
d. One week devoted to the following:
   (1) A.F.C.E. [Automatic Flight Control Equipment] — 16 "
   (2) Bombs and bomb racks — 16 "
   (3) Pedagogy — 8 "

After further consideration at Lowry and after receiving advice from members of the Air Corps Board, a revised program of instruction was substituted. Under the new program, still considered tentative, the authorities at Lowry reserved the right to "vary from it in order to adjust the training to the mental capacity of the students assigned to the course and to insure their absorbing the more important phases of it in the time allotted." The revised program was outlined as follows:[6]

1. Ground Training	Approximate Hours
(a) Laws of physics	4
(b) Theory of bombing	8
(c) Theory of bombsights	4

(contd.)

5. 1st Ind., Asst. Commandant, Lowry to C/AC through Commandant, Chanute, 17 June 1940, in ibid. This program was forwarded by the C/AC to the Commandant of the Air Corps Tactical School at Maxwell Field.
6. Asst. Comdt., Lowry to C/AC through Comdt., Chanute, 25 July 1940, in ibid.

1. Ground Training (contd.)	Approximate Hours
(d) Bombing technique	4
(e) Military instruction	60
(f) Electricity	4
(g) Bombing trainers	12
(h) Instruments and their calibration	6
(i) Use of computers and conduct of missions	6
(j) Forms	8
(k) The "M" Series bombsights	40
(l) Gyroscope	8
(m) Elementary navigation	8
(n) A.F.C.E. theory	44
(o) Scoring method	8
(p) Bomb racks control, bombs and fuses	16
(q) Causes of errors and analysis of results	8
(r) Train, formation, through clouds, and overcast bombing, bombing with assumed defective bombsight	8
(s) Theory of probabilities and bombing accuracy	12
(t) Bombing tactics	12
(u) Pedagogy	8
(v) Examination on listed subjects	60
Total hours Ground	348

2. Bombing. Trainer practice
3. Air instruction

Dry runs	40 per student
Bomb releases	200 per student

With this revision the course of instruction for bombardiers took on the general form, including content materials, which characterized all the future programs. Other programs, however, shifted the allotted time for various phases of instruction and occasionally added or deleted subjects. Just prior to the adoption of the above program, aerial gunnery was added to bombardier training.[7] It would seem, however, that such training, if given, was of a very incidental nature; it does not appear on any of the programs

7. 6th Ind. (basic unknown), OCAC to AG, 16 July 1940, in AAG 353.9, Training, General.

of instruction, except that in the case of the one class of cadets trained at Lowry the tentative curriculum included 46 hours of gunnery.[8] Two years later, however, in July 1942, it was directed that bombardier and navigator trainees be given flexible gunnery "to the extent that the facilities at flexible gunnery schools will permit."[9] The training was to be given between classification and preflight or between preflight and advanced training.[10] It was not possible to enter all students in the gunnery schools, however, and the others had to wait until their operational training for instruction in gunnery.

The first class of bombardier instructors was still in training when the Assistant Chief of the Air Corps informed the Commanding General, Southeast Training Center that "all officer bombardiers be qualified as Air Force Reconnaissance Observers and that proper instruction that will insure attainment of this objective be given in connection with the bombardier course at the flying schools that may be concerned." It was therefore requested that the existing program of instruction be revised to include such training for officer trainees. The suggestion was made that 40 hours be allotted to the subjects which would make up this phase of bombardier training and that the following topics be included: "Bombardment Objectives, Anti-Aircraft Defense, Employment and Organization of Ground

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8. Director of Bombardier Instruction, Lowry to CO, Lowry, 3 Jan. 1941, in AAG 353.9-1A, Bombsight Training.
9. AFRIT to CG, AFTTC, 27 July 1942, in AAG 353.9 B, Bombardiers, Gunners.
10. Daily Diary, AFTTC, 4/Aug. 1942; AFRIT to CG, AFTTC, 10 Aug. 1942, in AAG 353.9 B, Bombardiers, Gunners. and 17

Forces, Employment of Naval Forces, Aerial Photography, Maps, Codes, Recognition of Flags of all Nations, Reports."[11] In line with this suggestion, 47 hours of "Aircraft Observer Training" were incorporated in the program of instruction:[12]

(1) Bombardment Objectives	4 hours
(2) Aerial photograph and map reading	6 "
(3) Codes	6 "
(4) Operating procedure and reports	2 "
(5) Identification of aircraft	4 "
(6) Meteorology	17 "
(7) Navigation	8 "

After the three classes of bombardier instructors had been trained, consideration was given to running a test course for flying cadets. Plans for this course were delayed somewhat since there was considerable doubt as to whether bombardier training at Lowry would be continued. A decision was made, however, to conduct a 10-week "Service Test Course." A program of instruction was prepared in the Training and Operations Division, Office, Chief of the Air Corps, and Lowry Field was also requested to submit a plan for the course.[13] The curriculum prepared by the Training and Operations Division was forwarded to Lowry, through Chanute, on 24 January 1941. Three weeks before, the director of the department of bombardment at Lowry had submitted a tentative curriculum to the commanding officer at that field. The curriculum prepared by the Training and Operations Division has not been found, but the

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11. Asst. C/AC to CG, SEACTC, 26 Sep. 1940, in AAG 353.9, Bombing Training, Gunners.
12. Program of Instruction--Training of Aerial Bombardiers for Military Students to be given in Air Corps Advanced Flying Schools, 30 Dec. 1940 and subsequent revisions to 13 Nov. 1941, in AFINI files.
13. CO, Lowry to C/AC through Chanute, 6 Jan. 1941, in AAG 353.9-1A, Bombsight Training.

tentative curriculum prepared at Lowry provided for the following breakdown:[14]

1.	Basic theory	24 hours
2.	Bombing accessories	24 "
3.	Bombsights	52 "
4.	A.F.C.E.	20 "
5.	Scoring and analysis	16 "
6.	Bombing procedure	20 "
7.	Gunnery	46 "
8.	Bombing	60 "
9.	Examinations	32 "
10.	Military training	32 "
		294 hours (not including examinations)

The test course at Lowry was essentially a laboratory experiment which, with the experience gained from the previous training of bombardier instructors, was to be the basis for the preparation of the curriculum for the specialized bombardier schools soon to be opened at Barksdale and Ellington. Work was begun on the preparation of a new program of instruction before the test class had finished training. On 26 March 1941 a board of officers, made up of representatives of the GHQAF, the Gulf Coast Training Center, and the Office, Chief of the Air Corps, convened at Randolph Field for the purpose of making recommendations for a new bombardier training curriculum. On the basis of the recommendations of this board and the experience gained at Lowry, a program of instruction was drawn up and forwarded to the Commanding General, Air Corps Technical School at Chanute Field, who approved it and forwarded it to the

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14. Director of Department of Bombardier Instruction, Lowry to CO, Lowry, 3 Jan. 1941, in ibid. See Appendix 2 for a complete breakdown of this program of instruction.

Office, Chief of the Air Corps.[15]

This new program of instruction substituted a 12-week course for the 10-week test course. The principal difference in content was in the flying training phase. The required number of bomb releases might vary from a minimum of 145 to a maximum of 200, depending upon weather conditions. If bad weather conditions prevailed, the student might complete at least the qualification stage of bombing with 145 releases. If "ideal" weather prevailed, an additional three weeks of tactical bombing would be accomplished with the remaining 55 bombs.[16]

The commanding officer at Lowry Field believed that under the 12-week course 60 per cent of the students would "qualify for graduation and assignment as tactical bombardiers." He also felt "that regardless of the lengthening of the course . . . this percentage of qualification cannot be exceeded."[17] It is difficult to see the basis for expecting a 40 per cent elimination rate in bombardier training, especially if the course were lengthened to 12 weeks as recommended. The elimination rate in the test class was only 32 per cent, and in the 16-week course for bombardier instructors the elimination rate for the three classes was only 11.7 per cent. Also, the high elimination rate in the test class should be evaluated in the light both of the brevity of the course and the fact that 40 per

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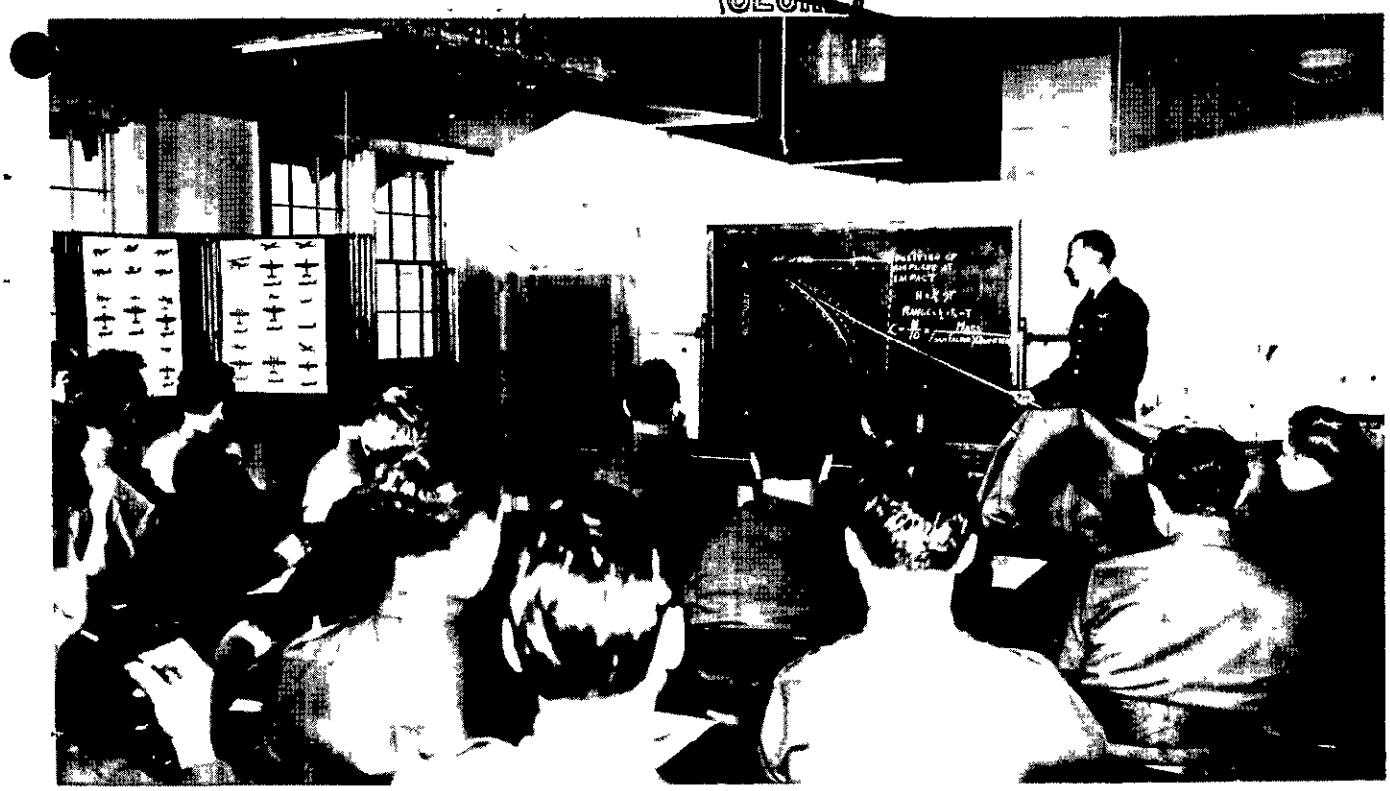
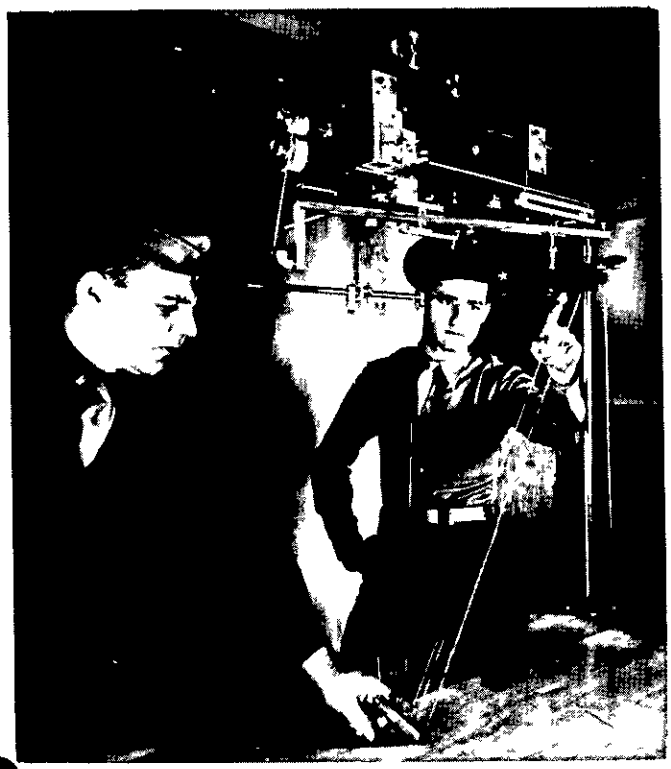
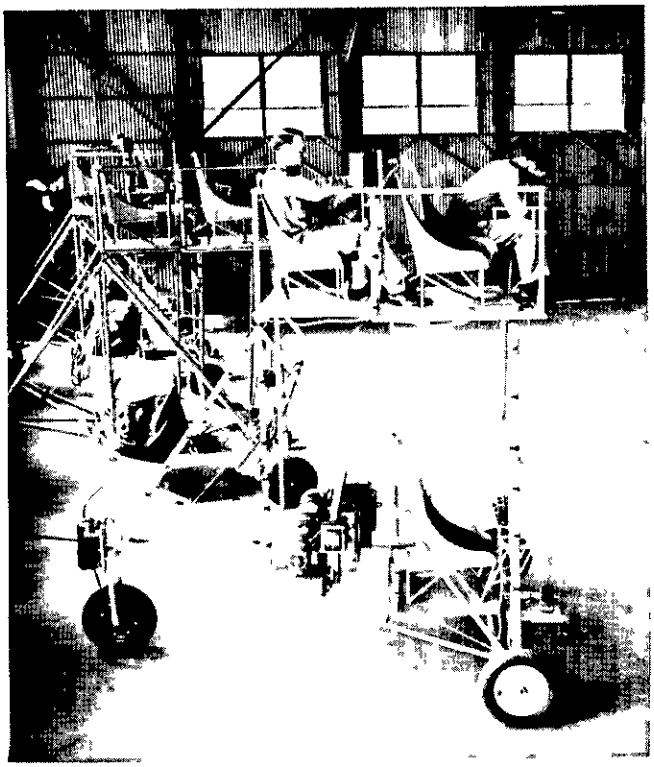
15. CO, Lowry to CG, ACTS, Chanute, 4 Apr. 1941; 1st Ind., CG, Air Corps Technical Training Command to C/AC, 12 Apr. 1941, in ibid.
16. Ibid.
17. Ibid.



A ground school instructor illustrates the theory of bombing, explaining the operations of the factors which determine the bomb trajectory, such as atmosphere, head wind, tail wind, and air speed.



By means of this bomb illustrator, the instructor gives a physical demonstration of the dropping angle.



The bombardier trainee gets instruction and practice in simulated bomb releases on A-2 bomb trainer.

cent of the days allotted to bombing were lost because of weather conditions.

Upon receipt of the final report from Lowry on the Service Test Course, the Commanding General, Southeast Training Center was informed that the program of instruction recommended by the director of the bombardier school at Lowry should be followed in the instruction of the class then entering training at Barksdale. The course, however, should remain a 10-week course until further notice, and qualification as third-class bombardier should continue as the requirement for graduation.[18]

The first bombardier training to be conducted in specialized bombardier schools under the Chief of the Air Corps was at Barksdale Field, where the first class entered training on 3 May 1941 with a class of 41 students. The exact program under which training began at Barksdale has not been ascertained, but a program of instruction with revisions of 23 May and 13 November 1941 is outlined below. The November program lengthened the course to 12 weeks, which change was authorized in September 1941.[19] Three weeks were allotted to preliminary ground training, six to ground and air training, and three to air training including tactical bombing and reconnaissance missions. The total of 373 hours of ground training were allocated as follows:[20]

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18. C/AC to CG, SEACTC, 2 May 1941, in AAG 352.11, Denver, Course of Instruction.
19. C/AC (TSO) to CG, Maxwell Field, 10 Sep. 1941, in AAG 352.01 B, Establishment of Schools. The revision of 23 May 1941 was made on the basis of the report on the training conducted at Lowry.
20. Program of Instruction . . . for Military Students to be given in Air Corps Advanced Flying Schools, 13 Nov. 1941, in AFHRI files.

1.	Basic theory	20 hours
2.	Bombing accessories	28 "
3.	Bombsights	33 "
4.	A.F.C.E.	18 "
5.	Scoring and analysis	28 "
6.	Bombing procedure	114 "
7.	Aircraft observer training	47 "
8.	Athletics and military training	85 "

Air training was to receive 85 hours; the qualification bombing course was to consist of 145 bomb releases and the tactical course of 55. The degree of proficiency required in all ground courses under this program of instruction was 75 per cent. In all the succeeding programs this was reduced to 70 per cent.

The end results at Barksdale were quantitatively little better than at Lowry. Four classes were graduated with a total of 144 graduates and 43 eliminations. This constituted an elimination rate of 29.8 per cent as compared with the 32 per cent at Lowry.

The program of instruction as revised in November 1941 continued in effect until replaced by a new program, dated 20 August 1942. By that time five new bombardier schools (Albuquerque, Midland, Victorville, Williams, and Roswell—in the order named) had been activated and were in operation. As a result of the training experience under the November program and after a Bombardier Training Conference at Headquarters, Flying Training Command, Fort Worth, Tex., on 4-7 August 1942, the program of instruction was revised.[21] In the new program the flying instruction remained the same except that the number of qualification bombs was decreased from 145 to 120 and the

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21. Program of Instruction, Training of Aerial Bombardiers, For Military Students to be given in Army Air Forces Bombardier Schools, 20 Aug. 1942, in AFHRI files.

number of tactical bombs increased from 55 to 80 per student. An additional change, which does not appear in the program of instruction, had been made in June 1942 in the tactical bombing phase. At that time the Directorate of Individual Training had directed the Flying Training Command to include in the curriculum instruction on fusing, handling, loading, and dropping of live demolition bombs, with the requirement that each student drop one demolition bomb.[22]

Ground training constituted 61.4 per cent of the entire program of advanced training in the August 1942 revision. Although the total hours allotted to ground instruction were only reduced by one hour, several changes were made in the program: (1) The "Basic Theory" phase was changed to "Basic Theory and Bombsights" and the allotted time was increased from 20 to 28 hours. This change was necessitated by the initiation of training on Sperry equipment. This phase of training now included instruction on the D-8 sight, the M series (Norden) sight, and the S-1 (Sperry) sight. The topic of "gyroscopes" was eliminated as a separate subject. (2) On the "Bombing Accessories" phase, the instruction in altitude indoctrination was shifted to the preflight schools, and topics were added on intervalometer, aerial cameras, radio procedure, and the duties of the aerial engineer. The study of "forms" was shifted, and the hours were increased from 28 to 32. (3) In the "Bombing Procedures" phase the 70 hours which had been allotted to the holding of critiques were eliminated. (4) "Scoring and Analysis" became "Bombing

22. Daily Diary, AFFTC, 10 June 1942.

Analysis," and the allotted time was reduced from 28 to 19 hours. (5) The "Aircraft Observer Training" phase was drastically changed, with a reduction in total hours from 47 to 38. Aerial photographs and map reading, codes, aircraft identification, and meteorology were transferred to the preflight schools. The time devoted to navigation was increased from 8 to 20 hours. (6) The "Bombsights" phase, to which 33 hours had been allotted, was eliminated as such, the subject matter being treated elsewhere. (7) Instruction on Automatic Flight Control Equipment (A.F.C.E.) was reduced from 18 to 8 hours. (8) The phase of training allotted the largest increase in instructional time was "Athletics and Military Training." Athletics was increased from 39 to 72 hours, while military instruction was decreased from 46 to 36 hours, a net increase for the combined subjects of 23 hours. (9) A new phase of instruction was added on "Bombsight Maintenance and Calibration," to which 36 hours were allotted.[23]

At the time this program of instruction was adopted, there was still an acute shortage of bombardiers. Methods of meeting this shortage were discussed at the Fort Worth conference on bombardier training. One of the possible means of expediting bombardier production was to place training on a seven-day week basis in order to utilise completely training equipment. Instruction would be staggered so that each student would have one day a week for rest.

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23. Program of Instruction, Training of Aerial Bombardiers, For Military Students to be given in Army Air Forces Bombardier Schools, 20 Aug. 1942, in AFHRI files.

This proposal, however, was not approved. Another plan was to reduce the length of the course from 12 to nine weeks, thereby stepping up school productivity by approximately 33 per cent. This proposal, it appears, did not receive very serious consideration. Still another possibility of meeting the urgent demand for bombardier production, and one which was put into operation about two months later, was discussed. This plan called for opening a special school to train D-8 bombardiers for use in the Third Air Force. Such a school was opened at Carlsbad, New Mexico where instruction began on 3 October.[24]

The 20 August 1942 program of instruction remained in effect until January 1943 when it underwent another revision, with only minor changes in the ground instruction but with more important revisions in the air training phase. The changes effected were the results of the Bombardier Training Conference held in the Headquarters, Flying Training Command, on 14-18 December 1942. This conference, attended by representatives of the Directorate of Individual Training, the Directorate of Bombardment, the Proving Ground Command, the Second and Third Air Forces, the Flying Training Command, and the bombardier schools, gave special consideration to the Central Bombardier Instructors School, the revision of TM 1-250, qualification standards for D-8 bombardiers, and combined bombardier and celestial navigator training. The changes made in the ground phase of instruction were: (1) "Bombing Accessories": the time allotted to instruments and their calibration was reduced from five hours to two and

24. Memo for Col. L. S. Smith (AFRIT) by Maj. E. H. Herzog, 11 Aug. 1942, in AFHRI files.

that devoted to radio operation from two hours to one. (2) "Bombing Procedure": six hours on "Trainer operation (combat)" were added to this phase. (3) "Aircraft Observer Training": the time allotted to navigation was reduced from 20 hours to eight. Six hours of this 12-hour reduction were allotted to aircraft identification (the Renshaw system).[25] It is difficult to understand this reduction in navigation instruction, unless it was based on the full expectation that the dual training of bombardier-navigators was to be initiated at once. For two years the desirability and possibility of initiating such training was under consideration. It would appear that this reduction of navigation instruction was somewhat premature; only small numbers of men actually received dual training, and training in bombardier/dead-reckoning navigation for all bombardiers was not begun until the summer of 1943. (4) "Athletics and Military Training": a marked reduction was made in the time allotted to military instruction, the hours being reduced from 36 to 12. Also, seven hours were allocated for a new subject in this phase of training, First Aid. The total time devoted to this phase was reduced from 108 to 91 hours. (5) Significant increases made in this program:

a.	Preflight preparation	50 hours
b.	Supervised study	30 "
c.	Administration	20 "
d.	Sperry training (for Midland)	29 "

Training on Sperry equipment had been planned early in 1942, but

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25. The Renshaw system of identification was considered definitely superior to the older WEFT (wings, engine, fuselage, and tail) system and was therefore incorporated in the new program of instruction. The August 1942 program of instruction had not provided for any recognition training.

shortages of sights, planes in which they could be installed, and personnel for this type of training were such that this could not be done. This training was concentrated at Midland, and the first class with "some" Sperry training was scheduled to graduate on 23 January 1943.[26]

The total hours of instruction under this program, exclusive of that on Sperry equipment, was 461 hours, an increase of 89 hours over the previous program. This program was superseded by another dated 19 April 1943, which, however, did not make any changes in either subject matter or time allotment, but merely indicated the standards of proficiency to be attained on certain phases of instruction. With these modifications the program of January 1943 remained in effect until the following June, when it was superseded by the 18-week bombardier/dead-reckoning navigator course.[27]

Program of Instruction in Advanced Bombardier Schools-- Air Training

The air training of bombardiers, only briefly referred to in the above description of the changing programs of instruction, began in the fourth week and continued throughout the remainder of the 12-week period. The requirements, standards, and regulations governing the air training of bombardiers were set forth in TM 1-250. The program carried out in line with this manual

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26. 1st Ind. (basic of 5 Dec. 1942 not found), CG, AFTTC to CG, AAF, 22 Dec. 1942, in files of AFACT-2, 353, Bombardiers.
27. See Appendix 4.

was as follows:

The air training of bombardiers was divided into two stages, the qualification stage and the combat, or tactical, bombing stage. The purposes of qualification bombing, referred to as "course 1," were to provide the initial instruction and to "develop a proper technique and a reasonable degree of skill in operating the bomb sight and accessory equipment." The course was also designed to ascertain whether or not the trainee was capable of developing into an efficient combat bombardier or should be considered for elimination. The instruction in this phase of training varied from time to time with the results of training and combat experience, the supply of practice bombs, and the discretion of the instructors and the directors of training.

Under the November 1941 program of instruction 145 bomb releases were allotted to this stage of instruction. In August 1942 this number was reduced to 120 and in January 1943 further reduced to 90, partly because of an acute shortage of bombs. Of the bombs allotted to the qualification stage, 40 were used as instructional bombs, and the remainder were scored for qualification purposes, the instructional bombs being interspersed throughout the qualification period. The first combat mission was flown and 20 of the qualification bomb releases were made without an instructor in the airplane. The number of bombs to be released, the various altitudes, the types of targets, and whether bombing missions were to be by day or night were specified in the manual.

The bombardier was required to inspect the bombs delivered to

him and to assume responsibility for any malfunction in dropping. Several training factors were left to the discretion of either the bombardier or "local authorities." These included the sequence of altitudes; speed during approach and release; sight synchronized or fixed; bomb rack control; use of bombing approach control; weather, visibility, and turbulence; and direction of approach (except that the angles between approaches could not be less than 30°). "Fouls" were imposed for certain malfunctions. The penalty for each foul was the addition of 10 per cent "to the measured circular error. . . of the releases for that mission, not to exceed five releases." The standard of proficiency prescribed for qualification bombing was a circular error of 230 feet when converted to an altitude of 12,000 feet. If the error exceeded this distance, the trainee was considered for elimination.

The combat stage of bombing, "course 2," had as its mission the improvement of the proficiency of the bombardier and the securing of "a diversity in bombing training with respect to conditions, so that tactical units may be more fully trained to accomplish any type of bombing" which combat conditions might require. Consequently, the regulations applicable to this stage of training were left to the discretion of the organization commanders. The number of bomb releases allotted to this stage of training shifted from 55, under the November 1941 program of instruction, to 80 under the August 1942 program, to 60 under the January 1943 program. The same options allowed in qualification bombing (as to speed and direction of approach, type releases, etc.) were also allowed in combat bombing. However, no fouls or penalties were imposed in

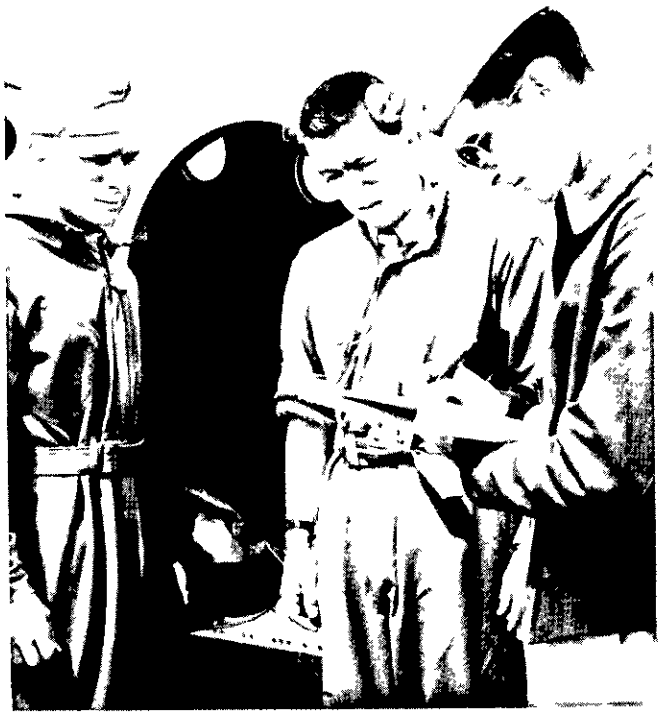
this stage of training. Twenty-five instructional bombs were allowed but all of the 60 combat bombs were scored and no malfunctions were permitted. The first combat mission was flown and 30 of the combat bombs released without an instructor in the airplane. Combat bomb releases were scored on the basis of circular error until early in 1943 when the basis of scoring was changed to hits and misses. As a matter of record, however, the circular error of combat releases was still computed.

The change in the basis for scoring combat bombs was made as a result of consideration given to the problem at the bombardier conference held in Headquarters of the Flying Training Command, 14-18 December, 1942. It was the feeling of the conference that the circular error basis for scoring was not conducive to maintaining in the trainee sufficient interest in improving his skill. Once the trainee had passed his qualification stage, he was inclined simply to maintain a satisfactory circular error rather than to be constantly challenged to become a more accurate bombardier. It was felt that there should be built "in the student's mind a more active combat spirit, and to train him in bomb selection on the basis of the effective radius of action of various bombs against various types of combat targets." For these reasons it was felt that the bombardier trainee should be made more keenly conscious of either hitting the target or missing it rather than merely maintaining a satisfactory circular error.[28] Since qualification scores were

28. Report on Bombardier Training Conference, Col. John P. Kenney, Chairman, to CG, AFFTC, 18 Dec. 1942, in AFHRI files.

Cadets check out cameras prior to a mission. Bomb releases are photographed for scoring purposes.

Instructor accompanies student on mission to check his procedures and give necessary instructions.



After each mission, the bomb-approach pilot goes over the flight record with the bombardier students.

Student learns how to fill out the forms necessary to maintain records of missions flown and bombs released.

established under the supervision of the Army Air Forces Proving Ground Command and since data on which to base a qualification score were not immediately available, a temporary score based on the hits attained by 90 per cent of the students in this phase of training was adopted.[29] After having made a study of combat bombing records, the Proving Ground Command recommended that the standard of proficiency tentatively be set at 22.5 per cent hits.[30] This standard was put into effect "tentatively" and was still in effect at the end of 1943.

It is difficult to compare or evaluate the scores made by different bombardiers, however, because of the lack of uniformity in scoring procedures at the various bombardier schools. Some schools used the scores of eliminees in computing the circular error of a particular class whereas others did not. Some schools were more rigid in imposing penalties than were others. There was a lack of uniformity in accepting estimates of bomb releases in the absence of photographs. Considerable variance also existed in the use of targets and overlays. Wild bombs were not scored alike in all schools. Also, some schools counted only record releases for certain computations while others counted the total releases.[31] Steps were taken, however, to effect uniformity in these practices. On

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29. Teletype, CG, AFFTC to AFRIT, 22 Jan. 1943, in files of AFACT-2, 353, Bombardiers.
30. CG, Proving Ground Command to CG, AFFTC, 6 Apr. 1943, in ibid.
31. "Inspection of Bombardier Schools under the Jurisdiction of this Command," 1-2, Air Inspector, AFTRC to CG, AFTRC, 19 July 1943, in AFIRI files.

16 August 1943, the Training Command issued a memorandum (50-11-4) which prescribed the rules to be followed in scoring bomb releases.

Bombardiers were rated according to their proficiency as either bombardier, master bombardier, or distinguished bombardier, the rating of "bombardier" being equivalent to the rating of expert gunner. The initial rating was of "bombardier" only and was given at the end of "course 3," the qualification course. The higher ratings were based upon scores made later in the combat stage of training or in actual combat bombing after training had been completed. The December 1942 conference went on record as being opposed to more than one rating as a result of school training, on the grounds that

> a student in a bombardier school cannot be measured only by the result of his bombing. His military aptitude, academic rating, mental attitude, etc., are all considerations which do not reflect accurately in his bombing score. Therefore, the conference members feel that all those students who have met the minimum standards in all departments should graduate and receive the same rating.[32]

No change was made, however, in the system of rating bombardiers.

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32. Report of Bombardier Training Conference, Headquarters, AFFTC, 18 Dec. 1942, in AFHRI files.

Chapter IV

DUAL BOMBARDIER-NAVIGATOR TRAINING IN AIR CORPS SCHOOLS

From the beginning of the expansion program, and especially after the development of the super-bomber, it was necessary to utilize the full capabilities of all aircrew personnel. This was desirable because of the pressing demand for trained personnel and in order to keep the pay load of the bombardment airplane at the maximum. One solution, of course, was to take a man trained in one specialty and give him an abbreviated course in some related field. He could then be used in a dual capacity. Out of this need for the most effective use of personnel came the adoption of a program of dual training of bombardiers and navigators. There is perhaps no more controversial aspect of bombardier training.

Numerous problems attended all efforts to perform dual training of bombardiers and navigators. With an almost constant shortage of trained men in one or the other or both specialties, there has been the difficulty of withholding from the air forces the men in the scarce category (which has been both categories during most of the period covered by the expansion program) while these specialists were undergoing the second category of training. At the same time there has been the problem of

securing men capable of being trained in both specialties. Another difficulty has arisen out of choosing the category in which training should be given first and deciding whether or not trainees should be commissioned at the end of the first stage of training or upon completion of the dual training.

Early Plans and Abandonment, 1941

Plans to combine the training of bombardier and navigator were made in September 1941. The annual production rate of such training was set at 5,500, and the bombardier and navigator schools were gradually to be integrated in order to perform dual training. It was recognized, however, that separate training would have to proceed until 1,388 bombardiers and 945 navigators, for the "First Objective" under the 54 Group Program, had been produced.[1] The plan for such training was approved, and on 19 November 1941, Military Personnel requested that a letter be issued by the War Department which would announce the immediate beginning of such training and prescribe the necessary qualifications to be met by trainees--the regular aviation cadet requirements.[2] The combined bombardier-navigator training was to be of 45 weeks' duration (including three weeks travel time between schools) and divided into four stages. The first stage was to

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1. R&R, No. 1, G/AS to G/AC, 26 Sep. 1941, in AAG 353.9, Specialized Training.
2. AFPMP to AG, 19 Nov. 1941, in ibid.

be a 10-week period of preflight training; in the second stage 16 weeks were to be allocated to navigator training; the third stage of 12 weeks was to be allotted to the bombardier course; and the last five weeks were to be devoted to flexible gunnery.[3] The first class scheduled for dual training entered the reception centers on 1 November 1941 and was to graduate on 1 August 1942.[4]

Upon the entry of the United States into war on 7 December 1941 this program of dual bombardier-navigator training for cadets was abandoned, and a "complete revision of course procedure, qualification requirements, and ratings of graduates" was made.[5] Consequently, bombardier training reverted to its former basis of specialized training of precision bombardiers. Training proceeded on this basis until mid-1942 when Brig. Gen. J. H. Doolittle recommended that "individuals be trained as navigator-bombardiers for medium bombardment."

Revival of Plans—
B-2 Bombardier and B/N Navigator

General Doolittle's recommendation was referred by the Directorate of Bombardment to the Directorate of Individual Training.[6] In turn, the Directorate of Individual Training requested

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3. WD Press Release, 5 Dec. 1941.
4. RAR, No. 6, 380 to AFPMP, 8 Nov. 1941, in AAG 353.9, Specialized Training.
5. Memo for AG by AFPMP, 13 Dec. 1941, in AAG 353.9, Specialized Training; Station Commanders' News Letter, 21 Dec. 1941.
6. RAR, AFRIB to AFRIT, 5 July 1942, in AAG 353.9-15, Bombsight Training.

the comments and recommendation of the Flying Training Command as to the feasibility of such training for men who were to be assigned to operational training for medium bombardment.[7] The Flying Training Command refused to recommend such training for several reasons: (1) Since it was "just as essential that the bombardiers hit the target in the case of medium bombardment as in heavy bombardment," the bombardier should be as proficient in the one case as in the other. (2) Since the range of medium bombardment approached, and occasionally exceeded, the range of heavy bombardment it was "essential that navigators for both types be proficient." (3) The results of such training would be to reduce by half the number of men who could be given such training. (4) The performance of the function of either bombardier or navigator on missions would fall below the required standard of proficiency. It was therefore recommended that training in the bombardier and navigator schools be continued as before, and that if such "curtailed" training were to be performed, it should be conducted in the operational training units. It was further recommended that for those medium bombardment airplanes which were to be equipped with the D-8 (low altitude, non-precision) sight, 75 per cent of the "desired personnel" should be basically trained as navigators and 25 per cent as bombardiers. The personnel to be assigned to medium bombardment airplanes equipped with Norden or Sperry sights should be trained in the

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7. AFRIT to CG, AFTTC, 6 July 1942, in ibid.

ratio of 75 per cent basically trained as bombardiers and 25 per cent basically trained as navigators.[8]

The Directorate of Bombardment did not concur in the comments and recommendations of the Flying Training Command, pointing out that the dual training of bombardier and navigator was not calculated to "increase operating efficiency." Rather, dual training was dictated by necessity based on the shortage of bombardiers and navigators. Such training "must be accomplished" if the medium bombardment units were to function at all. It was also pointed out that since medium bombardment airplanes would be equipped with the D-8 sight, priority on the precision sights and precision-trained personnel being given to heavy bombardment, precision bombing would be impossible in medium bombardment, regardless of training. Because of the shortage both of trained personnel and training equipment, which would "continue to exist for some time," it was held imperative that schools be established whose mission it would be to "train bombardier-navigators who will be proficient in the operation of D-8 bombsights, map reading, pilotage, and dead reckoning navigation." Although it was held that such training could not be "properly conducted" in the operational training units, it would be of necessity have to continue until there were enough trained bombardiers and navigators and until precision equipment could be made available for medium bombardment.[9]

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8. 1st Ind. (basic unknown), CG, AFFTC to AFRIT, 16 July 1942, in ibid.
9. RAR, AFRIT to AFDMR, 10 Aug. 1942, in ibid.

As a result of the recommendation of the Directorate of Bombardment that special schools be opened for training on the D-8 bombsight, a plan was approved for opening a school to conduct this type of training. The original plan called for training enlisted gunners who were to be selected from graduates of the gunnery schools or from the air forces. Training was to be confined to instruction on the D-8 sight. This was soon modified, however, to include "as much navigation training as possible," set at approximately 40 hours, which would be completed by the Third Air Force.[10] Upon graduating from this course, the trainees were to be rated as staff sergeants until they took "the precision course in either Bombardment or Navigation."[11] On 22 August 1942 it was directed that this type training be initiated.[12]

On 25 August the Flying Training Command was directed to select one of the bombardier schools which were scheduled to open on 26 September and, by diverting the preflight graduates scheduled for this school to other advanced bombardier schools, to open it as a D-8 bombardier school with a capacity of 400. The course of instruction was to last for four weeks with a class of 100 students entering each week. It appears that no personnel for this training were selected from the air forces, all of the trainees being procured from graduates of the gunnery schools. The Air Surgeon was

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10. Daily Diary, AFDMR, 26 Aug. 1942, in AAG 319.1-3, Daily Diaries; AFRIT to AFFTC, 26 Aug. 1942, in files of AFACT-2, 352, D-8 Bombardiers.
11. R&R, AFDMR to AFAAP, 20 Aug. 1942, in AAG 353.9-18, Bombsight Training.
12. R&R, AFACT to AFRIT, 22 Aug. 1942, in ibid.

requested to formulate the necessary aptitude tests and select the personnel for D-8 training.[13] On 19 September the Flying Training Command was instructed to have the public relations officers publicize this new course of instruction and its opportunities, pointing out that "This is the first opportunity that Enlisted Men have had to become Bombardiers in so short a time."[14] The bombardier school at Carlsbad, N. M. was selected for this training, and 105 graduate gunners began training on 3 October 1942.[15]

The original program for D-8 training comprehended only the training of enlisted men (gunners) as D-8 bombardiers for the Third Air Force. In September 1942, however, the Directorate of Individual Training suggested to the Directorate of Bombardment that navigators who were to be assigned to the Third Air Force could also be given training on the D-8 sight at Carlsbad. Since the school was to be operated for enlisted men, the training of officer navigators would require some special provisions for instruction, but such training could be performed.[16] At this time the Third Air Force was committed to the training of 150 precision bombardiers in addition to the job of qualifying officer navigators as D-8 bombardiers and officer bombardiers as dead-reckoning navigators. This was thought to be an excessive training load, in view of the normal task of operational training.[17]

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13. AFRIT to CG, AFFTC, 25 Aug. 1942, in files of AFAOT-2, 352, D-8 Bombardiers.
14. Ibid.
15. Daily Diary, AFRIT, 23 Sep. 1942, in AAG 319.1-3B, Daily Diaries.
16. Daily Diary, AFRIT, 24 Sep. 1942, in ibid.
17. Deputy Director of Bombardment to CG, 3d AF, 27 Sep 1942, in AAG 353.9-1B, Bombsight Training.

In the light of this condition, the Directorate of Individual Training, on the day before the training of D-8 bombardiers began at Carlsbad, pointed out the desirability of having navigators for the Third Air Force proficient on either the D-8 or T-1 sight and requested comments on the feasibility of performing such training for officer graduates at Carlsbad. It was suggested that this instruction might begin in December.[18] The Flying Training Command indicated that the training could be performed on certain conditions: (1) the number of gunnery trainees should be reduced by the number of navigators to be trained; (2) navigators should be entered at the rate of 100 every three weeks; (3) the necessary instructors, pilots, and training equipment should be provided. It was suggested that the course consist of 91 hours of instruction given in 15 days, and it was indicated that no longer course would be necessary for training on the T-1 sight.[19]

Regarding the initiation of D-8 bombardier training for graduate navigators, the Directorate of Bombardment informed the Directorate of Individual Training that since medium bombardment was to be "furnished one officer navigator per flight," it would "not be necessary to give D-8 bombardier training to one hundred (100) officer navigators every three weeks." It was recommended, however, that the navigators assigned to the Third Air Force for December, January, and February be trained as D-8 bombardiers.[20] Accordingly, the

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18. AFRIT to CG, AFFTC, 2 Oct. 1942, in files of AFACT-2, 352, D-8 Bombardiers.
19. 1st Ind. (AFRIT to CG, AFFTC, 2 Oct. 1942), CG, AFFTC to AFRIT, 19 Oct. 1942, in ibid.
20. R&R, AFRDB to AFRIT, 5 Nov. 1942, in AAG 352.11 A, Courses of Instruction.

first class of navigator/D-8 bombardiers began training at Carlsbad on 28 December 1942 and graduated on 16 January 1943. Only 225 men were given this type of training, and the last class graduated on 27 February 1943.[21] In the meantime, because of the decision to assign the duties of bombardier and navigator in medium bombardment to one officer, there was no longer a requirement for training enlisted men as D-8 bombardiers.[22] This type of training was terminated with the class which graduated on 19 December 1942, after a total of 666 men had been trained.[23]

At the periodic bombardier training conference held on 14-18 December 1942, the problem of training men to be assigned to the Third Air Force was discussed, a representative of this air force being present. The training of enlisted men as D-8 bombardiers was being terminated at that time, and the training of a small number of graduate navigators on the D-8 sight was presently to be initiated. However, the real problem of individual training for medium bombardment was not solved. Of the bombardiers and navigators being assigned to this air force, 25 per cent were navigators and 75 per cent were bombardiers. The navigators were given D-8 training by the Flying Training Command, and the bombardiers were given dead-reckoning navigation after reaching the Third Air Force. Therefore, the major

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21. Consolidated Flying Training Report, AFTTC, for Dec. 1942, Jan. and Feb. 1943, in AFIHI files.
22. R&R, AFRDB to AFRIT, 14 Nov. 1942, in files of AFACT-2, 352, D-8 Bombardiers.
23. R&R, No. 2, AFRIT to AFRDB, 30 Nov. 1942, in ibid; Consolidated Flying Training Report, AFTTC, Dec. 1942, in AFIHI files.

part of the extra individual training of these men still devolved upon the Third Air Force. It was apparent that the discontinuance of D-8 training at Carlsbad would make the problem still more acute.

As a result of the December conference, three steps were taken to meet more adequately the Third Air Force demands. It was generally agreed that if the Flying Training Command were notified a month in advance of the bombardiers to be assigned to this air force, an extra amount of training on the D-8 sight could be given to these students in the last month of training. In order that the Command might be informed, Military Personnel submitted to the Directorate of Bombardment the monthly requirements of bombardier-navigators of the Third Air Force from February through December 1943. These requirements averaged about 360 per month.[24]

The problem of giving additional navigation training (dead-reckoning) to bombardiers did not lend itself to so easy a solution. Bombardiers were already receiving 20 hours of navigation in their ground training but none in their air training. The minimum amount of dead-reckoning required was estimated at 50 hours. As this amount could not be incorporated into the bombardier course, it was proposed that one of the bombardier schools be selected to give a post-graduate course in dead-reckoning navigation for "those bombardier graduates not immediately needed for combat, and not qualified with a high enough classification for celestial navigation training." The existing policy was to send such surplus bombardiers to gunnery schools.[25]

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24. BAR, No. 1, AFRIT to AFPMP through AFRDB, 2 Jan.1943; No. 2, AFRDB to AFPMP, 6 Jan. 1943, in files of AFACT-2, 353, Bombardier-Navigator.
25. Memo for Col. T. J. Du Bose by Maj. E. N. Herzog, 1 Jan. 1943, in ibid.

On 21 January 1943 the Directorate of Individual Training directed the Flying Training Command to select one of the bombardier schools for this training and suggested that Carlsbad might be the "logical choice." It was desired that training begin about 15 February and that the instruction be given in a four and one-half week course. A requirement schedule, scaled down from that submitted by Military Personnel (360 per month) to about 275 per month beginning in March, was transmitted along with qualification standards provided by the Directorate of Bombardment.[26]

On the basis of the qualification standards established for bombardier/dead-reckoning navigators, it was decided to extend the course to six weeks with training to begin about 1 March 1943.[27] To alleviate further the training problem in the Third Air Force, the Flying Training Command was instructed to include as much D-8 bombing in the course of instruction at Carlsbad as time would permit.[28] Instructions were accordingly issued to Carlsbad to "include a minimum of one bombing mission per week, using the D-8 sight."[29] On 17 February the Flying Training Command was informed that the required production in this category of training was as follows:[30]

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26. AFRIT to CG, AFFTC, 21 Jan. 1943, in AAG 353 A, Bombsight, Gunnery Training.
27. R&R, No. 5, AFRIT to AFRBM, 28 Jan. 1943, in ibid.
28. 1st Ind. (CG, AFFTC to AFRIT, 28 Dec. 1942), AFRIT to CG, AFFTC, 4 Feb. 1943, in ibid.
29. 2nd Ind. (CG, AFFTC to AFRIT, 28 Dec. 1942), CG, AFFTC to AFRIT, 20 Feb. 1943, in ibid.
30. AFRIT to CG, AFFTC, 17 Feb. 1943, in ibid.

March	240
April	243
May	258
June	258
July	226
August	246
September	219
October	234
November	246
December	261

As instruction did not begin until 1 March, however, there were no graduates until 10 April. By the end of August production was on schedule with the graduates totaling 1,491 against requirements to that date of 1,473.[31]

This program for the training of bombardiers as dead-reckoning navigators was to become, in the summer of 1943, the standard course for all bombardiers.[32] In addition to the production of bombardier/dead-reckoning navigators at Carlsbad, there was still another expected source of such personnel for the Third Air Force, the bombardiers eliminated from celestial navigation training. In January 1943 when plans were being made to give dual training (precision bombardier-celestial navigator) to all bombardiers and navigators, it was anticipated that the eliminees (estimated at 25 per cent) from the navigation stage of training would be sufficient to provide virtually all the bombardier/dead-reckoning navigators required by the Third Air Force.[33] Experience indicated, however, that most eliminations occurred early in the course and before the dead-reckoning phase

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31. 1st Ind. (AFRIT to CG, AFTTC, 17 Feb. 1943), CG, AFTTC to AFRIT, 13 Mar. 1943, in ibid.; Consolidated Flying Training Report, AFTTC, April through August, 1943, in AFHRI files.
32. See Appendix 4.
33. R&R, No. 2, AFRIT to AFRIT, 15 Jan. 1943, in AAG 353 A, Bombsight, Gunnery Training.

was completed. Consequently, the demand for the special training performed at Carlsbad continued until the entire bombardier training program was changed to bombardier/dead-reckoning navigation. Following the termination of navigator/D-8 bombardier training at Carlsbad in February 1943, the Third Air Force had to continue giving such training to the celestial navigators whom it received from the navigation schools.[34]

Beginning of Complete Dual Training

Only the two types of dual training described above (navigator/D-8 bombardier and bombardier/dead-reckoning navigator) were accomplished before the end of 1942. The desirability of having dually trained personnel for heavy bombardment as well as for medium bombardment was continually voiced, but such training could not be inaugurated until the acute shortage of trained bombardiers and navigators was met. By December 1942 this shortage had been relieved; indeed, there was an actual surplus of bombardiers, and navigator production was sufficient to meet requirements. In addition to the possibility of starting dual bombardier-navigator training because of an adequate supply of trained men in these categories, there was also a positive necessity for such training because of the scheduled delivery in 1943 of the new super-bombers (B-29, B-32, B-33, etc.). The crew requirements for these planes demanded two dually trained bombardier-navigators. Still another and probably the strongest factor was that of reports and requests from the combat theaters. In October

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34. R&P, No. 4, AFRIT to AFPMP, 3 Feb. 1943, in files of AFACT-2, 353, Bombardier-Navigator.

1942, in answer to the question, "What should be done to improve the training of bombardment crews in the U. S. prior to dispatch to your theater?" the Commanding General of the Seventh Air Force stated that "the combat crew should include a bombardier and navigator, preferably 2 bombardier-navigators." "One bombardier-navigator," he claimed, "is insufficient."[35] A few months later, about January 1943, many of the members of the 19th Bombardment Group, called in for interview by Brig. Gen. N. L. Nuhank, Director of Bombardment, emphasized the need for dual training.[36]

The Directorate of Bombardment reopened the case for dual training on 18 September 1942, when the production schedule for super-bombers in 1943 and 1944 was sent to the Directorate of Individual Training. The range of the super-bombers made it necessary to have in the crew two officers who were qualified navigators "in order to prevent a waste of manpower." Training bombardiers and navigators in separate specialties constituted wastage of "high caliber" men. Certain subjects were common to both courses, and the "initial period of familiarization of the student with airwork" meant lost time. The comments and recommendations of the Directorate of Individual Training were requested on (1) the possibility of complete conversion, by a gradual process, to dual training; (2) the advisability of this "from a training point of view"; and (3) any alternate plan to meet the requirements occasioned

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35. Report, CG, 7th AF to CG, AAF, 21 Oct. 1942, in AAG 353.9 F, Training, General.
36. Interview between Capt. A. V. House and CWO Thomas J. Kelly, 10 July 1943, in AFIHI files.

by the use of super-bombers.[37]

The Directorate of Individual Training gave a general concurrence with the proposed plan and made several specific proposals: the conversion of this type of training could be effected "without great difficulty"; however, the system of specialized schools should continue, but their programs of instruction should be coordinated. Such coordination "would shorten the total time by at least 3 weeks, possibly more." The navigation course should probably precede the bombardier course. It would not be advisable, however, to effect a complete conversion of all bombardier and navigator training because of certain operations which did not require dual training, e. g., navigators for the Air Transport Command, the Troop Carrier Command, and these to be assigned to the Third Air Force who would require only B-8 bombardier training. Individual Training also suggested that valuable information could be obtained for working out the eventual program if a selected number of navigators were sent to one of the bombardier schools (Midland) coincident with bombardiers going to a navigation school (Hondo, Texas).[38] The Directorate of Bombardment concurred in these recommendations. Arrangements were made to send 20 navigators to bombardier training and 50 bombardiers to navigator training. The Air Surgeon was requested to select from Class 42-14 graduating from Albuquerque bombardier personnel who would be qualified to take navigation training. This assignment of graduates for additional training

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37. R&R, AFRDB to AFRIT, 18 Sep. 1942, in files of AFAGT-2, 353, Bombardier-Navigator.
38. R&R, AFRIT to AFRDB, 23 Sep. 1942, in ibid.

was not to constitute an overload for the schools but was to replace students scheduled to enter from preflight; such preflight graduates were to be sent to gunnery schools.[39]

This experiment in dual training was expected to serve two purposes: to provide experience which could serve as a basis for planning if it were decided to convert most bombardier and navigator training to dual training, and to provide trained personnel for the first B-29's. The bombardiers were scheduled to enter training at Hondo on 17 October and the navigators at Midland on 7 November. Both groups graduated on 28 January 1943--19 navigators from bombardier training and 40 bombardiers from navigator training. Since the first B-29 was not delivered until 31 December 1942, the production of dually trained men was well ahead of requirements.

There were several questions to be answered relative to the combined training of bombardiers and navigators before the program could proceed on any large scale. What would be the required production? Would there be a sufficient number of qualified trainees of both categories? Which phase of instruction should come first? How much of the proficiency attained in the first phase of training would be lost during the second phase? What should be the classification of bombardiers assigned to dual training? Should trainees be commissioned at the end of the first phase of training or at the conclusion of the dual training? What should be the length of the course? Should the length of the training period be less than the existing total of both

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39. Daily Diary, AFFTC, 18 Sep 1942.

courses? If so, which course should be shortened? These were problems of which all the agencies concerned were cognisant.

It was originally planned to hold a conference after the group of men had finished the dual training and, on the basis of experience, decide most of these questions and prepare a course of instruction for future training.[40] Conferences were not delayed, however, until the completion of the training of the first group of men, but were held intermittently during their training. Decisions and counter decisions were made regarding nearly all the questions involved. On 24 October 1942 the Directorate of Individual Training requested the Directorate of Military Requirements to reconsider the project. Individual Training believed that the navigator course should be given first and that the bombardier course should be reduced from 12 to nine weeks. The real problem, however, arose out of the curtailment of the number of men available for the combat training units which would be occasioned by the conversion to the program of dual training. It was estimated that conversion would result in a shortage under the 273 Group Program of 5,700 navigators and 1,500 bombardiers by the end of 1943. Also, the program would probably require the use of the facilities at Carlsbad which would occasion the loss of about 5,000 D-8 bombardiers--if the latter type of training needed to be continued. It was, therefore, questioned whether a "complete change-over" should be inaugurated within the next year.[41]

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40. AFRIT to CG, AFTTC, 2 Oct. 1942, in AAG 353.9, Specialized Training.
41. RAR, AFRIT to AFDMR through AFRMR and AFDOP, 24 Oct. 1942, in files of AFAOT-2, 353, Bombardier-Navigator.

A few days after transmitting the above request and proposals to the Directorate of Bombardment, Individual Training requested that the Flying Training Command make a study of the proposed dual training and submit a proposed plan and a program of instruction.[42] The Flying Training Command accordingly submitted a plan whereby such training would be accomplished by sending graduate navigators to a bombardier school in groups of 150 every three weeks for a nine-week bombardier course. This would occasion a loss of about 450 navigators during the first nine weeks, but it would not deter the training of bombardiers. A proposed program of instruction was also forwarded, and it was suggested that a conference be held in AAF Headquarters between the Directorate of Individual Training, the Directorate of Bombardment, and the Flying Training Command to establish a final directive for this type of training.[43]

This study and recommendations from the Flying Training Command were forwarded by the Directorate of Individual Training to the Directorate of Bombardment for consideration along with the proposals submitted by Individual Training on 24 October.[44] The Directorate of Bombardment replied that the loss of 450 navigators to the combat units made the plan unfeasible. A transition plan was necessary. The desired procedure would be to give D-8 bombardier training to the navigators assigned to the Third Air Force, if they had not had precision bom-

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42. AFRIT to CG, AFFTC, 28 Oct. 1942, in ibid.
43. 1st Ind. (basic of 28 Oct. 1942 not found), CG, AFFTC to AFRIT, 16 Nov. 1942, in ibid.
44. R&R, AFRIT to AFRDB, 23 Nov. 1942, in ibid.

bardier training. Such training could be discontinued about 1 June 1943, by which time the flow of dually trained men would begin. In the meantime all bombardiers for the Third Air Force should be given dead-reckoning navigation. The ultimate goal to be attained in bombardment crews was as follows: two bombardier-navigators for B-29 crews, one bombardier-navigator and one celestial navigator for other heavy bombardment crews, and one bombardier-navigator for medium bombardment crews. The requirements of the B-29 units and medium bombardment were to be given priority. In order to meet these requirements, and since there were sufficient graduate bombardiers available, it was recommended that all surplus officer bombardiers with a classification of five or better be sent to a navigation school. Although the most efficient system would have been to send graduate navigators to bombardier training, the relative shortage of navigators dictated that the above policy be followed until navigators were available in sufficient number to reverse the flow. With these comments and recommendations, the Directorate of Bombardment also forwarded proposed qualification standards for dual bombardier-navigators.[45]

The Directorate of Individual Training concurred in the above recommendations, including that of sending graduate bombardiers to navigation schools instead of vice versa. Attention was called, however, to the fact that the conversion to dual training would entail a 100 per cent increase in training facilities "if a dual man is to be

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45. BAR, No. 2, AFRIT to AFRIT, 26 Dec. 1942, in Ibid.

put in every combat crew position now held by a single specialist."[46] The Directorate of Bombardment agreed that training facilities would have to be doubled, but felt that "the expenditures in manpower and facilities is [sic] justified considering the increased efficiency of bombardment units."[47]

Dual Program Launched—Further Controversy

It was planned to begin making dually trained men available to the bombardment units by June 1943, which meant that such training would have to start in January. Accordingly, steps were taken in December to select the bombardier students who could be expected to complete successfully the navigation course. The Flying Training Command was instructed to initiate action to classify all cadets in bombardier training on the basis of their aptitude for navigator training. The Command decided that students having a navigator aptitude (stanine score) of six or better should be selected for dual training, but the Directorate of Individual Training ordered the Command to reduce this requisite score to five. By the reduction more men were rated for navigator training than could be accommodated in the navigator schools, and the surplus was sent to gunnery training.[48] Since there was a surplus of bombardiers, the Flying Training Command was instructed to classify these men so that all of those assigned to navigator training

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46. RAR, No. 3, AFRIT to AFRDB, 9 Jan. 1943, in ibid.
47. RAR, No. 4, AFRDB to AFRIT, 20 Jan. 1943, in ibid.
48. RAR, Nos. 1 to 6, between AFRIT and AFFTC, 7 Dec. 1942 to 8 Feb. 1943, in AAG 383 A, Bombsight, Gunnery Training.

would have a classification high enough to enable them to take the navigater course. The Command found that 50 per cent of the bombardiers had a score of five or better and that all these going to navigator training could be selected from this group.

The Flying Training Command had been informed of the air forces' requirements for bombardiers for the year 1943 and was requested to indicate the number which could be sent to navigation training after these requirements were met.[49] In compliance with this request the Flying Training Command informed the Directorate of Individual Training of the number of bombardiers which would be available for navigator training during 1943 as against the availability schedule. The requirements schedule for 1943, based on one bombardier-navigator for each medium and heavy bombardment crew and two bombardier-navigators for B-29 crews, was submitted to the Directorate of Individual Training by the Directorate of Bombardment:

Bombardier-Navigator Requirements for 1943[50]		Bombardier-Navigator Expected Availability during 1943[51]	
Jan.	1,078	Jan.	
Feb.	707	Feb.	
March	707	March	
April	928	April	
May	906	May	
June	931	June	176
July	889	July	397
Aug.	933	Aug.	521
Sept.	1,017	Sept.	14
Oct.	1,089	Oct.	690
Nov.	1,098	Nov.	168
Dec.	1,026	Dec.	878

49. R&R, AFRIT to CG, AFFTC, 26 Dec. 1942 in ibid.
50. R&R, No. 2, AFRIB to AFRIT, 20 Jan. 1943, in ibid.
51. 1st Ind. (AFRIT to AFFTC, 7 Dec. 1942), CG, AFFTC to AFRIT, 20 Jan. 1943, in files of AFAGT-2, 353, Bombardier-Navigator.

Throughout January and February groups of bombardier graduates were assigned to navigator training while the pros and cons on the many questions related to such training were being evaluated--and while the advisability of the entire program was also being questioned. All of the problems connected with the conduct of such training were discussed at the bombardier conference in December 1942. It was the consensus of the conference that the navigation stage of training should come first; that at least 20 hours of navigation should be put into the bombardier phase in order to "keep the graduate navigators in practice";[52] that if the navigation stage were extended from 15 weeks to 18, this additional time should be utilized to lighten the load on the trainees rather than to allow the preflight schools to transfer part of their instruction to the navigator schools; and that the bombardier stage of training could not be shortened to nine weeks without adversely affecting such training.[53]

One of the problems encountered in the administration of dual training was the commissioning policy. Should trainees be commissioned at the end of the first stage of dual training, thus maintaining equality between men trained in one specialty and those undergoing dual training, or should commissioning be delayed until the completion of the dual course? The Directorate of Individual Training held that the "ideal" solution would be for trainees to remain on cadet status until

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52. Similarly, it was later agreed by the Directorate of Individual Training and the Directorate of Bombardment that bombardier equipment should be provided to the navigator schools in order to enable the graduate bombardiers in such schools to maintain their bombing proficiency. Daily Diary, AFRIT, 17 Mar. 1943, in AAG 319.1-0, Daily Diaries.

53. Memo for Col. T. J. Du Bose by Maj. E. H. Herzog, 22 Dec. 1942, in files of AFAGT-2, 337, Bombardiers.

dual training was completed; otherwise the men would take the last stage as second lieutenants and would have no incentive "to do well or even to pass navigation." However, it was thought that it would be impossible to continue them in cadet status. A possible solution was to rate trainees as flight officers at the conclusion of the bombardier stage and to commission them when the dual training was completed. The Assistant Chief of Air Staff, A-1 objected to the argument that students would lack incentive during the last stage of training and indicated that a trainee who manifested this attitude "should not only be eliminated therefrom [navigation training] but also be relieved of his commissioned status as undesirable officer material." After over three months of concurrence and nonconcurrence the matter was dropped with no action taken.[54] Trainees continued to be commissioned upon the completion of bombardier training.

The Directorate of Individual Training and the Flying Training Command had held that graduate bombardiers would have more difficulty in successfully completing navigation training than vice versa and that the navigation course should therefore precede bombardier training. The soundness of this policy was borne out by the results of the experimental groups of bombardier-navigators who graduated on 28 January 1943. Of the 20 navigators who took bombardier training, none were eliminated and only one was held over (because of illness), whereas of the 53 bombardiers who took nav-

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54. R&R, Nos. 1 to 16, between AFRIT, A-3, A-1, AFRDB, and AFMMR, 6 Jan. to 18 Mar. 1943, in AFACT-2, 353, Bombardier-Navigator.

igator training, 14 were eliminated.[55]

While the various problems relative to the conduct and administration of dual training were in the process of being worked out by the interested agencies, Col. E. P. Sorensen, Assistant Chief of Air Staff, A-2 and formerly Director of Bombardment, expressed opposition to the program of dual training. In the resulting correspondence there is found the clearest available statement of the case for and against such training. Colonel Sorensen expressed his opinions as follows:

> On paper this plan looks practicable. In practice, any diversion of functions or duties which detracts in any way from the one-hundred percent concentration of the bombardier's attention and best effort will be detrimental to the effectiveness of our striking force. Some of us have worked hard for several years to put the bombardier on a pedestal and in his proper place. Today our bombing effectiveness is far inferior to what it should be, largely because of incomplete training of the bombardier. If additional time can be spared for training this individual, we would be better off in the long run to double the time of his training in the bombardier school [or] in the OTU system or both in order to get the bombing accuracy which we have a right to expect.
>
> In emphasizing the extreme importance of the bombardier and his function, no belittlement of any other crew member is necessary. The fact remains that unless we can hit the target the bombardment mission fails. To place a mission's bombs on a target well within the enemy's territory is a costly adventure. Only through the hands of the bombardier will we get a return for the risk and cost of the mission. The maximum in training and capabilities of the bombardier is not too good under war conditions. . . .
>
> To give all bombardiers a full course of training as navigators and vice versa would be detrimental to the quality of our bombing. To change to such a training plan is believed to be definitely a step backward.[56]

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55. Daily Diary, AFRIT, 2 Dec. 1942, in AAG 519.1-A, Daily Diary and Daily Log; Daily Diary, AFTTC, 7 Jan. 1943.
56. Memo for C/AS by AC/AS, A-2 through AFRIT, 13 Feb. 1943, in AAG 353, Bombardier Training.

The Directorate of Bombardment answered that the program of dual training had been put into effect after discussion throughout the AAF. "In no case," the reply stated, had "anyone voiced objection to the plan; all . . . expressed approval, many being enthusiastic." Certain phases of bombardier and navigator training were common to both, and in the bombardier's training in the past a great deal of time had "necessarily been devoted to instruction in the actual technique of bombsight manipulation, thereby minimizing instruction in items" that were common to both categories of training. The communication further stated that

> Bombardiers are known to be weak in these items, especially map reading and basic dead reckoning navigation. A broadening of the bombardier's knowledge and experience, as will result from the combined training, will do much toward eliminating such weakness.
>
> Elimination of any bombing instruction heretofore included in /the/ bombardier training curriculum is not contemplated. On the contrary, additional instruction will result since it is planned to include refresher bombing missions during the navigation training period of bombardiers. Experience in the combat theaters has clearly indicated that the bombardier with navigation training is superior to other bombardiers. His improved conception of the entire problem is obviously the answer.
>
> On the combat crew of heavy bombardment airplanes there will be assigned two qualified bombardier-navigators. The one most skilled in bombing will serve as bombardier. Valuable assistance can be rendered by the other during the bombing approach since he is thoroughly familiar with the bombing problem and, in addition, is a skilled navigator. Improved crew coordination can be expected.
>
> In the case of a bombardier casualty, an adequate replacement is available, heretofore /not/ provided. The same applies in event of a navigator casualty.

Other advantages of this type of training were also emphasized: (1) On heavy bombardment missions the navigator suffers from fatigue because of the length of the mission; this program would provide relief

without the addition of another crew member. (2) The crew in medium bombardment would be reduced by one member, and performance would be increased because of the reduced weight. (3) The reduction in total requirements of bombardiers and navigators would permit the selection of higher caliber men. (4) The morale of bombardiers would "undoubtedly be improved by a broadening of their education."

> It is fully appreciated that unless the bombs hit the target the mission fails. Any program detrimental to the bombardier's training and efficiency would be unacceptable. With this in mind, the combined training program has been put into effect. It is difficult to see how a program designed to broaden the bombardier's experience and knowledge will result in other than better precision bombing.[57]

These two sides of the case were submitted by the Chief of the Air Staff to the Assistant Chief of the Air Staff, A-3 and to the Directorate of Individual Training for comments. A-3 concurred in the opinions of the Directorate of Bombardment, stating that "The only disadvantage apparent is the additional time required for training in dual functions."[58] The Directorate of Individual Training commented that dual training could be performed if time and equipment (planes for the navigation schools) were provided, but added that, since navigators would have to be trained for Air Transport and not all trainees could successfully complete both courses, the numbers would be limited.[59] In the Flying Training Command it seems that there was a growing feeling that dual training was not the wisest policy. The predominance of opinion, however, appeared to be in favor of continuing the program of dual training, although this was far from being unanimous.

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57. R&R, AFRDE to C/AS, 22 Feb. 1943, in ibid.
58. R&R, No. 3, AC/AS, A-3 to C/AS through AFRIT, 1 Mar. 1943, in ibid.
59. R&R, No. 4, AFRIT to C/AS, 9 Mar. 1943, in ibid.

This bombardier-navigator not only bombs the target but navigates the airplane to and from the target.

Dual Training of Bombardiers and Navigators

Dual training of bombardier-navigators, planned before Pearl Harbor but necessarily abandoned immediately thereafter, was inaugurated late in 1942 to meet demands of both medium and heavy bombardment. For medium bombardment the combination of these two functions would reduce the size of the aircrew. For heavy bombardment, considering the exhausting nature of long-range missions, there would be distinct advantage in having a replacement for either navigator or bombardier.

Several types of dual bombardier-navigator training were conducted. Celestial navigators were trained as D-8 bombardiers for medium bombardment and as precision bombardiers for heavy and very heavy bombardment. Precision bombardiers were trained as dead-reckoning navigators for both medium and heavy bombardment. The dually trained personnel for the very heavy program were also given radar training.

The navigational function on such aircraft as this B-29 demanded dually trained bombardier-navigators.

No large number of men were being given the dual training. The experimental group which graduated in January 1943 was used for instructors in the dead-reckoning navigator school at Carlsbad when it opened in March. No other graduates of the dual course were expected to be available until May and June, when 589 bombardiers who had entered navigation training in January and February were scheduled to graduate.[60] About 80 per cent of the 589 were expected to graduate. Thus it was anticipated that it would be about June 1943 before the combat units could receive dually trained precision bombardiers and celestial navigators.[61] By 1 October 1943 a total of 1,133 such men had been graduated.[62] In the meantime the demands of the Third Air Force were met by graduates of the bombardier/dead-reckoning navigation course at Carlsbad. A settled program, however, was yet to be adopted.

Bombardier/Dead-Reckoning Navigator Program

With the pressing demand for some type of dual training and with almost insuperable obstacles to supplying this demand with precision bombardier-celestial navigators, the bombardier/dead-reckoning navigator appeared to be the answer. The Flying Training Command, on 10 April 1943, expressed the belief that it was neither feasible nor "in the best interests of manpower economy to attempt to specialize one individual in two categories." In line with the wishes of the Director of Bombardment, the Command was planning to incorporate dead-reckoning navigation in the standard bombardier course. It was believed that the graduate navigator

60. Daily Diary, AFRIT, 25 Jan. 1943, in AAG 319.1-B, Daily Diaries.
61. R&R, No. 3, AFRIT to AFRAB, 28 Jan. 1943, in files of AFAGT-2, 353, Bombardier-Navigator.
62. R&R, AFMSC to AFIND, 15 Oct. 1943, in AFIND files.

could be trained as a "precision bombardier in six weeks" and that the proficiency of such men would "materially improve in their OTU and combat training." Authority was requested to discontinue the training of bombardiers as celestial navigators and to substitute for it bombardier training of navigators according to a six-week curriculum which was transmitted with this proposal. The curriculum submitted consisted of 180 hours of ground instruction and 65 hours of air training.[63]

While the Directorate of Bombardment had expressed the desire for this proposed program, that office had at the same time stressed the fact that there was still a need for the precision bombardier-celestial navigator for future use on heavy bombardment.[64] A training program to meet such requirements, however, was still not begun by early fall of 1943. The Flying Training Command was directed, on 24 July 1943, to discontinue the flow of graduate bombardiers to navigator training. At the same time it was indicated that "Graduate navigators will be ordered to [ ] special nine week bombardier course in sufficient numbers to meet existing commitments for precision bombardier-celestial navigators." One bombardier school, Roswell, was to be set aside to do only this type of training, which was to begin 14 August 1943.[65] Five days later, however, the begin-

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63. CG, AFTRC to AC/AS, Training, 10 Apr. 1943, in AFHRI files.
64. Ibid.
65. Daily Diary, AFTRC, 24 July 1943, in files of AFAGP-2.

ning of such training was postponed, and though the date for initiation of the program was not definite, it was expected to be 2 October 1943.[66]

The essential content of this nine-week course of bombardier training for graduate navigators follows:[67]

A.	Ground training		
	1. Bombing (theory, sights, and accessories)	46	hours
	2. Bombing procedure	50	"
	3. Bombing analysis	12	"
	4. Bombardment aviation	8	"
	5. G-1 pilot	10	"
	6. Bombsight calibration and troubleshooting	35	"
	7. Allied training (Blinker and code, aircraft identification, athletics, and first aid)	65½	"
	8. Review and examination	38	"
	9. Critiques	12	"
	Total ground training	329½	hours
B.	Flying training (Dry runs 3, bombing 70)	73	hours
	Total hours	402½	

In the meantime plans were being made to incorporate dead-reckoning navigation into the regular bombardier course of instruction as requested by the Flying Training Command on 10 April. On 14 April the Assistant Chief of Air Staff, Training transmitted to the Flying Training Command the directive for initiating an 18-week bombardier/dead-reckoning navigator course. Changed require-

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66. Ibid., 29 July 1943.
67. TC Memo 50-11-3, 28 Sep. 1943. For the objectives, proficiency requirements, and detailed outline of this program of instruction see Appendix 8.

ments of the combat units made necessary the new type of training. For each B-17 and B-24, requirements called for one navigator and one bombardier, the bombardier to be "proficient in dead reckoning navigation; capable of acting as assistant navigator"; for each B-29, two bombardier/celestial navigators "completely dually trained"; for 25 per cent of medium bombardment, one bombardier/celestial navigator "completely dually trained"; for 75 per cent of medium bombardment, one bombardier/dead-reckoning navigator as in the case of B-17's and B-24's. In the light of these future requirements, all previous directives on dual training were rescinded, and approval was given for the new 18-week course, for which qualification standards were enclosed. The annual production rate for the new dual training was tentatively set at 12,000.[68] At the bombardier conference held in the headquarters of the Flying Training Command on 11-12 May 1943, plans for the new program were explained, and the respective bombardier schools were notified when it would be initiated.[69]

Training under the new program was scheduled to begin at Childress on 3 June, at San Angelo on 24 June, and to be under way in all bombardier schools by 25 October 1943. There was, however, a delay of approximately one month in the initiation of this training. A tentative program of instruction was prepared, dated 16 June 1943

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68. AG/AS, Training to CG, AFTTC, 14 Apr. 1943, in AAS 353.01A, Training, Schedules and Directives.
69. Report on Bombardier Conference at Fort Worth, 11-12 May 1943, in files of AFAGE-2, 337, Bombardier.

(F.T.C.Memo. 50-11-1). This program was thoroughly discussed at the bombardier conference in Fort Worth in July and, with the revisions agreed upon at the conference, appeared as the authorized program of instruction on 20 August 1943. The 20 August program, however, underwent a further revision on 29 September. The schedule for initiating training under this program was as follows: (1) as of 1 August 1943 training had already started in the following schools--at Albuquerque, on 10 July; Childress and San Angelo, on 16 July; and Deming on 31 July; (2) training in the other four schools was to begin as follows--at Carlsbad, on 31 August; Victorville, on 23 October; Midland, on 21 January 1944; and Big Springs, on 11 February 1944.[70]

With the conversion of the entire bombardier training program to dual bombardier-navigator training, the Army Air Forces had at last been able to initiate the type of training which was scheduled for the fall of 1941 but which the pressure of immediate needs following Pearl Harbor had forced aside.

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70. Consolidated Flying Training Manual (July, 1943), AFTRC, in AFIHI files; TC Memo 50-11-1, 20 Aug. 1943. For detailed program of instruction (TC Memo 50-11-1, 29 Sept. 1943) see Appendix 4.

MONTHLY FLOW OF BOMBARDIER GRADUATES

NOVEMBER 1940 THROUGH OCTOBER 1943

PERIOD	Precision Bombardiers		Precision Bombardier-Celestial Navigators		Bombardier-Navigators		[illegible] Bombardiers (Gunners)		[illegible] Bombardiers (Navigators)	
	Grads this Period	Grads to Date	Grads this Period	Grads to Date	Grads this Period	Grads to Date	Grads this Period	Grads to Date	Grads this Period	Grads to Date
November, 1940	18*	18								
December, 1940	0	18								
January, 1941	55*	73								
February, 1941	0	73								
March, 1941	49*	122								
April, 1941	34	156								
May, 1941	0	156								
June, 1941	0	156								
July, 1941	32	188								
August, 1941	0	188								
September, 1941	44	232								
October, 1941	0	232								
November, 1941	68	300								
December, 1941	28	328								
January, 1942	0	328								
February, 1942	0	328								
2-2 -42 to 3-2 -42	130	458								
3-2 -42 to 5-4-42	208	666								
5-4-42 to 6-3-42	333	999								
6-3-42 to 7-5-42	512	1511								
7-5-42 to 8-15-42	249	1760								
8-15-42 to 9-2 -42	1115	2875								
9-2 -42-to 10-31-42	791	3666					4	4		
November, 1942	713	4379					37	41		
December, 1942	862	5241					147	188		
January, 1943	1067	7308	5	5					116	116
February, 1943	699	7,37	1	61					109	225
March, 1943	1043	8780	4	65						
April, 1943	14	10,794	4	69						
May, 1943	1382	11782	2	71			7	7		
June, 1943	1507	13,289	4	75	14	14	3	10		
July, 1943	1382	14,671	12	87	15	29	4	14		
August, 1943	1446	16,117	11	98	4	33	3	17		
September, 1943	1274	17,391	11	109	11	44	4	21		
October, 1943	1144	18,535	6	115	4	48	2	23		

* Bombardier graduates from [illegible]

Source: R&R, AFMSC to AFIHD, 15 Oct. 1943, in AFIHI, Archives.

Chapter V

INSTRUCTORS AND BOMB-APPROACH PILOTS

Instructors

The accomplishment of the mission of individually training bombardiers is conditioned by personnel and materiel factors. The most important personnel factors are those of instructors and bomb-approach pilots. The problem of bombardier instructors was, logically, one of the first factors to which attention was given, with the result that the first bombardier training conducted by the Chief of the Air Corps was the training of bombardier instructors. One hundred and twenty-two instructors graduated from this training by March 1941. Since there were never more than 150 bombardier students in training at any one time before January 1942, the problem of instructors was not acute until after this date. After the beginning of 1942, however, the number of students under instruction rose rapidly, as the following tabulation reveals:[1]

Students under instruction as of:	
1 January 1942	248
1 April 1942	895
1 July 1942	1,431
1 October 1942	2,456
1 January 1943	3,573
1 April 1943	4,570
1 July 1943	4,430
1 October 1943	5,157

The minimum instructor-student ratio in effect by the summer of 1942 was one flying instructor for each four students. But inasmuch

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1. Consolidated Flying Training Report (Monthly), AFTTC, in AFHRI files.

as there was a shortage of bombardiers until the end of 1942, there was constant contention over the disposition of graduate bombardiers. Upon graduation all bombardiers were under the administrative jurisdiction of the Directorate of Bombardment, and no graduate could be retained by the Flying Training Command for instructor purposes without the approval of that office. It appears that the demand for instructors did not become critical until about June 1942, when the number of students under instruction rose to approximately 1,400. For the next six months there was a struggle to obtain instructors for the bombardier schools.

In June 1942 the Flying Training Command was informed that all graduates for that month were required for the combat units and none would be available for instructor purposes. The Gulf Coast Training Center alone requested 50 graduates from class 42-8, graduating in June.[2] In July a directive was issued to the bombardier schools to increase production "to the maximum available capacity,"[3] which seems to have been an increase of 70 per class.[4] At the same time the requirements for additional instructors from July 1942 to March 1943 were forwarded to the Directorates of Individual Training, Personnel, and Bombardment. The requirements for the remainder of

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2. Daily Diary, AFFTC, 6, 7, and 9 June 1942.
3. Ibid., 4 July 1942.
4. General Yount's Project Book, Bombardier Training Section, 1 Aug. 1942, in AFHRI files.

1943 were as follows: July, 34; August, 43; September, 237; and October, 110--a total of 424.[5] The Flying Training Command was informed that it would get the number requested for July in the two months of July and August but that the Directorate of Bombardment needed all other graduates and that the Command would have to function with the instructors it had.[6] However, after insistence by the Directorate of Individual Training that the requirements of the combat units could not be met unless the schools had instructors, the Flying Training Command finally got the instructors required for July and August.[7] By the end of August the Directorate of Bombardment indicated that in order to maintain the schedule of training nearly twice as many bombardier graduates would be needed for instructors as had been allocated for that purpose.[8]

By the end of September, bombardier trainees were being entered for a production rate of over 12,000 per year, a rate in excess of the training schedule. As a result of this, additional instructors were requested for November in order to maintain the instructor-student ratio of one to three which, prior to the marked increase in the number of bombardier students under instruction, the schools were able to maintain.[9] With the tremendous increase in school popu-

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5. CG, AFFTC to AFRIT, AFDOP, and AFRMB, 13 July 1942, in files of AFAGT-2, 352.16, Bombardiers.
6. Daily Diary, AFFTC, 28 July 1942.
7. Daily Diary, AFRIT, 23 Aug. 1942, in AAG 319.1-3, Daily Diary.
8. R&R, AFRMB to AFDMR, 27 Aug 1942, in AAG 353.9-13, Bombsight Training.
9. CG, AFFTC to AFRIT, 27 Oct. 1942, in AAG 352.16 A, Instructors; teletype, CG, AFFTC to AFRIT, 24 Dec. 1942, in files of AFAGT-2, 352.16, Bombardiers.

lation in the spring of 1942, the ratio was set at one to four. In December 1942, however, when it appeared that there would be an actual surplus of bombardiers in the following month, the Flying Training Command requested that the former ratio of one to three be reestablished. This request was readily granted, on 26 December 1942.[10]

The student-instructor ratio month by month from September 1942 through July 1943 was as follows (for precision bombardiers, D-8 bombardiers, and bombardier/dead-reckoning navigators):[11]

	Students under instruction	Flying instructors	Student-instructor ratio
September, 1942	2,486	572	4.3
October, 1942	3,578	872	4.1
November, 1942	4,007	960	4.1
December, 1942	3,691	1,137	3.3
January, 1943	3,758	1,258	3.0
February, 1943	4,034	1,228	3.3
March, 1943	4,871	1,445	3.3
April, 1943	5,146	1,485	3.4
May, 1943	5,210	1,673	3.1
June, 1943	4,937	1,861	2.7
July, 1943[12]	4,866	1,880	2.6

The above data indicate the progress made in the procurement of bombardier instructors. Most of this increase in instructor personnel came from the retention of selected graduates. In some cases bombardier graduates were retained as instructors on a temporary basis pending assignment to combat units.[13] Civilians and military men either

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10. Teletype, CG, AFFTC to AFHIT, 24 Dec. 1942, in files of AFAOE-2, 352.16, Bombardiers.
11. Consolidated Flying Training Report (Monthly), AFFTC, in AFHRI files.
12. The data for this month include students in training under the new combined program of bombardier/dead-reckoning navigation which was in effect in five schools.
13. Daily Diary, AFFTC, 15 Apr. 1942.

over-age or unsuited for combat duty constituted other sources of instructors.

In July 1942, when there was an acute shortage of instructors, the Directorate of Individual Training requested the recommendation of the Flying Training Command on the "advisability of putting a number of older men through the bombardier schools with the intention of making them instructors." These were to be selected from men over 26 years of age who were at that time officers, potential officers, or World War I flyers.[14] The Flying Training Command opposed such a policy on several counts: (1) Although men between the ages of 18 and 26 were performing the actual instruction, the plans for programs of instruction and indoctrination were "edited and decided upon by the more mature and experienced personnel" of the Flying Training Command and AAF Headquarters. (2) The men in charge of directing and improving bombardier training were "active pilots" who were familiar with the bombing problem, who had followed the development of bombardment from its beginning, and who were better qualified to improve bombing than any beginner could be. (3) It was inadvisable to bring in "relatively inexperienced men" who would exercise command "in spite of their low level of experience." (4) Instructors must be able to undergo all the rigorous experiences of the men in training

14. AFRIT to CG, AFTTC, 22 July 1942, in AAG 353.9 B, Gunners, Bombardiers; Daily Diary, AFRIT, 22 July 1942, in AAG 319.1 B, Daily Diaries.

and must be able to answer the questions which could not be answered by men whose knowledge came "mostly from text books." (5) Since bombardiering, a "relatively new science," required flexible, alert, and open minds, it was felt that older higher-ranking officers should not be assigned as bombardier instructors. (6) Bombardier instruction would be improved when it became possible to maintain an instructor-student ratio of one to two in the "primary instructional phase." (7) It was planned to establish a bombardier instructors' course at some bombardier school when enough qualified men were available and when the demand for maximum production was eased somewhat.[15]

These objections of the Flying Training Command were not concurred in by the Directorate of Individual Training. Decision was made to utilize officers of other arms and services concurrently on duty with the Army Air Forces and officers and civilians who were unfit for combat duty. These men would be given a full course of bombardier training in addition to an instructors' course. Information was requested on the number of such men that could be used and the rate at which they should be obtained.[16] The authorization for the use of officers in the capacity mentioned above was given by AAF Memorandum, 50-5, dated 9 September 1942. By this authorization only those officers under 36 years of age could be used as flying

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15. 1st Ind. (AFRIT to AFFTC, 22 July 1942), CG, AFFTC to AFRIT, 5 Aug. 1942, in files of AFAGT-2, 352.16, Bombardiers.
16. AFRIT to CG, AFFTC, 27 July 1942, in ibid.

instructors, while those over this age were to be used for ground instruction.[17]

The use of men commissioned directly from civilian life as ground school instructors has been one of the most debated questions of the instruction program. The extent of the use of these men and the evaluation placed upon their effectiveness vary widely. The conflicting views on this type of instructor were, on the one hand, that there were men of ability with instructor experience and with highly specialized training in the subjects which make up a large portion of the ground school instruction. Many of these men were over military age or were unfit for combat duty; unless they were commissioned and used as instructors their abilities would be lost to the war effort. On the other hand, there was the feeling that men who had neither bombardier nor Army experience would be deficient in a knowledge of aviation, aerodynamics, mechanical aptitude, and other desirable qualifications and would therefore be incompetent as ground instructors.

Because of the shortage of instructors for the bombadier schools, the policy of commissioning men directly from civilian life was adopted, and such instructors were in the schools by September 1942. There has been a lack of uniformity, however, in the extent to which the two training centers which perform bombardier training have utilized such men for instructor purposes. The schools of the Gulf

17. AAF Memo 50-5, 8 Sep. 1942, superseded on 25 Sep. 1943; TC Memo 50-0-4, 24 Aug. 1943.

Coast Training Center have used these men exclusively,[18] but the West Coast Training Center appears to have made a more limited use of them. In July 1943 the ground school staff in half of the bombardier schools was composed of men who in background and training were professional teachers, but none of whom were graduate bombardiers.[19] This divergence of policy seems to have resulted from the fact that the schools in the Gulf Coast Training Center took pains to give a rather thorough course of instruction to these men. Generally, these men have been superior instructors.

Another source of instructor personnel has been the men returned from combat and assigned to the Flying Training Command on temporary duty for the purpose of advising in methods of instruction or, if unfit for further combat duty, assigned permanently to the instructional staff. The first requests for such personnel were for "personnel of all categories" of specialty.[20] The following month a special request was made for "any available navigators and bombardiers having combat experience."[21] It appears that after this date plans were made for definite assignment to the Flying Training Command of bombardiers and navigators who had returned from combat and who were classified for limited service only.[22] The men returned from

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18. Interview between Capt. A. V. Mouse and CWO Thomas J. Kelly, 10 July 1943, in AFIHI files.
19. Air Inspector, AFTRC, to CG, AFTRC, "Inspection of Bombardier Schools under the Jurisdiction of this Command," 19 July 1943, 3, in AFIHI files.
20. Daily Diary, AFRIT, 29 July 1942, in AAG 319.1-3, Daily Diaries.
21. Ibid., 10 Aug. 1942.
22. Ibid., 22 Aug. 1942.

combat have been used both as ground school and flying instructors. The estimates of the value of such men as instructors have a wide variation. Most of the men themselves appear to have had the natural feeling that they could make a valuable contribution to the training of bombardiers. These men, fresh from combat theaters, felt that their greatest contribution was to be made to the men in operational training who were soon to reach combat,[23] rather than to the men who were in the stage of individual training and who would not reach the combat theaters for several months. This latter view was apparently in line with that of the AAF Headquarters offices in charge of training, since by far the larger percentage of the bombardiers returned from combat and assigned to training organizations were assigned to the training air forces. As of 20 August 1943, there were 388 bombardiers returned from combat and assigned to various duties within the United States. Of this number only 72 (18.55%) were assigned to the Flying Training Command and 352 (64.9%) were assigned to the domestic air forces.[24]

The views of the officers in charge of bombardier training in the various schools and training air forces, however, have been only partially in agreement with the views expressed by the men themselves. The views of these officers have varied all the way from fairly strong

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23. Interview of Bombardiers Returned from Combat, transmitted by the Director of Training, AAF Instructors School (Bombardier), Carlsbad, New Mexico, to CG, AFTRC, 9 July 1943, in AFHRI files.
24. "Disposition of Officer Personnel, AAF, Now Assigned in the U. S., Who Have Served Outside The Continental U. S. During The Present War," prepared by the Records Section, Officers Branch, AFPMP, 7 Sep. 1943, in AFHRI files.

support for the use of these men in training to the feeling that they had "no contribution whatever" to make to bombardier training. Those who were skeptical of the value of the men returned from combat as instructors had found that these men were prone to insist that all training should conform to the needs of the particular theater in which they had experience, and their own personal experience in particular. Too, the men from combat, and others who have registered complaints on pre-combat training, have often assumed that the current training mission was being no better performed than earlier, when training facilities were inadequate and when some students were graduated ahead of schedule[25] and then rushed through a very brief period of operational training. Some of this feeling toward the opinions of combat personnel was part of the general attitude throughout the Flying Training Command that the bombardier was so neglected during the period of his operational training that the proficiency acquired in the bombardier school was partially lost. It was argued, therefore, by those charged with the individual training of bombardiers, that much of the alleged lack of proficiency of bombardiers in actual combat was not due to the inefficiency of the individual training of the bombardier but rather to the weaknesses that existed in operational training.[26]

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25. 2d Ind. (AFFTC to CO, Army Air Base, Albuquerque, N. M., 27 May 1942), Comdt., Army Air Base, Albuquerque, N. M. to CG, AAFTC, 16 June 1942, in AAG 353.9-1B, Bombsight Training.
26. Lt. Col. J. B. Ryan, AAF Bombardier School, Midland, Tex., to AFRDB (by verbal authorization of AFFTC), 12 Jan. 1943, in files of AFACT-2, 353, Bombardier; memo for AC/AS, Training by Maj. H. E. Herzog through Col. T. J. Du Bose and Col. J. B. Montgomery, 14 June 1943, in files of AFACT-2.

Training of Instructors

Once bombardiers are assigned for instructional purposes, there remains the necessity of seeing that they are proficient as instructors as well as bombardiers. Instruction is an art within itself, and it is a patent fact that the most highly skilled person in any trade or profession will not, ipso facto, be effective in conveying that skill to others. Likewise the bombardier with the lowest circular error will not necessarily be the most effective instructor. Consequently, one of the important tasks of the bombardier schools has been that of training instructors.

The first bombardier training under the Chief of the Air Corps, early in the expansion program, was the training of three classes of bombardier instructors, from which classes there were 122 graduates. The training of these men at Lowry Field, however, was only partially an instructor course, since the classes were made up of men without prior bombardier training, flying cadets who had been eliminated from pilot training. The course of instruction consisted of a regular course of bombardier instruction with eight hours allotted to pedagogical procedures. Nevertheless, an examination of the outline of instruction offered in this eight hours (about 2.3 per cent of the time allotted to ground training) leaves the impression that a more thorough job was done on this part of the training of bombardier instructors than has thus far been done in the Central Bombardier Instructors School, established in January 1943. The time allotted to "Teaching Methods and Technique" at the latter school constitutes

only 0.9 per cent of the academic instruction.[27]

The instructors trained at Lowry were sufficient to carry on the instruction at the bombardier schools until about February 1942. By this time the number of students under instruction had passed the 500 mark, and an instructor shortage existed throughout most of the year. Graduate bombardiers were assigned to the bombardier schools, but there was no established policy or procedure relative to providing additional training for these men in order to enable them to become efficient instructors. Each school seems to have handled this problem in its own way. In July the Flying Training Command recommended that three weeks' additional training be given to graduate bombardiers who were to be used as instructors.[28] No record of action on this recommendation has been found, but apparently the individual schools did give some additional training to such men. In November, however, the Flying Training Command made a study on the feasibility of the establishment of a "Central Bombardier Instructors' School at Carlsbad."[29]

At the bombardier conference held in Fort Worth on 14-18 December, 1942, the establishment of an instructors' school was discussed and a definite plan formulated and recommendations made. The recommendations included: (1) The program of instruction should consist of two phases, a six-week course in ground school and bombing at the school, and a two-week tour of duty with an operational training unit. (2) Classes

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27. Lowry Report, in files of AFTRC, file no. 299; memo (no number), AAF Instructors School (Bombardier), Carlsbad, N. M., 14 July 1943, in AFHRI files.
28. Daily Diary, AFFTC, 8 July 1942.
29. 3d Ind. (basic unknown), CG, AFFTC to CG, AAF, 28 Nov. 1942, in AAG 353 A, Bombsight, Gunnery Training.

should enter every three weeks and should be composed of five instructor students from each of the eight bombardier schools, the first selection to be made from the "older instructors and supervisory personnel." (3) Instructors for the new school should be selected from the "most experienced bombardier instructors in the several schools, in the ratio of one instructor per ten student instructors." (4) The director of the school should function "directly under Headquarters" of the Flying Training Command. (5) The first week of the two weeks of duty with an operational training unit should be spent with a unit in the first phase of operational training and the second week with a unit in one of the two advanced phases, where the student could observe and participate in operational missions. (6) A recommended program of instruction for the first phase (six weeks at the school) was prepared.[30]

It was felt that such a school would not only raise the quality of bombardier instructors but would "also serve to coordinate requirements with the 2d and 3d Air Forces."[31] On 24 December 1942 the Flying Training Command sent a directive to the Commanding General of the West Coast Training Center to "establish a Central Bombardier Instructors School at Carlsbad, New Mexico, on 15 January 1943, or as soon thereafter as practicable."[32] Instruction began on 18 January 1943, to fulfill the following mission:

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30. Report of Bombardier Training Conference, from chairman of conference to CG, AFFTC, 18 Dec. 1942, in AFHRI files.
31. Memo for Col. T. J. Du Bose by Maj. E. H. Herzog, 22 Dec. 1942, in files of AFACT-2, 337, Bombardiers.
32. Daily Diary, AFFTC, 24 Dec. 1942.

a. Conduct advanced training of bombardier instructors assigned or to be assigned to the bombardier schools. . . .
b. Conduct refresher courses for bombardiers returning from combat zones and other personnel as may be authorized. . . .
c. Test, evaluate and publish, after approval by this [Flying Training Command] Headquarters, methods and procedures of instruction.
d. Test and evaluate training aids submitted for approval.[33]

The school was under the administrative control of the West Coast Training Center, but the director of training was "selected" by Flying Training Command Headquarters.

The program of instruction at the school, until July 1943, was made up of 134-1/2 hours of academic training and 36-1/2 hours of air training. In July the program of academic, or ground, instruction was revised with 16-1/2 hours allotted to the C-1 automatic pilot and 9 hours to instrument calibration. These, together with other minor changes, resulted in an increase of 28 hours in ground instruction.[34] Before the school started operation a change was made in the second phase of training, that is, in the tour of duty with the air forces. This change was the result of a request from the Second Air Force that the second phase of instruction be extended from two weeks to three, which would allow the instructor students to spend one week in each of the three stages of operational training. This request was approved by the Directorate of Individual Training and arrangements were made with the Second and Third Air Forces.[35]

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33. FTC Memo 50-11-6, 5 July 1943.
34. For the program of instruction and the July and November changes see Appendix 6.
35. Daily Diary, AFRIT, 14 Jan. 1943, in AAG 319.1-B, Daily Diaries.

The experience in the air forces of the first groups of graduates from the instructors' school proved unsatisfactory. The Assistant Chief of Air Staff, Training informed the Flying Training Command of reports which had been received to the effect that

> in the majority of cases the Operational Training Units are too busy with their own program to devote any time to these officers. Some of the older officers are able to dig out the information they were sent there for, of their own accord. However, most of the younger officers avail themselves of this period as a three-weeks vacation.

Opinions and recommendations relative to the value of this type of training were requested.[36] It appears that the class which graduated on 1 May 1943 was the last group to be detailed to the air forces for this phase of training. This attempt to coordinate the training of the Flying Training Command with that of the Second and Third Air Forces met the fate of previous efforts. These air forces requested and were granted authority to give individual training to bombardiers, but they soon found that they had no time for such training, and some of the men had to be returned to the Flying Training Command for the completion of their training. It was at the suggestion of the Second Air Force that the two-week period of duty for graduates of the instructors' school was extended to three weeks, but again it was found that such training could not be given satisfactorily, and hence it was terminated.

The classes at the Central Bombardier Instructors School were in the beginning composed of five instructors from each of the eight

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36. AC/AS, Training to CG, AFFTC, 28 Apr. 1943, in files of AFAOT-2, 352.17, Bombardier

bombardier schools. This practice was followed for the first six classes. Beginning with class 43-7 the number was increased to 10 from each school, plus some men returned from combat. Ten combat men were enrolled in class 43-7 and 30 in class 43-8 and 43-9. In July 1943 the ratio of distribution of combat men processed through the Central Bombardier Instructors School was approximately one to the Flying Training Command and two to the air forces. The Flying Training Command tried at one time to have all men from combat who were assigned to the Command and the training air forces processed through the Central Bombardier Instructors School. By the end of 1943 all of those going to the Command were processed through the school; but the air forces had sent so many that the school had been unable to accommodate them, and in August 1943 the quota for the air forces was set at 15 per class. As of 1 October 1943 consideration was being given to the establishment of such a school in the air forces solely for the purpose of further training for combat men assigned to the air forces. This was caused not only by the inadequacy of accommodations but by the feeling that a different program of instruction was needed for the men assigned to the air forces.

The academic standards of the Central Bombardier Instructors School were high. Upon entrance to the school each instructor was given a comprehensive examination in order to ascertain his strengths and deficiencies in order to adjust instruction to his needs. The minimum passing grade for any single course was 80 per cent, but an average grade for all subjects of 85 per cent was required for graduation. Students falling below this minimum requirement were recommended

for reclassification by the Instructors School to the school from which they came. One of the most striking facts about the instruction was that, though the school was established for the training of instructors for the various bombardier schools, approximately 97 per cent of the ground instruction was devoted to giving technical knowledge and only about 1 per cent to instructional procedures. It was indicated, however, in the early program of instruction that additional time would be devoted in each course to instructional techniques. Nevertheless, the course of instruction was, until the fall of 1943, almost entirely a post-graduate course rather than a course designed to improve the teaching proficiency of instructors. These two things, further technical training and improvement of teaching proficiency, are not mutually exclusive of each other in the training of instructors. It appears obvious that the program was overbalanced in the favor of an increased technical knowledge with a very limited amount of time devoted to the improvement of instructional technique.

It seems that a better balance in the program of instruction was attained by a revision of November 1943. The newly stated objectives of the school included the following significant addition: to "Prepare personnel by familiarization with teaching methods and through practice teaching, to assume their duties as instructors," whereas previous statements of the mission had indicated only that the school was to "Conduct advanced training of bombardier instructors assigned or to be assigned to the bombardier schools of the Training Command." Another significant change in the November program was that of increasing the time allotted to pedagogical procedures from four

hours devoted to "Reasoning Methods and Technique" and "Rating Procedure" to 18 hours devoted to "Instructional Analysis."[37]

The records made by the instructors sent to the Instructors School by the several bombardier schools varied a great deal. Some schools selected their best instructors, some a cross section, and some the instructors most in need of additional training. Some schools, it is alleged, gave special instruction in their own instructors' school to the men scheduled to go to the Central Instructors School. There was a marked feeling at the Instructors School that the bombardier schools relied too much on the circular error in the selection of instructors.

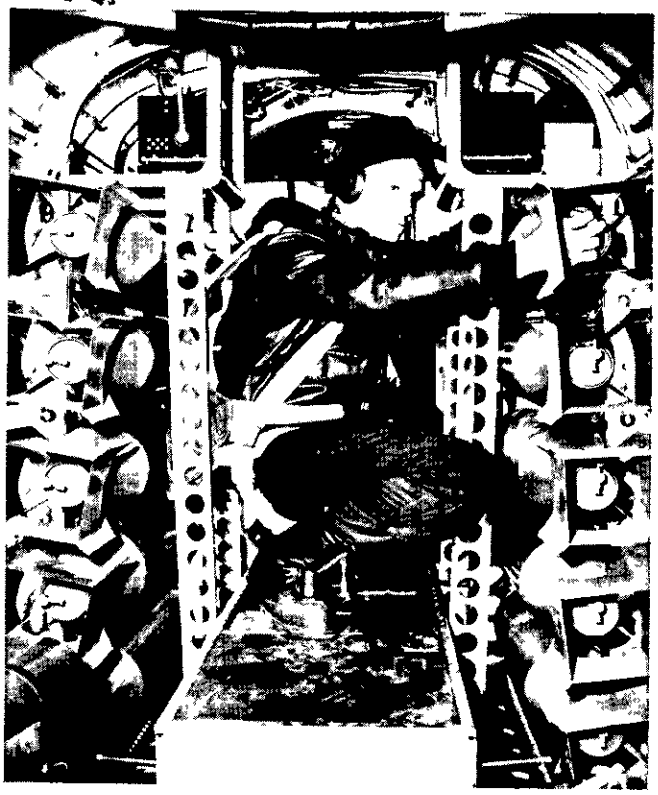
On 6 August 1942 the Instructors School was transferred from Carlsbad Army Air Field, Carlsbad, N. M. to Midland Army Air Field, Midland, Tex., and its designation was changed from "The Central Instructors School (Bombardier)" to the "Army Air Forces Instructors School (Bombardier)."[38] The number of graduates from the Instructors School (Bombardier) through October 1943, with eliminations was as follows:[39]

Month	Graduates	Eliminees[40]	Graduates to date
February and March 1943	81	4	81
April	43	4	124
May	74	15	198
June	35	6	233
July	176	14	409
August	114	00	523
September	116	18	639
October	238	5	877

37. TC Memo 50-11-6, 12 Nov. 1943. For a reproduction of this Memo see Appendix 6.
38. TC Memos 50-11-6A and 50-11-6B; AAF Letter, 352, 23 Aug. 1942.
39. Consolidated Flying Training Summary (Monthly), AFTTC, in AFHRS files. The report on "Graduates to date" varies slightly from this compilation.
40. On the basis of these data the elimination rate in instructor training has been 6.8 per cent.

SECRET SECURITY INFORMATION

Preparatory to a bombing mission, bombsight is installed in the bombardier's compartment of an AT-11.



Soon after the take-off, bombardier removes arming pins from his bombs, thus readying them for release.

Bombardier sets his final corrections in the sight, the airplane now on collision course with target.

A bomb is seen falling through the bomb-bay doors of an airplane, after release on a night mission.

Instructor Training in Individual Bombardier Schools

Another type of training for bombardier instructors was that conducted in each bombardier school, primarily for the purpose of training recent graduates who had been assigned to the schools for instructor purposes. The first step in this direction was simply extending the regular training of students beyond the date of graduation.[41] It appears that this policy was followed more or less generally by the various schools until the bombardier conference in Fort Worth in May 1943. At this time the Instructors School, unable to meet the full demand for instructor training, recommended a standard program of instruction "for an instructors school to be conducted at all" of the bombardier schools. This program called for three weeks' instruction to be conducted in two phases. Seventy-three hours of further specialized technical training were to be given in the first two weeks; while the last week was to be devoted to 36 hours of instruction in pedagogy and rating. During this second phase of training the new instructor was to be called upon "to demonstrate his ability to instruct" by a laboratory-type demonstration utilizing "pilots, student pilots, bombardier students, and any administrative personnel."[42] By the end of 1943 such instructor schools were conducted in each of the bombardier schools.

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41. Daily Diary, AFTTC, 8 July 1942, in AAG 319.1-3, Daily Diaries.
42. Report on Bombardier Conference at Fort Worth, Texas, 11-12 May 1943, dated 15 May 1943, in files of AFACT-2, 337, Bombardier.

This type of instructor training was absolutely essential because of the turnover in instructor personnel, the constant need to improve instruction in the schools, and the inability of the Central Bombardier Instructors School to conduct all of such training. The turnover of instructor personnel was the result of the demand for seasoned bombardiers for combat duty, the desire on the part of the schools to release for combat duty some of the men who were good bombardiers but who did not make good instructors, and the policy of maintaining a regular flow of instructors from the bombardier schools to the Second and Third Air Forces to serve as staff bombardiers.[43] It was the established policy on the transfer of experienced instructors to have 9 per cent of the instructors in the bombardier schools to go to the air forces each month, thus accomplishing a complete turnover every 11 months. This constituted a much more rapid turnover than was contemplated in December 1942 when the policy was adopted and at which time a definite schedule was established to extend from December 1942 through September 1943. This schedule called for the transfer of only 345 instructors during the 10-month period.[44] After December 1942, however, there was an increasing realization of the superior nature of the training in the bombardier schools and the need for more of the school instructors in the operational training units.

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43. AFFIT to CG, AFFTC, 1 Dec. 1942, in AAG 352.16 A, Instructors; AAF Memo 35-13, 23 Nov. 1942.
44. AAF Memo 35-13, 23 Nov. 1942.

The transfer of instructors from the bombardier schools to the air forces occasioned further complaints regarding the training conducted in the air forces. The bombardier schools obviously preferred not to lose their good instructors, and their reluctance increased as reports came in to the effect that these men were not being fully utilized in the operational training units. In July 1942 the Flying Training Command informed the Directorate of Individual Training that it had recently found that the bombardier instructors taken from the bombardier schools for a "Medium Bombardment Group had not dropped a bomb since they left the bombardier schools approximately two months" before. The bombardier instructors "stated that practically all the time was spent in checking off the pilots in the combat type airplanes."[45] This same complaint was made several months later when it was pointed out that some of the staff bombardiers released by the Flying Training Command were not assigned for such work after reaching the air forces. As a result of these reports, the Directorate of Individual Training registered a strong complaint with the Directorate of Bombardment:

> These officers were selected from the cream of the bombardier instructors in the schools of the Flying Training Command at the request of our directorate for use as staff bombardiers. If their services are not actually needed in this capacity, request reassignment

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45. Chief of Staff, AFTC to AFRIT, 17 July 1942, in AAG 353.9-1B, Bombsight Training.

to the Flying Training Command, and discontinuance of the plan of taking instructors from the bombardier schools for use as staff bombardiers.[46]

The practice was nevertheless continued.[47]

Bomb-Approach Pilots

One of the most important requisites of bombardier training is an adequate supply of proficient bomb-approach pilots. The effectiveness of the bombardier is largely dependent upon the proficiency exercised in piloting the airplane. This is true not only where the bombing run is performed manually; even when the automatic pilot is used, the pilot of the airplane must know the bombing problem and how to fly the airplane with the use of the automatic pilot. The demand for such pilots for both the bombardier schools and the operational units was so great that the bombardier schools found it difficult to train and keep enough pilots of this type to conduct their training in the most efficient manner. The shortage in the operational units was even more acute than in the bombardier schools. It existed both in numbers of pilots and in pilots experienced in flying bombing missions.

The shortage of pilots for bombardier training was one of the first problems encountered when the Chief of the Air Corps began such training. In June 1941 the Chief of the Air Corps pointed out the shortage of twin-engine pilots for non-pilot training and

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46. AFRIT to CG, AFTTC, 19 Mar. 1943, in files of AFAOT-2, 352.16, Bombardiers; AFRIT to AFRIB, 19 Mar. 1943, in ibid.
47. Daily Diary, AFTTC, 5 June 1943.

requested a loan of 60 pilots from the Air Force Combat Command. The Commanding General of the Combat Command indicated that there was also a similar shortage in that command and that such a loan was impossible.[48] By February 1942, when the annual production rate for pilots was only 13,000, the pilot shortage was so critical as to "warrant the use of [only] one pilot in B-18 type airplanes on training missions."[49]

By the middle of the year 1942, when the annual production rate for pilots had reached 30,000, the shortage had been somewhat relieved, but the demand for experienced pilots in the tactical units had so increased that more and more of the experienced bomb-approach pilots in the bombardier schools were demanded by the tactical units. On 5 June the Flying Training Command was notified that 400 pilots were to be transferred from the Command.[50] All of these were not, of ocurse, to be taken from the bombardier schools, but in the following month the Directorate of Individual Training requested the suggestions of the Flying Training Command relative to a policy of transferring 10 per cent of the pilots at each bombardier school to the operational training units every three months. It was felt that such a policy would have the advantages of providing experienced bombing pilots to the air force units and of improving the morale of the pilots, since "those desiring combat would have something to work for."

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48. C/AC to CG, GHQAF [sic.; GHQAF became the AFCC on 20 June 1941], 25 June 1941 and 1st Ind., 28 June 1941, in AAG 211 6, Pilots.
49. CG, AFTC to Chief, AAF, 20 Feb. 1942, in AAG 211 D, Pilots.
50. Daily Diary, AFTC, 5 June 1942.

These experienced pilots lost to the Flying Training Command would be replaced by graduates of the twin-engine pilot transition schools. This policy was agreed to by the Flying Training Command and was placed in operation.[51] This practice was also approved by the Directorate of Bombardment, which was interested in raising the experience level of pilots in the Second and Third Air Forces.[52]

Since bombardier classes graduated every three weeks, the Flying Training Command requested that 2 per cent of the bomb-approach pilots at each school be turned over to the air forces with each graduating class. It was further requested that the graduates of the twin-engine schools who were to replace the experienced pilots arrive at the bombardier schools three weeks before the experienced pilots were to be released. These requests were concurred in and such a policy was established.[53]

Pilots with experience in the bombardier schools were especially useful to the tactical units since pilot-bombardier coordination in the bombardier schools was more highly perfected than at any other place in the AAF. Training in the bombardier schools was conducted in such a manner that both pilot and bombardier had an understanding of the functions of the other. It was the policy of the bombardier schools to utilize student bombardiers "as safety observers ... seated

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51. AFRIT to CG, AFTTC, 22 July 1942, in AAG 211 B, Pilots; Daily Diary, AFRIT, 22 July 1942, in AAG 319.1-3, Daily Diaries.
52. MAR, AFHDB to AFRIT, thru AFDMR, 3 Aug. 1942, in files of AFAGT-2, 211, Bombardier.
53. 1st Ind. (AFRIT to AFTTC, 22 July 1942), CG, AFTTC to AFRIT, 6 Aug. 1942; Daily Diary, AFTTC, 6 Sep. 1942.

in the co-pilot's position during certain phases of training." Also, they were "used to pilot the trainers during this phase of training" and thus became "familiar with the pilot's responsibility and technique in following the PDI [Pilot Direction Indicator]."[54] Before April 1943 it had been the policy of the Gulf Coast Training Center to qualify supervisory pilots as bombardiers. After this date the policy in both the Gulf Coast and West Coast Training Centers was "to qualify pilots as bombardiers" when it became apparent that they were "to be selected as supervisory officers."[55]

It is obvious from all the records available, and from observations on bombardier training in all its stages, that there was a better pilot-bombardier coordination in the bombardier schools than in any other stage of training. One of the most important by-products of the bombardier schools was the supply of experienced bomb-approach pilots for the operational training units. In the early period of bombardier training, however, the loss of these pilots was a real problem for the bombardier schools.

Throughout 1943 the supply of bombardier instructors was adequate. In fact, with the inauguration of the 16-week program of instruction and the change of the instructor-student ratio from 1 to 3 to 1 to 4 there was an apparent instructor surplus of more than 500.[56] There

54. 2d Ind. (CG, 4th AF to CG, AAF, 5 Nov. 1942), CG, AFFTC to AFHIT, 11 Dec. 1942, in AAG 353 A, Bombsight, Gunnery Training.
55. 1st Ind. (basic unknown), CG, AFFTC to CG, AAF, 16 Apr. 1943, in AAG 352.11 A, Courses of Instruction.
56. Memo for Col. T. J. De Bose by Maj. H. C. McTague, 27 Oct. 1943, in files of AFAGT-2.

was room for improvement, however, in the quality of instruction. While instruction in the bombardier schools was definitely superior to that in the training air forces, the effectiveness of bombardier instructors could have been increased. The principal weakness in this regard was in the Central Bombardier Instructors' School. The flying training phase of instruction in this school was apparently superior, but the ground school instruction fell short of its possibilities.[57] The importance of superior instructor training was emphasized by the need for marked improvement in bombardier instruction in the training air forces. These air forces were dependent for their staff bombardiers upon the bombardier instructors from the bombardier schools and the bombardiers who were returned from combat and processed through the instructors' school. The turnover of experienced bombardier instructors and bomb-approach pilots to the training air forces was one of the most important contributions of the Training Command to the AAF training program.

57. Ibid.

Chapter VI

MATERIEL FACTORS

Bombardier training, like all other missions of the AAF, has been vitally conditioned by the supply of materiel items. Items of prime importance in bombardier training are airplanes, bombsights, and bombs.

Airplanes

At the beginning of the expansion program there were no up-to-date bombardier training airplanes, and no new ones were expected for nearly two years.[1] The airplanes used in bombardier training before about March 1941, when the AT-11 went into production, were B-12's and B-18's. The B-18's were used in both bombardier and gunnery schools. By the end of 1940 apparently only the B-18's were being used in bombardier training, and there were only 197 of these in the continental United States. Of these, only 25 were listed as assigned to Air Corps "Training Activities." It seems, however, that these 25 did not include those loaned by the GHQ Air Force to Lowry Field for the bombardier training at that school. The Training and Operations Division, Office, Chief of the Air Corps, recommended the transfer of 74 of the B-18's from the GHQ Air Force to training activities, in-

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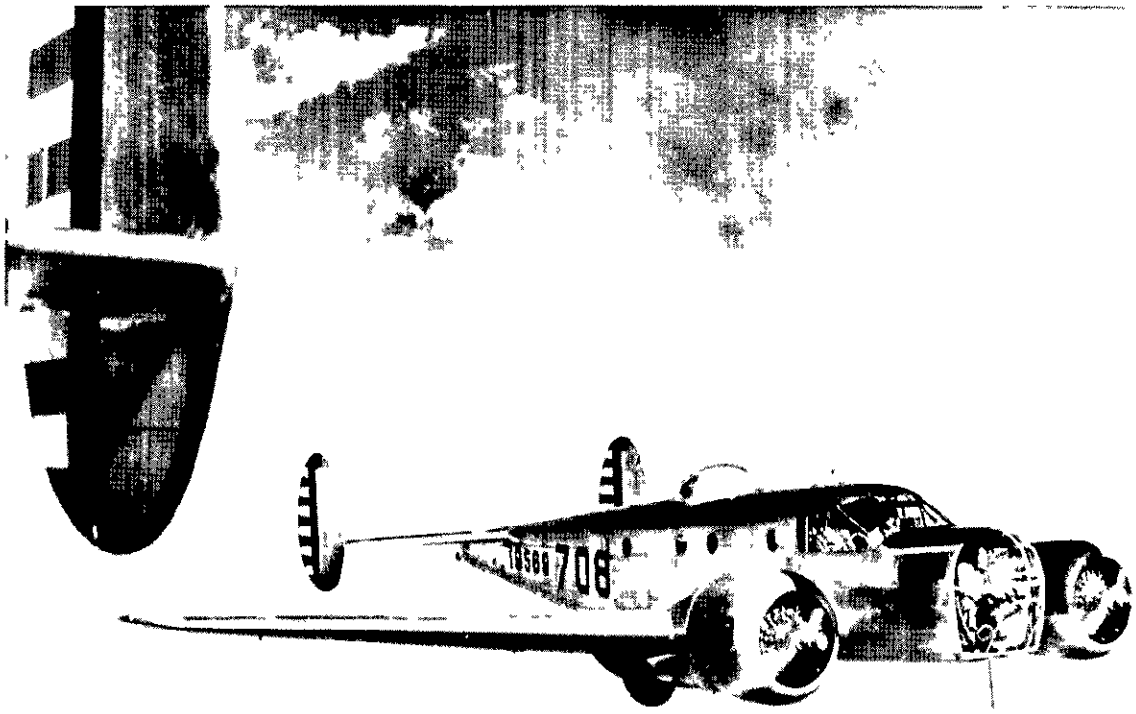
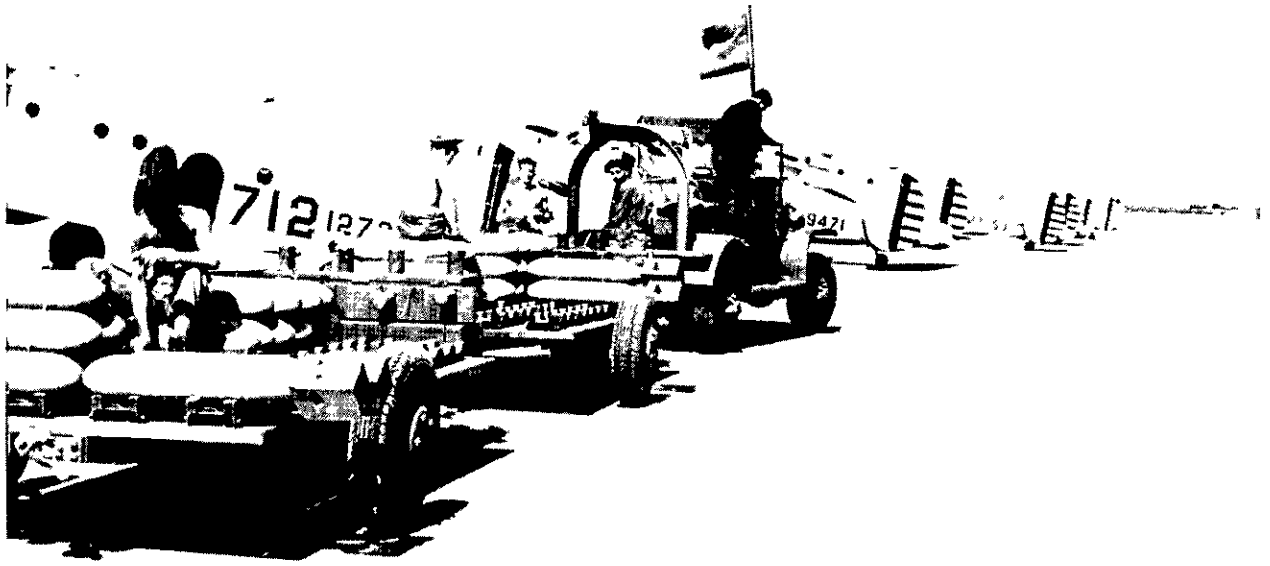
1. Station List, 28 Aug. 1939, in AFIHI files.



This Beechcraft AT-11 became the standard trainer airplane used in the bombardier schools. Most Sperry training was conducted on the B-34, though AT-11's were also engineered for the Sperry sight.



These AT-11's on the flying line are ready to be loaded with M38A2 bombs. The bombardier inspects bombs upon receipt from the ordnance department and may reject any which he considers defective.

dicating that the bombardier training at Barksdale and Ellington was "absolutely dependent" upon obtaining these planes. Also, it was held that "the present vagueness of general plans as they affect the future activities of the several training centers can almost be attributed entirely to the failure to reach a definite determination with respect to the future availability of combat types of equipment to these commands."[2] The number of B-18 airplanes on hand does not accurately reflect training possibilities, however, since it was difficult to keep these airplanes in operating condition.[3]

In January 1942 when the program rate for bombardier production was 5,590, the Commanding General of the newly established Air Corps Flying Training Command informed the Chief of the AAF that the schedule of bombardier production furnished by his Command could not be depended upon "due to shortages of airplanes and bomb sights."[4] On 6 March 1942 there was on hand at the three bombardier schools a total of only 130 airplanes as against 234 which had been requested. At this time, however, training airplanes were being requested on the basis of one airplane to each three students,[5] whereas the established ratio about a year later was one to six.[6] By September 1942,

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2. R&R, T&O to Executive through Plans, 30 Dec. 1940, in AAG 353.9-1A, Bombsight Training.
3. 2d Ind. (AFRIT to AFFTC, 5 Mar. 1943), CG, SCACTC to CG, AFFTC, 29 Mar. 1943, in AAG 352.11 A, Course of Instruction.
4. CG, AFFTC to C/AAF, 31 Jan. 1942, in AAG 353.9-1A, Bombsight Training.
5. R&R, CG, AFFTC to CG, AFASC, 6 Mar. 1942, in ibid.
6. Daily Diary, AFRIT, 25 Feb. 1943, in AAG 319.1-C, Daily Diaries.

however, the student enrollment in the bombardier schools was approximately 50 per cent larger than was expected when the schedule of equipment was requested. But when it is considered that many of the airplanes on hand in March 1942 were B-18's, a large percentage of which could not be kept in operation, the student-plane ratio rises considerably.

The most important problem which faced the bombardier schools in 1943 in the way of training airplanes was that of securing tactical types. In February 1943 the Flying Training Command had "no 'operational airplanes,' i.e., airplanes that have been flown less than 25 per cent allowable engine time, and have been modified."[7] These airplanes were needed not only for training two- and four-engine pilots, but there was also a feeling that more of the training of the bombardier should be on the heavier type aircraft, especially for the training on Sperry equipment. In June 1943 efforts were still being made to secure tactical aircraft "for all phases of Flying Training Command activities," and the Command was assured that by early fall an increasing number would be available.[8]

The ratio of students to airplanes (training and tactical) assigned to the bombardier schools for the training of precision bombardiers, D-8 bombardiers, and bombardier/dead-reckoning naviga-

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7. Ibid.
8. 1st Ind. (AFFTC to AC/AS, Training, 28 May 1943), AC/AS, Training to CG, AFFTC, 10 June 1943, in files of AFACT-Z, 337, Bombardier.

tors for the period from October 1942 through July 1945 was as follows:[9]

Month	Student Population	Airplanes Assigned	Student-Airplane Ratio[10]
October 1942	3,578	577	6.2
November	4,007	652	6.1
December	3,691	728	5.0
January 1943	3,758	812	4.6
February	4,034	811	4.3
March	4,871	824	6.0
April	5,146	792	6.6
May	5,210	753	6.6
June	4,937	766	6.2
July	4,866[11]	740	5.0

Bombsights

The bombsight was even more basically necessary than training airplanes for bombardiers' training. The bombsight was used not only for air training but also for ground training, a considerable portion of the ground training time being allocated to instruction which involves the use of the bombsight. At the end of 1943 approximately 88 hours of the ground instruction involved the use of the bombsight.

As in the case of airplanes, several different types of bombsights were used in bombardier training. There were two types of

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9. Data taken from Consolidated Flying Training Report (Monthly) AAFTC, in AFIHI files; RAR, AFMSC to AFIHD, 15 Oct. 1943, in AFIHI files.
10. These ratios do not necessarily reflect the actual availability of training planes since some of the assigned planes were not in the bombardier schools.
11. The number of students appears small this month due to shifting the program from precision bombardier to bombardier/dead-reckoning navigator.

precision sights, the Sperry and Norden, and two types of non-precision sights, the D-8 and T-1. In addition to these, various foreign bombsights were used from time to time. The training problem was affected both by the problem as to the type of sights on which bombardiers were to be trained and by the number of sights available. As a general policy the Flying Training Command requested bombsights on the basis of one sight for each training airplane.[12] As in the case of all other types of materiel, a shortage of bombsights existed, and there was the same struggle to secure them as there was to secure airplanes.

In January 1942 the Chief of the Air Corps informed the Chief of the Army Air Forces that bombardier training would be "severely handicapped due to the shortage of bombsights and that bombardiers would be of inferior quality unless 75 sights were made available during the month of May." [13] On 6 March 1942 there were only 187 bombsights on hand in the bombardier schools.[14] The need to speed up the production of bombsights was such that in March it was recommended that the "Automatic Erection System be eliminated in order to expedite the procurement of bombsights."[15]

The shortage of the precision bombsights made it necessary virtually to confine their use to the bombardier schools and the Second

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12. R&R, CG, AFFTC to CG, AFASC, 6 Mar. 1943, in AAG 353.9-1A, Bombsight Training.
13. C/AC to C/AAF, 12 Jan. 1942, in ibid.
14. R&R, CG, AFFTC to CG, AFASC, 6 Mar. 1943, in ibid.
15. Daily Diary, AFDMR, 15 Mar. 1942, in AAG 319.1-3, Daily Diaries.

Air Force, taking practically all of these sights from the multi-engine pilot schools and from the Third Air Force. The Third Air Force, however, since its training consisted of low and medium altitude bombardment, could utilize the non-precision sights. In the period of most acute bombsight shortage, these sights were used in the bombardier schools.[16] Instruction on the non-precision sights continued in the schools also for the training of bombardiers who were to be assigned to the Third Air Force.

With the exception of the problem of procuring bombsights in sufficient quantity, probably the biggest problem encountered relative to the precision sights was that of training on Sperry equipment. Though the Sperry sight was in production as early as 1937, it had not by October 1943 undergone sufficient improvement to satisfy those responsible for bombardier training and bombardment. Neither the supply nor the performance of this sight had been adequate. Even in the face of an ever-increasing demand for bombsights and related equipment, there was a strong resistance to its use in the Flying Training Command and the Second Air Force.

As late as April 1942 the installation of the S-1 (Sperry) sight on training airplanes was proceeding at a very slow rate. The Flying Training Command was informed that two B-18A's were in the process of being equipped with the S-1 sights but that the shipment of this type of sight to Midland would be delayed. Also, the two

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16. Daily Diary, AFTTC, 16 Mar. 1942.

airplanes referred to would not be equipped with the A-5 (Sperry) automatic pilot as the gyro for this pilot was unavailable.[17] In the following September delivery of the Sperry sights had improved somewhat, and plans were made to install these sights on 14 airplanes in each of five medium bombardment groups.[18] By 29 October, however, there were only 86 Sperry sights in the bombardier schools--when the student population of these schools was over 3,000. Only four of the eight schools had any of these sights, and only one (Midland) had airplanes equipped with them. Midland had 53 sights but had only 11 airplanes equipped with them--5 B-34's, 2 B-18A's, and 4 AT-11's. The AT-11's were the property of the Netherland East Indies Government and were scheduled to go to Jackson, Miss. with the Netherland East Indies students then in training at Midland.[19]

Still another handicap to training on Sperry equipment, as far as airplanes was concerned, was the fact that the greater percentage of the bombardier training airplanes (the AT-11's) were not engineered to take the Sperry sight. Only the old B-18's and the B-34's were so constructed as to make it possible to use Sperry equipment; the B-34 did not "have a bombardier compartment large enough to contain

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17. R&R, AFAMC to AFFTC, 11 Apr. 1942, in AAG 353.9-1B, Bombsight Training.
18. Deputy Director of Bombardment to CG, 3d AF, 27 Sep. 1942, in ibid.
19. 1st Ind. (AFRIT to AFFTC, 29 Oct. 1942), CG, AFFTC to CG, AAF, 11 Nov. 1942, in AAG 353 A, Bombsight, Gunnery Training.

an instructor as well as a student." These conditions existed as late as the middle of April 1943. At that time, however, plans were being made to have the AT-11's engineered to take the Sperry bombsight.[20] Arrangements were made to have 200 AT-11's engineered for and equipped with the Sperry sight and the A-5 pilot. At least 100 of these were actually delivered by 13 August 1943.[21] In addition to the shortage of Sperry sights and airplanes in which such sights could be used, there was the further deterring factor of the difficulty of getting the Sperry sight in and out of the airplanes before and after missions. This tended to build up a prejudice on the part of the bombardier against the use of this sight.

The obvious effect of all these obstacles to the training of precision bombardiers on the Sperry bombsight was that only a very small percentage of bombardiers were trained on this equipment, most of them receiving training only on the Norden sight. The natural result of this fact was that Sperry training was still further limited because of the shortage of men who had had Sperry training and experience and who were qualified to conduct such training. In June 1942 the beginning of Sperry training in the West Coast Training Center had to be postponed indefinitely because of the lack of personnel qualified to conduct such training.[22] A small number of students received training on Sperry equipment throughout 1942, but the first

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20. R&R, AC/AS, Training to AC/AS, OC&R, 14 Apr. 1943, in files of AFACT-2, 353, Bombardiers.
21. AC/AS, Training to C/AS, 13 Aug. 1943, in files of AFACT-2, 475.371, Bombing Equipment.
22. Daily Diary, AFTTC, 20, 21 June 1942.

class of bombardiers to graduate with "some training on the Sperry sight" was either Class 43-1 or 43-2 at Midland which graduated in January 1943.[23] The next school to graduate a class with training on this sight was Big Springs, which class was scheduled to complete training on 8 June 1943. These two schools were expected to graduate bombardiers with a "working knowledge of the Sperry sight" at the rate of 300 every three weeks.[24]

In the face of such conditions there was a strong demand to concentrate all precision bombardier training on Norden equipment. The demand for bombsights was so heavy, however, that the Norden company could not supply sufficient sights, and it was felt that Sperry equipment must be utilized in spite of all the difficulties encountered. Also, since plans called for the use of the Sperry bombsight in the tactical units, it was essential that some portion of bombardiers be trained on this equipment. The desired ratio of training on the two types of precision bombsights changed from time to time. The objective, in January 1943, was to have all students receive half of their training on the Norden sight and half on the Sperry sight.[25] In the following March the desired distribution of training was that of having three-eighths of all bombardiers trained on Sperry sights and five-eighths on Norden sights.[26] It was, of course, impossible

23. 1st Ind. (basic unknown), CG, AFFTC to CG, AAF, 22 Dec. 1942, in files of AFACT-2, 353, Bombardiers.
24. Daily Diary, AFFTC, 28 Apr. 1943; 3d Ind. (AFRIT to CG, AFFTC, 5 Mar. 1943), CG, AFFTC to CG, AAF, 27 Apr. 1943, in AAG 452.11 A, Courses of Instruction.
25. AFRIT to CG, AFFTC, 5 Mar. 1943, in AAG 352.11 A, Courses of Instruction.
26. Daily Diary, AFFTC, 15 Jan. 1943.

to attain either of these objectives.

Until April 1943 the qualification standards for bombardiers required that the bombardier be able "to bomb within accuracy requirements with . . . M-series [Norden], S-series [Sperry], and D-series" bombsights. The program of instruction called for all bombardiers to be basically trained on Norden sights and to accomplish 25 releases with the Sperry sight. It was felt that this would provide sufficient basic training on Sperry equipment in the individual training stage and would prepare the bombardier for additional training on Sperry equipment in the operational training stage.[27] There continued to be, however, an inadequate supply of Sperry sights and the qualification standards for bombardier/dead-reckoning navigator dated 20 August 1943, while requiring proficiency on the three types of sights, contained the provisions: "S-series proficiency dependent on availability of training equipment."[28] The objective of the program of instruction dated 29 September 1943 called for the attainment of basic proficiency on the Norden sight "plus a working knowledge of all other standard types of bombsights."[29] This apparently meant simply a "familiarization course" on Sperry equipment.[30]

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27. 1st Ind. (AFFTC to AC/AS, Training, 14 Apr. 1943), AC/AS, Training to CG, AFFTC, 22 Apr. 1943, in files of AFACT-2, 353, Bombardier-Navigator.
28. TC Memo 50-11-1, 20 Aug. 1943.
29. TC Memo 50-11-1, 29 Sep. 1943.
30. General Yount's Project Book, Bombardier Training, 20 Aug. 1943, in AFHRI files.

Because of the limited equipment for conducting training on the Sperry sight, the advisability of conducting such training at all bombardier schools was questioned. As early as December 1942 plans were made to concentrate all Sperry training at one bombardier school. As a result, all such training was confined to the school at Midland where this type of training had begun about July 1942. This policy was followed until about April 1943 when Sperry training was initiated at Big Springs.[31] On 5 March 1943 the Flying Training Command was informed that existing training on Sperry sights was inadequate, that "the total students receiving Sperry training, [should] be increased to approximately three-eighths of the total bombardier production," and was requested to redistribute equipment to other schools.[32]

Pursuant to these requests the matter was referred to the Commanding General, Gulf Coast Training Center, who was asked to submit plans for an increase in Sperry training with information on the personnel and materiel which would be necessary. In compliance with this request two plans were forwarded to the Flying Training Command. "Plan A" provided for retaining all Sperry training equipment at one bombardier school (Midland) and lengthening the course of instruction three weeks in order to provide the additional Sperry training without impairing the Norden training. By this plan students would

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31. Daily Diary, AFFTC, 28 Apr. 1943.
32. AFRIT to CG, AAFTC, 5 Mar. 1943, in AAG 352.11 A, Courses of Instruction.

graduate from the 12-week course and then be sent to Midland for a 8-week course on the Sperry bombsight, that is, take a "post graduate course in Sperry training." Since there existed a surplus of bombardiers, this additional training would not affect the flow of bombardiers to the air forces and would provide all bombardiers with Sperry training.

The second plan, "Plan B" provided for distributing Sperry equipment and personnel among three of the bombardier schools (Midland, Big Springs, and San Angelo). The objections to this plan, which objections accompanied the plan itself, were as follows: (1) as the student would have to learn the operation and maintenance of two "complicated mechanisms at the same time," his Norden training would be compromised; (2) three different types of aircraft would have to be maintained at each of these schools. The problem of maintenance on the old B-18's and the B-34's was pointed out, and it was emphasized that this problem would become more acute when the airplanes and the maintenance equipment and personnel were distributed among three schools. Although both plans were submitted, the Gulf Coast Training Center recommended the plan for keeping training concentrated at Midland.[33]

The Flying Training Command decided to distribute Sperry training between two schools, Midland and Big Springs. The Directorate

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33. 2d Ind. (AFRIT to AFFTC, 5 Mar. 1943), CG, GCACTC to CG, AFFTC, 29 Mar. 1943, in ibid.

of Individual Training was informed of this decision and of the expected flow of graduates trained on the Sperry bombsight. Midland was expected to graduate 150 Sperry-trained bombardiers every three weeks, and, beginning 3 June, this flow would be supplemented by a like number from Big Springs.[34] The recommendation for lengthening the course of instruction by three weeks was not approved until 14 June 1943.[35] Even after approval, however, this extra training was not placed in effect, because of the uncertainty of future Sperry training and the decision that "no extra emphasis will be placed on this phase of training."[36] In October, however, the policy of confining Sperry training to the two bombardier schools was abandoned, and such instruction was put into all the bombardier schools except Roswell. All students were to be qualified on Norden sights before they released any bombs with the Sperry sight.[37]

In addition to problems of material, personnel, and training, there arose others, springing from lack of confidence in the operational value of the Sperry sight itself. This feeling, applying to both the A-5 (Sperry) automatic pilot and the bombsight, was widely held throughout the Training Command and the Second Air Force and also to a considerable extent in AAF Headquarters.[38] On 10 August the

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34. 3d Ind. (AFRIT to AFFTC, 5 Mar. 1943), CG, AFFTC to AFRIT, 27 Apr. 1943, in ibid.
35. Daily Diary, AFFTC, 15 June 1943.
36. General Yount's Project Book, Bombardier Training, 26 June 1943, in AFIHI files.
37. Daily Diary, AFTRC, 7 Oct. 1943, in AFIHI files.
38. Memo for Lt. Col. E. H. Herzog by Capt. H. O. McTague, 13 Aug. 1943, in files of AFACT-2. See Appendix 7.

Flying Training Command was informed that consideration was "being given to abandonment of the Sperry bombsight and the Sperry A-5 Pilot"; until a decision was reached, however, it would "be necessary to continue Sperry training under present directives."[39] During the ensuing weeks a special study was made on the policy of the future use of the Sperry bombsight. The result of this study was a recommendation that the use of this equipment be discontinued. On 29 September 1943 this recommendation was approved by Brig. Gen. E. S. Perrin, Deputy Chief of Air Staff. It appeared, however, that the Sperry sight would continue to be used for several months, until Norden production reached the point where it could meet the demands of the AAF. As of 15 October 1943 no directive had been issued to discontinue training on Sperry equipment.

Bombs

Another materiel problem, the supply of practice bombs, became acute in December 1942 and continued so until well into March 1943. The production schedule for practice bombs (M 38A2) for the early part of 1943 was as follows: January, 300,000; February, 460,000; and thereafter 800,000 per month. Delivery of bombs under this schedule fell far short because of a drastic decline in production. December production was 100,000, and in February it was only 135,000, or less than one-third of the scheduled production.[40]

39. Daily Diary, AFACT-2, 10 Aug. 1943, in AFHRI files.
40. Daily Diary, AFRIT, 4 Jan. 1943, in AAG 319.1-C, Daily Diaries; ibid., 5 Mar. 1943, in AAG 319.1-C, Daily Diaries.

During this period of bomb shortage the Flying Training Command attempted to maintain the training schedule by securing bombs from other AAF organizations, such as the Technical Training Command and the Second and Third Air Forces.[41] Though the air forces had enough bombs to continue their training schedule, sufficient bombs could not be diverted from them and the Technical Training Command to meet the demands of the bombardier schools. As a result, the AAF had to resort to procuring the MK-15 water-filled practice bombs from the Navy. These were only 49-pound bombs and contained no spotting charge, but the Flying Training Command found that they could be used for missions of 500 to 1,000 feet.[42]

The training schedule of bombardiers could not, however, be maintained, even with the bombs secured from other sources, and the bombardier schools were forced to make a reduction in the required number of bomb releases per student. This number was reduced in December 1942 from 200 to 150, and in the following month further reduced to 125,[43] although in May 1943 provision was made to allow the full 150 bombs per student at Midland and Big Springs where Sperry training was conducted.[44] These reductions in bomb releases

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41. Daily Diary, AFFTC, 5 Jan. 1943.
42. Ibid., 18 Feb. 1943; Daily Diary, AFRIT, 16 Jan. 1943, in AAG 319.1-B, Daily Diaries.
43. Daily Diary, AFRIT, 30 Dec. 1942, in AAG 319.1 A, Daily Diaries; Daily Diary, AFFTC, 25 Jan. 1943.
44. FTC Memo 50-11-3, 3 May 1943.

made it difficult to maintain the required flying time with the result that the number of dry runs had to be increased. The shortage of bombs continued, it appears, until August 1943. On 7 August the Training Command was informed that the restrictions on the M38A2 bombs were removed; the provisions of TM 1-250 were again in effect, and students would resume bombing on the basis of 150 bomb releases.[45]

45. Teletype, AC/AS, Training to CG, AAFTC, 11 Aug. 1943, in files of AFACT-2, 475.731, Bombing Equipment; CG, AFTRC to CG, AAF, 13 Aug. 1943, in ibid.

Chapter VII

CONCLUSION

The accomplishments of the Army Air Forces in the individual training of bombardiers in Air Corps schools have been phenomenal. In 1940 there were no specialized schools for bombardier training, and at the end of 1941, with the United States at war, the two bombardier schools which had been opened had to be closed and bombardier training moved to another section of the country. Thus, virtually all the progress made in bombardier training was made in 1942 and 1943. During these two years 13 bombardier schools were activated, of which 9, with a student capacity of over 7,500, were in operation at the close of 1943. In 1940 there were no bombardier graduates from Air Corps schools with the exception of 18 bombardier instructors. In 1941 an additional 104 instructors and 208 bombardiers were graduated. The annual production figures for 1942 rose to 5,679, and the number of graduates for 1943 was approximately 19,000!

This record of achievement was made in the face of all the types of difficulties encountered by the AAF in conducting its training mission. There has existed throughout the period of the expansion program the problem of procuring a sufficient number of trainees with the desired aptitudes. In the early stages of the training program virtually all bombardier trainees were eliminated pilots.

As a result of improved classification procedures and an extensive advertising program the AAF has been able to rely less on eliminated pilots as the principal source of bombardier trainees.

One of the constructive steps taken in the early period of bombardier training was that of separating the preflight stage of training from the advanced stage. This resulted in the establishment of aircrew replacement training centers which were later redesignated "Preflight" schools, the mission of which was to conduct basic military training and ground instruction. This left the specialized bombardier schools free to conduct only the advanced ground and aerial training. The preflight training, which is not peculiar to bombardier training but is applicable alike to all aircrew training, had not by the close of 1945 reached a settled status. Until early 1945 there were different programs of instruction for pilot preflight training and bombardier-navigator preflight training. After that time, however, the same program of instruction was used in all preflight schools, and eliminated pilots who were assigned to bombardier training were no longer required to go through a second preflight course. Consideration was given, however, to establishing three preflight programs for pilot, bombardier, and navigator, respectively. Also, the College Training Program, which is pre-preflight, posed the question of some reorganization of all preflight training--basic training, the college training program, and the training in the present preflight schools.

Prior to the establishment of the specialized bombardier schools, all bombardier training was conducted in and by the tactical units. After the early part of 1942, when the specialized schools got into production, bombardier training in these units progressively declined. At the end of 1943 the amount of this type of training was negligible, except for the completion of certain types of dual training, for example, dead-reckoning navigation for graduate bombardiers. Many problems were encountered in conducting individual training in the tactical units, and the results were generally unsatisfactory. This type of training interfered with the accomplishment of the essential function of these units, and the individual training was frequently neglected. The period of training was usually briefer, and there was a lack of uniformity in the training conducted by the different units. Also, there was the recurrent problem of commissioning the bombardiers trained in the tactical units. This necessitated coordination of the training performed in these units and in the Flying Training Command. The latter insisted that all such training be conducted in the bombardier schools of that Command and that if such training were to be conducted in the tactical units, it must conform with that conducted by the Command. The bombardier training performed in the specialized schools was definitely superior to that conducted in the tactical units. Until the bombardier schools got into production on a large scale, however, there was no alternative but to train bombardiers

in the tactical units.

The record of bombardier training in the advanced schools was one of inordinate delays and difficulties on the one hand and of impressive accomplishment on the other. This record was marked by rapidly expanding production goals, the evolution of the program of instruction, the activation of new training establishments, the initiation of various types of dual training, the problem of securing and training instructors and bomb-approach pilots, and the difficulties encountered due to shortage of material items--airplanes, bombsights, and bombs.

The first of the specialized bombardier schools (Barksdale) was not opened until seven months prior to Pearl Harbor, by which date 144 bombardiers had been graduated. The second school (Ellington) was opened just one month before the United States entered the war and graduated its only class, 26 bombardiers, on 27 December 1941. Both of these schools abandoned advanced bombardier training within a few weeks after the beginning of the war, and it was approximately three months before any other bombardier trainees were graduated. Furthermore, the United States had been at war about a year before bombardier production in the specialized schools was adequate for the requirement of the operational training units.

The length and content of the course of instruction in the advanced schools underwent numerous changes. The course was lengthened, first, from 10 weeks to 12 and then to 18 weeks. There were many changes in the content of the course of instruction, changes

caused by the numerous shiftings of course offerings from advanced training to preflight training and vice versa, by the embodiment in training of the experience of the combat units, and by the experience gained in the training of bombardiers. Another source of change was the inauguration of the various types of dual training, which at the end of 1943 characterized all bombardier training. The institution of dual (bombardier-navigator) training for bombardiers was probably the most significant change made in the bombardier training program.

The procurement and training of instructors was one of the most important phases of the bombardier training mission. The demand for ground school instructors was partially met by the procuring and commissioning of civilians, many of them professional teachers from high schools and colleges. Ultimately, most of the ground school instructors were drawn from these sources. The procurement and training of flying instructors, however, constituted a more difficult problem. Very few men qualified for this type of instruction could be procured from civilian life but had to be trained as bombardiers and then as instructors. This was especially difficult in the period when the tactical units were in dire need of all bombardier graduates.

It was unfortunate that there was no bombardier instructors' school in existence until after the period of bombardier shortage--about December 1942. The Central Bombardier Instructors School began

operation in January 1943. From March 1941 to January 1943 such training was confined to that which each bombardier school provided for the graduates who were assigned to it as instructors. For approximately nine months after it began operating, the instructors' school limited its function to post-graduate bombardier training with comparatively little time devoted to the development and improvement of instructional technique and procedures. Later, however, more emphasis was placed on the latter phase of the mission of this school.

The demand for flying instructors for the bombardier schools was in excess of the actual number required for conducting instruction there. This was due to the turnover which took place among this personnel. Instructors were constantly being assigned to combat duty and to service as staff bombardiers in the training air forces. Other than the instructor training conducted by the individual bombardier schools, 999 bombardier instructors, including 122 trained at Lowry Field from July 1940 to March 1941, were graduated from bombardier instructor courses by the end of October 1943.

Among the basic needs in bombardier training were bomb-approach pilots. These, along with instructors, constituted the key personnel necessary for the actual aerial training of bombardiers. These pilots were among the most proficient men in the AAF in the flying of bombardment missions and were one of the most

important factors in the superior training performed in the bombardier schools. The training and experience provided these pilots prior to their subsequent transfer to the training and combat air forces constituted one of the significant contributions of the bombardier schools to the bombardment function of the AAF.

Another factor which conditioned the accomplishment of the mission of the bombardier schools was that of materiel items, such as training airplanes, bombsights, and practice bombs. Both the number of bombardiers trained and the quality of their training were adversely affected by the shortage which existed in these items of equipment. Critical shortages in one or more of these items existed until the summer of 1943.

Taking into consideration all of the conditions and factors which constituted barriers to the bombardier training program, the accomplishments in this field were probably all that could be expected. By October of 1943 this program of training had reached a point where most of the acute problems encountered appeared to have been solved in at least a reasonably satisfactory manner.

Toward the close of 1943, with all bombardier training recently converted to dual training, additional adjustments in the program, following upon this new development, appeared likely. For example, it seemed apparent that the nine-week course in bombardier training given at Roswell for the completely dually trained bombardier-navigators would prove inadequate. It did not appear likely that

the bombardier's function in the mission of the super-bomber could be performed with proficiency by a navigator who had had only an abbreviated bombardier course.

GLOSSARY OF ABBREVIATIONS

AAF	Army Air Forces
AAG	Air Adjutant General
AC/AS	Assistant Chief of Air Staff
ACTS	Air Corps Technical School
AFAAP	Assistant Chief of Air Staff, Personnel
AFACT	Assistant Chief of Air Staff, Training
AFACT-2	Air Crew Training Division
AFAMC	Materiel Command
AFASC	Air Service Command
AFCC	Air Force Combat Command
AFDMR	Directorate of Military Requirements
AFDOP	Directorate of Personnel
AFRDB	Directorate of Bombardment
AFFTC	Flying Training Command
AFIHI or AFIHD	Historical Division
AFMSC	Statistical Control Division
AFPMP	Military Personnel Division
AFRIT	Directorate of Individual Training
AFTRC	Training Command
AG	The Adjutant General
C/AAF	Chief of the Army Air Forces
C/AC	Chief of the Air Corps
C/AS	Chief of the Air Staff
CG	Commanding General
CO	Commanding Officer
Comdt.	Commandant
FTC	Flying Training Command
GCACTC	Gulf Coast Air Corps Training Center
GHQAF	General Headquarters Air Force
OCAC	Office, Chief of the Air Corps
R&R	Routing and Record Sheet
SEACTC	Southeast Air Corps Training Center
TC	Training Command
T&O	Training and Operations Division
WCACTC	West Coast Air Corps Training Center

[redacted] SECRET SECURITY INFORMATION

BIBLIOGRAPHY

Official Publications

War Department:

WD Adjutant General Letters
Principally used as the basic authority for the activation, designation, and redesignation of training establishments.

WD Press Releases
In lieu of original documents, Press Releases have occasionally been used as secondary materials.

Headquarters, Army Air Forces:

AAF Letters
AAF Memorandums
AAF Regulations
These publications indicate the policies, practices, and standards established for all Army Air Forces functions.

Commanding Officers Official Bulletins
Station Commanders News Letters
Valuable for information on training from the "field" point of view. They also serve to fill gaps found in original documents.

Station Lists
These have been utilized for the early part of the period covered by this study because they contain data relative to training equipment on hand.

Headquarters, Army Air Forces Training Command (Flying Training Command)

FTC Memorandums
TC Memorandums
These are especially valuable for statements of the specific objectives of particular types of training, qualification standards, and programs of instruction.

Army Air Forces Central Files

211 C	Pilots
211 D	Pilots
211 E	Pilots
211 E	Cadets
211 F	Cadets
319.1-3	Daily Diaries
319.1-3B	Daily Diaries
319.1-B	Daily Diaries
319.1-C	Daily Diaries
319.1B	Reports Annual and Semi-Annual
321.9B	Training and Operations, Training Division
337 D	Conferences
337 E	Conferences
337 F	Conferences
352.01 C	Establishment of Schools
352.01 D	Establishment of Schools
352.11	Courses of Instruction
352.11	Denver, Courses of Instruction
352.11	Training at Lowry Field
352.11 A	Courses of Instruction
352.16 A	Instructors
353	Bombardier Training
353	Pilot Training
353 A	Bombsight, Gunnery Training
353.01 A	Training Programs
353.01 A	Training Schedules and Directives
353.1-B	Daily Diaries
353.9	Training, General
353.9	Specialized Training
353.9	Navigation Training
353.9	Training, Bombers, Gunners
353.9 A	Denver, Miscellaneous Training
353.9 A	Training, General
353.9 B	Training, General
353.9 B	Bombardiers, Gunners
353.9 C	Training, General
353.9 C	AC Training Directives and Programs
353.9 F	Training, General
353.9 H	Aviation Pilot Training
353.9 I	Aviation Pilot Training
353.9-1A	Bombsight Training
353.9-1B	Bombsight Training

As indicated by the above titles, these books contain material on virtually all phases of bombardier training, especially from the Headquarters point of view.

Headquarters Staff and Training Command Files

Office of AC/AS, Training, Air Crew Training Division:

Daily Diary, Army Air Forces Training Command (Flying Training Command)

Programs of Instruction

Bombardier Training Files

211	Bombardiers
337	Bombardiers
352	D-8 Bombardiers
352.16	Bombardiers
352.17	Bombardiers
353	Bombardier Training
353	Bombardier-Navigator
475.371	Bombing Equipment

Miscellaneous correspondence
These materials have been utilized extensively due to the fact that some of them are not available elsewhere, and others are more readily accessible than copies in Central Files.

Office of AC/AS, Intelligence, Historical Division

Report of Flying Training Students (Consolidated Flying Training Command Reports)
These are monthly statistical reports on flying training used principally for data on eliminations and graduates.

Programs of Instruction

Training Manuals
Valuable in tracing the evolution of programs of instruction for the training of bombardiers. Copies of all programs used in the training of bombardiers in Air Corps schools are in these files.

Daily Diaries: A-3; Directorate of Individual Training; AC/AS, Training; AC/AS, Materiel, Maintenance, and Distribution; Training Command.
Valuable both for indicating developments under way and limited information on such developments.

Special Reports

"Inspection of Bombardier Schools under the Jurisdiction of [the Training] Command," 19 July 1943.
Good survey of divergent practices in bombardier schools and recommendations for effecting uniformity.

Special Reports (cont'd)

"[Report on] Bombardier Conference at Fort Worth, [Tex.] August 4-7, 1942."
"Report [on] Bombardier Training Conference" at Fort Worth, Tex, 14-18 December 1942.
These two reports contain information on program of instruction and bombardier instructor training.

"Annual Report," for the fiscal year 1942, of the Psychological Division, Office of the Air Surgeon.
Contains information on selection and classification of bombardier trainees.

Special Studies

"Circular Error as a Measure of Bombardier Proficiency," prepared by the Psychological Unit, Office of the Surgeon, Army Air Forces Training Command, 15 July 1943.
Contains data relative to selection and classification of bombardier trainees.

Interviews

"Interview between Capt. [A.V.] House and CWO Thomas J. Kelly," 10 July 1943.
CWO Kelly has been connected with Air Corps bombardier training since its inception in July 1940. This interview contains general information and data on this type of training from 1940 to 1943.

"Interview of Bombardiers Returned from Combat" who were graduated in the class of 3 July 1943 at the Army Air Forces Instructors School (Bombardier), Carlsbad, N.M.
Valuable for comments on bombardier training.

Army Air Forces Training Command (Flying Training Command):

Correspondence and reports in Central Files
Used principally for material on bombardier training at Lowry Field.

A-3, Bombardier Section files
Contain material on administration of bombardier training from the Command headquarters.

Statistical Section files
Data on bombardier graduates from Lowry, Barksdale, and Ellington fields.

Project Book of the Commanding General
Exceedingly valuable. Consists of biweekly status reports on every category of flying training in the Training Command since 25 March 1942. Contains directives, plans, programs, training establishments, production rates, etc., relative to each category of flying training.

Interviews and Conversations with Personnel in:

Office of AC/AS, Training

Air Crew Training Division
Unit Training Division

Office of AC/AS, Material, Maintenance, and Distribution

Material Division

Headquarters, Army Air Forces Training Command

AC/S, A-3, Bombardier Section
Office of the Surgeon, Psychological Unit

Bombardier Schools

Army Air Forces Bombardier-Navigator Preflight School, Ellington Field, Tex.
Army Air Forces Bombardier School, Midland, Tex.
Army Air Forces Instructors School (Bombardier), Midland, Tex. (Carlsbad, N.M.)

Second Air Force Bases

Davis-Monthan Field, Tucson, Ariz.
Biggs Field, El Paso, Tex.
From interviews and conversations in AAF Headquarters important current materials were secured and specific questions answered on every phase of bombardier training. Similar information and materials were secured at the headquarters of the AAF Training Command, Fort Worth, Tex. At the bombardier schools in the Training Command and at Second Air Force bases the writer obtained first-hand information and understanding of bombardier training as it is conducted in the field.

Appendix 1

Bombardier-Navigator Preflight Program of Instruction, July 1943

The following is a statement of the objective, scope, and an outline of the contents of the preflight courses of instruction as of July 1943:

I. Code (radio and visual) - 48 hours

1. Objectives and scope: To lay the "foundation for future work with radio code which is closely related to flying" and to attain "proficiency in reading visual signal lamps which are [the] only means of communications during periods of 'radio silence.'" [1]

2. Contents of instruction:

a. Radio code

(1) Sounds of characters (letters of the alphabet and numerals) and correct method of recording them	1 hour
(2) 12 characters and review	4 hours
(3) Test on receiving 12 characters at rate of five words per minute	1 hour
(4) 12 additional characters and review	5 hours
(5) Test on receiving 24 characters at rate of five words per minute	1 hour
(6) 36 characters and review	5 hours
(7) Test on receiving 36 characters at rate of five words per minute	1 hour
(8) Review of 36 characters	5 hours
(9) Test on receiving 36 characters at rate of six words per minute	1 hour

b. Radio and visual code

(1) Review radio (36 characters) and introduce visual code	1 hour
(2) Improve radio code and receiving and recording visual code	4 hours
(3) Review and test radio code at rate of seven words per minute. Additional receiving and recording of visual code	1 hour
(4) Additional radio and visual reception	5 hours
(5) Additional radio and visual reception and recording and test on radio code at rate of eight words per minute	1 hour
(6) Additional radio and visual code and special visual code	5 hours
(7) Additional instruction and tests on radio code at rate of eight and ten words per minute and visual at five words per minute	1 hour

[1] Radio and Visual Code - Instructor's Guide, 1st ed., 1 Mar. 1943, p. 2, in AFIHI files.

(8)	Additional instruction	3 hours
(9)	Additional instruction and test on radio code at rate of twelve and fourteen words per minute	1 hour
(10)	More instruction and test on radio at rate of eight and ten words and visual at five words	1 hour
(11)	Reexamination test on radio at rate of eight words and visual at five words	1 hour[2]

3. Instructional methods and training aids

The methods of instruction employed in this course consist of (1) the "call back" method whereby the instructor sends each character twice and "calls" the second letter to the class; (2) the "print and call" method, by which the instructor sends each character twice and the students record both characters and call the second one aloud; (3) and the "silent call" method, by which the instructor sends the character and the student records each character.

The training aids utilized in instruction in this course are as follows:

a. Code practice tables equipped with headsets only
b. Automatic code transmitting equipment
c. Table or rack for transmitting equipment with jack panel
d. Instructors table or platform equipped with hand keys and headsets
e. Lamps, Neon Glow, 110 volt, 2 watt, for Visual Code in classroom
f. Signal Lamps, Type C-3, for night Visual Code
g. Code practice tapes for transmitters
h. Formal test tapes for transmitters
i. Code practice paper
j. Chart showing required method of recording characters
k. Timer, Eastman or General Electric

II. Physics - 18 hours

1. Objective and scope:

The purpose of this course is to give ". . . an understanding of the more important natural laws and scientific principles upon which the construction and operation of aircraft and aircraft instruments are based," and to acquaint him "with the fundamental principles and terminology of meteorology."[3]

2. The phases, or topics, of Physics and Meteorology which make up this course and the time allotted to each are as follows:

a. Units of measure	1 hour
b. Weather and atmosphere	1 hour
c. Composition and Resolution of Forces	2 hours
d. Accelerated motion	2 "
e. Work and Power	1 hour
f. Energy and Friction	1 "
g. Fluids at Rest	1 "
h. Buoyancy, Atmospheric Pressure	1 "

2. Ibid., Table of Contents.
3. Physics - Student's Workbook, 1st ed., 1 Mar 1943, Preface, in AFIHI files.

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i.	Fluids in Motion	1 hour
j.	Theory of Flight and Flight Instruments	1 "
k.	Temperature and Heat	2 hours
l.	Heating of the atmosphere	1 hour
m.	Properties of gases	1 "
n.	Moisture	1 "
o.	Moisture in the atmosphere	1 "
p.	Reviews and examinations	6 hours[4]

III. Mathematics - 20 hours

1. Objective and scope: In order to understand the principles of bomb ballistics, to be able to use the tables and computers which are a part of the bombardier's equipment, and to make the necessary bombing solutions, it is indispensable that the student be proficient in certain mathematical functions. It is the purpose, therefore, of this course to develop in the student such competence. Included in the scope of this course are: a review of arithmetic, algebraic equations, formulae, graphs, maps, and charts.
2. Contents of course:

a.	Fundamental operations	1 hour
b.	Fractions	1 "
c.	Decimal fractions and percentage	1 "
d.	Ratio and proportion	1 "
e.	Positive and negative numbers, powers, and square roots	1 "
f.	Simple and fractional equations	1 "
g.	Formulae	1 "
h.	Problems	1 "
i.	Graphs and use of scales in maps and charts	1 "
j.	Angular measurements	1 "
k.	Vectors	4 hours[5]
l.	Reviews, drills, and examinations	6 hours

IV. Maps, charts, and aerial photographs - 18 hours

1. Objectives of the course: One of the basic principles of warfare is that of the "importance of military personnel being where they are supposed to be when they are supposed to be there." The importance of maps is therefore very obvious and in Vertical Warfare the most important maps are aerial photographs. It is, therefore, the essential purpose of this course to give the trainee the fundamentals of the construction, use, and interpretation of aerial photographs which must be read accurately and quickly.
2. The content of the course is indicated by the following topics and the time allotted to each:

a.	General Consideration of Maps and Charts	1 hour
b.	Latitude and Longitude	1 "
c.	Map Projections: Mercator and Lambert	1 "

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4. Ibid., Table of Contents.
5. Mathematics - Students Workbook, 1st ed., 1 Mar. 1943, in AFIHI files.

d. Map Projections: Polyconic and Gnomonic	1	hour
e. Practical Problems on Interpretation of Maps	1	"
f. Directions, Bearings, and Courses	1	"
g. Distances and Coordinates	1	"
h. Elevation, Relief, and Contour Maps	1	"
i. Practical Problems on Interpretation of Maps	1	"
j. Training Films 1-2A5 and 5-12	1	"
k. Charts	1	"
l. Interpretation of Aeronautical Charts	1	"
m. Introduction to the Study of Aerial Photographs	1	"
n. Use and Interpretation of Aerial Photographs	1	"
o. Interpretation of Aerial Photographs	1	"
p. Interpretation of Aerial Photographs and Camouflage	1	"
q. Examinations	2	hours[6]

V. Identification and tactical functions of aircraft - 18 hours

1. Objective and scope of the course:
There are two basic reasons why members of the combat crew must be able to identify accurately and know the tactical functions of aircraft. In the first case, it is absolutely necessary to be able to distinguish between friendly and enemy planes in order to avoid the loss of one's own comrades. In the second case, after having identified an airplane as an enemy craft, it is vitally important to know its offensive and defensive characteristics. Also, it is important that the reports made to intelligence officers following each mission on aircraft encountered be as accurate as possible. The study in pre-flight school covers only British and American aircraft.

2. Contents of the course of instruction:
   a. Airplane terminology, e.g., airfoil, air scoop, axes of the airplane, ceiling, chord, cowling, dihedral angle, nacelle, stabilizer, trim tabs, etc.
   b. Plane tails, wings, fuselage - types and parts of each
   c. Symbols for designation of aircraft
   d. Types of tactical aircraft and the following information relative to each:
      (1) Name
      (2) Specifications - wingspan, length and height
      (3) History of the airplane
      (4) Engines - type, position, number of cylinders, horsepower, make, and propellers
      (5) Performance--speeds (maximum), cruising, and landing, ceiling (service and maximum), range, climb, maneuverability, etc.
      (6) Weight--empty, loaded, bomb load, racks
      (7) Armament--armor, machine guns, cannon, etc.
      (8) Other--crew, radio, landing gear
   e. Organization of Army Air Forces

[6] Maps, Charts and Aerial Photographs - Students Workbook, Preflight, 1st ed., 1 Mar. 1943, in AFIHI files.

3. Instructional techniques and devices
   a. Miniature planes
   b. Plane silhouettes
   c. Projectors and slides
   d. Film strips
   e. Films
   f. "Box for 'Today's Craft.'"
   g. Flash system of recognition (Henshaw system)[7]

VI. Identification and tactical functions of naval vessels - 12 hours
   1. Objective of the course:
      The purpose of this course is essentially the same as that on identification and tactical functions of aircraft. The course is devoted to a study of 23 American and 15 English vessels
   2. Contents of program of instruction:
      a. Naval organization
         (1) Naval policy
         (2) Shipboard nomenclature
      b. Naval weapons and ammunition
      c. Naval vessels and their weapons
         (1) Basis of naval cooperation
         (2) Characteristics and limitations of naval weapons
         (3) Characteristics and functions of naval vessels
      d. Naval formations and dispositions
      e. Shipboard defense against aircraft
         (1) Anti-aircraft defense
         (2) Passive defense of ships
            (a) Compartmentation, damage control, camouflage, degassing, maneuverability, etc.
      f. Naval aircraft
         (1) Types and functions of naval aircraft
         (2) Utilization of aircraft for control of shipping
      g. Employment of aviation in sea warfare
      h. Recognition of warships
         (1) Characteristics of nationality and by class and type
      i. Identification of warships based on
         (1) Class, type, and nationality
         (2) Dimensions
            (a) Length--overall and waterline
            (b) Beam
            (c) Draft
         (3) Power plant
            (a) Number and type of engines
            (b) Speed and horsepower
            (c) Boilers
            (d) Fuel capacity and range

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7 Identification and Tactical Functions of Aircraft--Instructor's Guide, Preflight, 1st ed., 1 Mar. 1943, in AFIHI files.

(4) Defensive
(a) Belt amidship, forward and aft
(b) Upper deck and lower deck
(c) Turrets
(d) Conning tower
(e) Stock base
(5) Offensive
(a) Main battery
(b) Secondary battery
(c) Anti-aircraft
(d) Torpedo tubes
(6) Aircraft
(a) Catapults, and location
(7) History of the vessel
(a) Commissioning date
(b) Remodeling date

j. Merchant ships
(1) General
(2) In detail
(The required proficiency of preflight students in recognition of naval vessels is recognition of a vessel within three seconds)[8]

VII. Ground forces and military subjects - 10 hours

1. Objective of the course: It is the purpose of this course to "provide basic information necessary for close cooperation of Air Forces with Ground Forces."

2. Contents of the course:

a. Elements and organization of the U.S. Army	1 hour
b. Offensive operations	1 "
c. Defensive operations	1 "
d. Campaigns of World War II	2 hours
e. Safeguarding military information	2 "
f. War Department publications	2 "
g. Review and examination	1 hour[9]

3. Military training
Although not a part of the course on "Ground forces and military subjects," military training constitutes an important part of preflight training. During the first eight weeks the following training is given--the last week

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8. Naval Forces--Operations and Ship Recognitions, AAF Preflight School (B/N), Ellington Field, 1 Apr. 1943; also, Identification and Tactical Functions of Naval Vessels--Instructor's Guide, Preflight, 1st ed., 1 Mar. 1943.

9 Ground Forces and Military Subjects--Outline of Instruction, July 1943, Ellington Field, Tex. in AFHRI files.

[redacted]

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being spent in field training:

(1)	Physical training	40 hours
(2)	Drill	40 "
(3)	Squadron	40 "
(4)	Military	20 "
(5)	Small arms	15 "
(6)	Military courtesies and customs of the service	5 "
	Total	160 hours[10]

VIII. Chemical warfare defense - 12 hours

1. Objectives of the course: It is the purpose of this instruction to provide the student with the training necessary to enable him to protect himself and his comrades from gas attacks and also to protect property against incendiary bombing. One of the important phases of the course is training in the use of the various types of equipment used in such protective actions.

2. Contents of course of instruction:

a. Preceding training in classification center: 1 hour

(1) The gas mask and its adjustment
(2) Gas mask drill and gas chamber training

b. Training in preflight school:

(1)	History and potentialities of gaseous agents	1 hour
(2)	Vesicants and first aid	1 "
(3)	Non-persistents and first aid	1 "
(4)	Field identification (detonation) and demonstration of smoke	1 "
(5)	Individual and collective protection	1 "
(6)	Incendiaries--types, uses, and control	2 hours
(7)	Decontamination--apparatus, materials, and methods	2 "
(8)	Material and weapons, screening smoke	1 hour
(9)	Review and examination	1 "

Approximately one-third of the time allocated to this course is spent in actual field training.[11] Only nine hours were allotted to this course prior to February 1943.[12] As the new eighteen-week course for bombardier/dead-reckoning navigator goes into effect this course is to be incorporated into the course on Military Training with the same allotment of time.

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10. Weekly schedule of activities at AAF Preflight School (B/N), Ellington Field, Tex., in AFIHI files.
11. Scheduled Aviation Cadet Training in Chemical Warfare Defense.1, undated, Ellington Field, Tex, in AFIHI files.
12. F.T.C. Memo 50-27-3, 14 June 1943, in AFIHI files.

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The outline of the new course on Military Training is as follows:

1.	Close order drill	45 hours
2.	Ceremonies	9 "
3.	Interior guard instruction	4 "
4.	Inspections	9 "
5.	Chemical warfare	11 "
6.	Thompson sub-machine gun	4 "
7.	Pistol, 45 cal.	16 "
8.	Customs and courtesies of the service	4 "
9.	Honor indoctrination	2 "
10.	War Department publications	2 "
11.	Safeguarding military information	2 "
12.	Ground Forces	5 "
	Total	113 hours [12]

IX. First aid and field sanitation - 8 hours

1. Objective of the course:
   The essential purpose of this instruction is to provide a knowledge of the most common types of physical damage incurred by men in training and combat, the symptoms, first aid treatment, and the necessary care in each case.
2. Contents of instruction:
   a. Traumatic shock
   b. Wounds
   c. Hemorrhage
   d. Fractures, dislocations and sprains
   e. Bites and stings
   f. Transportation of victims
   g. Field sanitation
   In treating each of the topics in this course, the following phases are dealt with: definition, causes, symptoms, resulting physiological condition, precautions to be taken, first aid to be rendered, and the materials to be used.[13]

X. Altitude training

XI. (See VII and VIII)

XII. Physical training - 54 hours
The stated objective of this program of instruction is "To develop and maintain that state of physical fitness and mental alertness necessary to insure that all members of the Army Air Forces Train-

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[12] F.T.J. Memo 50-27-3, 14 June 1943, in AFIHI files

[13] First Aid and Field Sanitation, 15 July 1943, Ellington Field, Tex., in AFIHI files

ing Command will perform their duties effectively in theaters of operation."

The preflight program of instruction consists of the following:

a.	Conditioning exercises	18 hours
b.	Running activities	25 hours
c.	Competitive games	5 "
d.	Individual instruction	5 "
e.	Test evaluation	1 hour[14]

[14] T.C. Memos 50-21-1, 25 Aug 1943, and 50-21-2, 27 Aug. 1943, in AFIHI files

Appendix 2

Tentative Program of Instruction, Lowry Field, January 1941

a.	Basic theory - 24 hours	
	1. Bombing theory	12 hours
	2. Electricity	4 "
	3. Gyroscopes	4 "
	4. Trainer theory	4 "
b.	Bombing accessories - 24 hours	
	1. Forms	4 "
	2. Bombs and bomb fuses	4 "
	3. Bomb racks and controls	4 "
	4. Computers	8 "
	5. Instruments and their calibration	4 "
c.	Bombsights - 52 hours	
	1. Sight theory	16 "
	2. Sight-operation and technique	12 "
	3. Breakdown sight system	8 "
	4. Trouble shooting and analysis	8 "
	5. Low altitude attachment	8 "
d.	A.F.C.E. - 20 hours	
	1. Theory of A.F.C.E.	4 "
	2. Adjustment	8 "
	3. Bombardier-pilot coordination	8 "
e.	Scoring and analysis - 16 hours	
	1. Scoring methods	4 "
	2. Analysis of results	4 "
	3. Theory of probabilities	4 "
f.	Procedure of bombing - 20 hours	
	1. Conduct of missions	4 "
	2. Causes of errors	4 "
	3. Defective sight bombing	4 "
	4. Low altitude bombing	4 "
	5. Double drift solutions	4 "
g.	Gunnery - 46 hours	
	1. Principles of ground gunnery and ballistics	2 "
	2. Ground gunnery--1,000' range	8 "
	3. Photo-electric firing-moving target	4 "
	4. Camera gun at landing aircraft	4 "
	5. Moving M-6 target models	16 "
	6. Skeet-500 rounds per student	12 "
h.	Bombing - 60 hours	
	1. Trainer practice	approximately 20 hours
	2. Air Instruction	" 40 "
	(a) Dry runs and 140 bombs	
	3. Bombing score	

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i.	Examinations on all of above subjects	32 hours
j.	Military	32 "
	Total hours	294 (not including examinations)[1]

[1] Director of Department of Bombardier Instruction, Lowry to CO, Lowry, 3 Jan 1941, in AAG 353.9-1A, Bombsight Training.

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Appendix 3

Program of Instruction, Advanced Bombardier Schools, November 1941

I. OBJECTIVE:

Proficiency as the Bombardier member of the Air Force Combat Team with a minimum of tactical transition training after the completion of this course.

II. SCOPE:

1. Qualification in the technical duties of a Bombardier.
2. Qualification as Third Class Bombardier.
3. Qualification in the technical duties of Aircraft Observer.
4. Physical training to develop and maintain the alertness required in combat crew members.
5. Military training to indicate an appreciation of strict compliance with instructions from higher authority.

III. DURATION:

1. Twelve weeks.
   a. First three weeks—Preliminary ground training.
   b. Fourth to ninth weeks inclusive—Ground and Air training.
   c. Tenth to twelfth weeks inclusive—Air training to include tactical bombing and reconnaissance missions.

IV. PROGRAM:

The hours prescribed herein per phase of instruction represent the time required for the average student to accomplish the objective.

1. GROUND TRAINING:

	Subject Hours	Phase Hours
a. Basic Theory		20
(1) Theory of Bombing	12	
(2) Gyroscopes	4	
(3) Trainer Theory and Operation	4	
b. Bombing Accessories		28
(1) Forms	4	
(2) Bombs and Fuses	2	
(3) Operation of Bomb Racks and Controls	4	
(4) Instrument Errors, Calibration, and Correction Cards. Computers: C-1 and C-6-B, Smithsonian Tables.	12	

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	Subject Hours	Phase Hours
(5) Familiarization with Aircraft - Ground, Care & Handling of Parachutes	2	
(6) Oxygen Equipment and Physical effects of High Altitude Flying	4	
g. Bombsights		33
(1) Sights-Operation and Construction	21	
(2) Procedure for preflight inspection	4	
(3) Trouble shooting & minor adjustments of the sight.	8	
d. A.F.C.E.		18
(1) A.F.C.E. Operation and Mechanics	4	
(2) A.F.C.E. Adjustment	14	
e. Scoring and Analysis		28
(1) Scoring Methods	2	
(2) Causes of Errors	8	
(3) Analysis of Results	8	
(4) Probabilities	6	
(5) Tactical Bombing	4	
f. Bombing Procedure		114
(1) Conduct of Missions, Safety Precautions: Bombing Team Procedure: Qualification Bombing Requirements	4	
(2) Bombardier-Pilot Coordination	4	
(3) Technique of Defective Sight Bombing	4	
(4) Technique of Bad Weather, Train and Formation Bombing	4	
(5) Double Drift Solutions & Low Altitude Bombing. E-6-B Computer	8	
(6) Bombing Trainers:	20	
(a) Prior to starting bombing-10 hours		
(b) Faulty sight bombing--2 hours		
(c) Low Altitude bombing procedure--2 hours		
(d) Maneuvering targets--2 hours		
(e) Additional training and night practice with lighted target--4 hours		
(7) Critique	70	
Before and after each bombing mission, and additional instruction in causes of errors and analysis of results--using the trainer and demonstration equipment when necessary. General review of all subjects.		
g. Aircraft Observer Training		47
(1) Bombardment Objectives	4	
(2) Aerial Photograph and Map Reading	6	
(3) Codes	6	
(4) Operating Procedure and Reports	2	
(5) Identification of Aircraft	4	
(6) Meteorology	17	
(7) Navigation	8	

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	Subject hours	Phase hours
h. Athletics and Military Training		85
(1) Athletics	39	
(2) Military Instruction Includes 30 minutes each day in marching formation	46	
TOTAL HOURS (Ground Training)		373

2. AIR TRAINING:

a. Calibration of Instruments in a Bomber	2
b. Tracking (Dry Runs)	3
c. Qualification Bombing Day and Night (145 bombs per student)	65
d. Tactical Bombing Day and Night (55 bombs per student)	15
(1) Bombing from very low altitudes from 10 feet to 100 feet using land targets and/or water targets, if available	
(2) Bombing of night target illuminated by flares, using any type flare available	
(3) Glide bombing up to maximum speed allowable in airplane available	
(4) Horizontal bombing using straight approaches of 20 seconds or less	

TOTAL HOURS (Air Training)	85
TOTAL HOURS (All Phases)	458[1]

1. Program of Instruction . . . for Military Students to be given in Air Corps Advanced Flying Schools, 13 Nov. 1941, in AFIHI files.

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Appendix 4

T. C. MEMORANDUM)
NUMBER 50-11-1)

HEADQUARTERS
ARMY AIR FORCES TRAINING COMMAND
FORT WORTH, TEXAS 29 Sept 1943

TRAINING

Bombardier Training, Program of Instruction

(This Memorandum supersedes T.C. Memorandum No. 50-11-1, 20 August 1943.)

SECTION I - General
II - Proficiency Requirements
III - Ground Training
IV - Flying Training and Scoring

SECTION I - General

1. Mission: The mission of the AAF Bombardier Schools is to train students in the theory and practice of aerial bombardment as employed by the Air Forces in the various theaters of operation.

2. Objective: The bombardier training conducted in the Army Air Forces Schools will have the following as its objective:

a. The qualification of students as precision bombardiers with basic proficiency in the use of M-series equipment plus a working knowledge of all other standard types of bombsights.

b. The qualification of students as dead reckoning navigators as specified herein.

c. The qualification of students as officers of the Army Air Forces.

d. The attainment and maintenance of the high degree of physical fitness requisite to a combat crew member.

3. Duration: The training period of the AAF Bombardier Schools, under this directive, is eighteen weeks.

4. Organization: The organization of the AAF Bombardier Schools will be governed by the Exact Manning Tables for the station concerned. The size of classes and flow of students will be as prescribed by this

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Headquarters. At the conclusion of each class training period, statistical data concerning the class will be submitted on Form FTC A-308.

SECTION II - Proficiency Requirements

1. Qualified as bombardier as prescribed by TM 1-250 (Course 1).

2. Able to bomb within accuracy requirements with following type bombsights: M-series, S-series, D-series (accuracy requirements to be established by Headquarters, Army Air Forces).

3. Thorough knowledge of bombing problems to include theory of bombing and theory of bombsights.

4. Thorough knowledge of method of train bombing to include:

   a. Ability to calculate rapidly the time interval between successive releases necessary to obtain desired linear spacing of bombs.

   b. Ability to release bombs in train at desired intervals by manual operation of release switch.

   c. Ability to properly operate intervalometer.

5. Proficient in bombing with defective bombsight.

6. Instructed in method of computing bombing probabilities.

7. Instructed in current methods of scoring and analyzing bombing results.

8. Proficient in pilotage and map reading.

9. Proficient in target identification and in the selection of an initial point that will allow a bombing run of definite duration.

10. Able to navigate during daylight hours by dead reckoning means with a maximum course error of one and one half degrees, and a maximum E.T.A. error of one and one half minutes per hour of flight from the last known position.

11. Proficient in "follow the pilot" method of navigation and able to maintain a log correctly.

12. Demonstrate ability to solve, in the classroom:

   a. Radius of action

   b. Interception

c. Search problems

d. Proficient in planning rendezvous problems to include; calculating time of take-off, time required for climb to altitude, and speed along desired track.

13. Proficient in calibration of navigation instruments.

14. Proficient in use of current type bombing and navigational computers such as the present type C-2, (Altitude Correction Computer), and E-6B, (Aerial Dead-Reckoning Computer).

15. Proficient in the operation and air adjustment of C-1 auto pilot.

16. Familiar with proper methods of operation and adjustment of bomb racks and controls. (NOTE: To the limits of available training equipment.)

17. Instructed in the proper care and handling of bombing and navigation equipment.

18. Instructed in performing preflight inspection of bombing and navigation equipment.

19. Proficient in method of handling, loading and fusing aircraft bombs.

20. Able to act as trouble-shooter on bombsights and advise maintenance personnel accordingly.

21. Proficient in the calibration of aircraft instruments to include:

a. Air and ground swinging of compass.

b. Aligning of driftmeter.

c. Calibrating airspeed meter, altimeter, and free air temperature gauge.

22. Proficient in sending and receiving radio telegraph code signals at the rate of 10 or more words per minute.

23. Proficient in sending and receiving blinker signals at the rate of 5 or more words per minute.

24. Thorough knowledge of basic weather analysis as contained in TM 1-232 with emphasis placed in interpretation of weather on military

operation; weather conditions producing aircraft icing; thunderstorms and atmospheric turbulence.

25. Qualified as aerial gunner as prescribed in TM 1-270. (NOTE: To be accomplished up to the limits of the quotas available to bombardiers at the flexible gunnery schools).

SECTION III - Ground Training

1. Outline: Hourly requirements.

	Subj. Hours	Phase Hours	Total Hours
a. Introduction		1	
b. Pilotage		45	
(1) Maps & Map Reading(U.S. and Foreign)	20		
(2) Pilotage and Log Book	6		
(3) Practical Problems	5		
(4) Pilotage Pictures	6		
(5) Plotting: Lambert to Mercator	1		
(6) Night Pilotage	2		
(7) Review Pilotage	5		
c. Dead-Reckoning		51	
(1) Vector Problems	6		
(2) D.R. Procedure, Log Book & Problems.	8		
(3) R/A Same Base, Log Book & Problems .	6		
(4) Interception, Log Book & Problems .	5		
(5) Review R/A & Interception	1		
(6) Search & Patrol, Log Book & Problems	3		
(7) Graphic Mercator Instruction	2		
(8) Fuel Consumption	1		
(9) Follow-the-Pilot (Air Plot) & Problems	6		
(10) Ground speed by Timing	2		
(11) Controlled Ground Speed & Problems .	4		
(12) Visual Bearings & LOP'S	4		
(13) Comp. Swing, Terrestial Bearings and Other Methods	3		
d. Basic Theory and Bombsights.		45	
(1) Theory of Bombing & Bombsights . . .	13		
(2) M-series Sight (Preflight, Construction and Operation)	15		
(3) Non-Synchronous Sights.	2		
(4) Sperry Bombsight.	15		
Ground Instruction on the Sperry sight will be conducted to insure that each student is able to detect and analyze malfunctions, and perform routine inspections.			

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	Subj. Hours	Phase Hours	Total Hours
e. Bombing Accessories		17	
(1) Bomb Racks and Controls.	8		
(2) Bombs and Fuses.	6		
(3) Intervalometer	1		
(4) Aerial Cameras	2		
Students whose proficiency rating as a photographer drops below seventy-five (75) percent (basis of calculation to include ratings on all missions upon which the student rode as photographer where bombs were released) will be brought to the attention of the faculty board.			
f. Trainer Procedure		39	
(1) Trainer Theory	4		
(2) Trainer Operation.	25		
(3) Trainer Operation (Evasive action using Automatic Bombing Computer).	2		
(4) Fixed Angle Bombing.	2		
(5) Tactical Bombing	6		
(a) To include thorough knowledge of method of train bombing.			
(b) Defective sight bombing to include proficiency in bombing with defective bombsight with the following conditions (where applicable to type bombsight):			
1. Telescope motor inoperative			
2. Directional gyro inoperative			
3. Sight gyro inoperative			
4. Disc speed tachometer inoperative (disc speed to be determined by stop watch).			
g. Bombing Analysis		17½	
(1) Scoring Methods and Forms	1		
(2) Causes of Errors.	8		
(3) Analysis of Results	8		
(4) Probabilities	½		
h. Bombardment Aviation		16	
(1) Bombardment Objectives.	7		
(2) Objective Folders	4		
(3) Duties of Staff Bombardiers . . .	2		
(4) Anti-Aircraft Fire.	3		
i. C-1 Pilot		8	
j. Bombsight, Troubleshooting, Construction, and Calibration		25	
k. Aerial Engineer		2	

		Subj. Hours	Phase Hours	Total Hours
l.	Oxygen Indoctrination		4	
m.	Altitude and Pressure		2	
n.	Instruments		16	
	(1) Altimeter & Calibration	5		
	(2) A.S. and Temperature Calibration . .	5		
	(3) Driftmeter	2		
	(4) Alignment of Driftmeter and Bombsight	2		
	(5) Ground Speed on Bombsight	2		
o.	Computers		17	
	(1) Time, Speed, Distance E-6B.	2		
	(2) Vectors on E-6B.	4		
	(3) TAS on E-6B.	2		
	(4) Drift, Doubledrift on E-6B	3		
	(5) Conversion and Altitude on E-6B. . .	2		
	(6) Altitude on C-2	4		
p.	Critiques and Preflight Inspections . . .		80	
q.	Flight Planning		4	
r.	Aid and Surface Craft Recognition		9	
s.	Blinker System and Code		9	
t.	Military Training		50	
u.	Physical Training (See TC 50-21-2). . . .		108	
v.	Weather		42	
w.	First Aid		8	
	(1) Use of first aid kit aeronautic. . .			
	(2) Artificial Respiration			
	(3) Emergency care of gas casualties (Ref. Chap. 14 FM 20-100 and FM 20-11)			
x.	Study		87	
y.	Administration (Drawing equipment, etc.)		16	
	Total Ground Hours	718½		
	Total Flying Hours	120		
	TOTAL SCHEDULED HOURS	838½		

SECTION IV - Flying Training

1. Outline: Hourly requirements. Flying Training will consist of a minimum of 120 flying hours, during which time the missions will be combined as much as practicable. The navigation missions will include day and night pilotage, straight D/R, dog legs D/R, follow-the-pilot, and controlled ground speed. Missions will also be scheduled to teach calibration of instruments.

a. Combat bombing will include the following basic features: (See attached diagrams, Inclosures #1 and #2)

(1) Each approach will vary in direction from any other on the same mission by at least thirty (30) degrees (where local conditions prohibit this on certain targets, the airspeed or altitude will be varied so as to preclude the utilization by the student of the experience gained from previous releases. When more than one bombardier is to release bombs on a given mission, the instructor, or pilot if no instructor is available, will be responsible that no interchange of information is permitted between students).

(2) Objective folders will be used on a minimum of ten bombing missions per student. Where the objective folders include maps of cities and towns, and where the target objective precludes the actual dropping of bombs, dry runs will be accomplished by using objective folders. The use of objective folders must insure practice in map reading and target identification and the use of evasive action within definite defended areas.

(3) The A-4 camera will be used on a minimum of five (5) missions to identify an assigned objective through the bombsight.

(4) The student will, invariably, be given an opportunity to find the wind direction and velocity outside the defended area. (A-B) An ouportunity will be given the student to make a dry run in the contemplated direction of approach, or at the new airspeed or altitude if these factors only are changed, this to be performed outside the defended area. (B-C)

(5) Final approaches to the target will be straight and level for not exceeding 45 seconds. Every effort will be made to reduce this time. Use of the ABC computer is desired.

(6) During that portion of the approach which lies within the defended area, (C-D), evasive action will be continuous. A minimum of 50% of these missions will be flown with the airplane controlled by the O-1 pilot. The bombardier will control 50% of these missions with the sight gyro uncaged. The pilot will fly 50% of these missions while the sight gyro is caged. In both instances, the bombardier will be responsible for timing the start of the straight and level final approach.

(7) Low altitude combat missions will place an emphasis on high ground speeds. Combat bombing will be conducted as prescribed in TM 1-250.

(8) Each bomb will be released under such conditions as will insure the maximum benefit to the student.

(9) No bomb will be released utilizing data from previous releases unless such data is utilized to recompute a triple drift solution.

b. Proficiency in the operation of air adjustment of automatic pilots will be required.

c. The flying time allotted to each student by this training program is adequate to enable each bomb released under combat conditions to be solved as a separate problem. It is the intent that the procedure on each combat bombing run follow the diagram attached to this Memorandum.

d. All instructional, combat and qualificational bombs are to be dropped at altitudes not be vary over five hundred (500) feet from true prescribed altitude.

e. Pilots and instructors are to be present at all briefing of missions in which they participate.

2. Scoring Accuracy. It is of the utmost importance that each bomb impact be scored accurately and honestly. To accomplish this, the following will govern:

a. The provisions of TM 1-250 specifies, in paragraph 13, that scoring estimates, in the absence of photographs, be accomplished by a trained, disinterested observer. It is the opinion of this Headquarters that bombardier students are in no manner disinterested observers and that their estimates of scores will not be accepted.

b. Under any conditions where less than one hundred (100) per cent of all bomb impacts are photographed, estimates will be accepted only when accomplished by a trained, disinterested observer.

c. Circular errors greater than seven hundred (700) feet will be scored as seven hundred (700) feet.

d. All combat bombs will be dropped on actual silhouettes on targets. The use of an overlay is prohibited.

e. It is possible that some schools will desire to utilize pilots in the capacity of scorers and observers, but it is not felt that this is conducive to flying safety.

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f. The policy of scheduling solo missions as prescribed by the latest amendment to TM 1-250 will not be considered violated if there is a bombardier instructor in the airplane whose sole function is scoring and observation, and who does not offer any assistance of any kind to the student bombardiers.

By command of Major General YOUNT:

WALKER F. KRAUS
Brigadier General, General Staff Corps
Chief of Staff

Official:

J. H. HILLS
Colonel, Adjutant General's Department
Adjutant General

2 Incls
Incl #1 - Combat Bombing Approach
Incl #2 - Combat Bombing Approach

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A. Triple drift solution should always be made to obtain drift and ground speed.

Two 45 and one 90 degree turns. B.

Bombardier positions telescope index to indicate position of start of 30 second run.

In the event a triple drift solution is impractical, a trial run should be made in the intended direction of target approach. Synchronize for rate and course. C.

Defended Area

Defended Area

Begin evasive action. Sight gyro is caged if pilot is controlling airplane or uncaged if bombardier controls airplane.

Turns should be limited to change headings not over 10 or 15°.

Target is picked up in sight

Limit turns to retain target in optics

Bombardier turns airplane into heading which will utilize data obtained previously. D.

Straight run with final refinements of course and rate. E.

Inclosure No. 1 (TS Memo 50-11-1)

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SECURITY INFORMATION

DIAGRAM – Combat Bombing Approach

A. Triple drift solution should be made to obtain drift and ground speed. In using bombsights other than M-series, this is the only method that may be used.

Triple drift solution is easily accomplished by two 45° turns and one 90° turn. When using M-Series sights a dry run will be made before initial point is reached to obtain data for ABC computer.

B.

Bombardier positions lateral cross-hair on target as soon as possible and starts optics to drive.

C.

Defended Area

Defended Area

Begin evasive action Turns should be limited to change in headings not over 10 or 15°.

Bombardier notes position on tangent index that indicates a 20-second run and levels out for the bombing run as the telescope index reaches this prescribed point on the tangent scale.

Bombardier turns airplane into planned heading if possible.

Straight run with final refinements of course and rate.

D.

E.

NOTE: Procedure will follow methods outlined in "High Altitude Combat Procedure" prepared by Central Instructors School (Bombardier) paying especial attention to correct use of Automatic Bombing Computer.

Inclosure No. 2. (TC Memo 50-11-A)

SECURITY INFORMATION

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T. G. MEMORANDUM)

NUMBER 50-11-3)

HEADQUARTERS
ARMY AIR FORCES TRAINING COMMAND
FORT WORTH, TEXAS 26 Sept 1945

TRAINING

Bombardier Training. Graduate Navigator's Nine Week Course

SECTION I - General
II - Proficiency Requirements
III - Ground Training
IV - Flying Training

SECTION I - General

1. Mission: The mission of the Army Air Forces Bombardier School in conducting this nine week course is to train graduate navigators in the theory and practice of aerial bombardment as employed by the Air Forces in the various theaters of operations.

2. Objectives - The training conducted at this school will have as its objective the following:

a. The qualification of students as precision bombardiers with basic proficiency in the use of the M-Series equipment.

b. Continued training to maintain navigation proficiency with special emphasis on the practical application of pilotage and map reading.

c. Maintenance of physical fitness.

3. Duration: The period allotted for this type of training is nine weeks.

4. Organization: The organization of the school or schools designated to conduct this type of training will be governed by the Exact Manning Tables for the station concerned. The size of the classes and flow of students will be as prescribed by this Headquarters. At the conclusion of each class training period, statistical data concerning the class will be incorporated on form F.T.C. A-308, this Headquarters, 9 July 1943.

SECTION II - Proficiency Requirements

1. Bombing:

a. Qualified as bombardier as prescribed by TM 1-250 (Course 1) dated 15 January 1945.

b. Able to bomb within accuracy requirements with following type bombsights: M-series.

e. Thorough knowledge of the bombing problem to include theory of bombsights.

d. Thorough knowledge of method of train bombing to include:
(1) Ability to calculate rapidly the time interval between successive releases necessary to obtain desired linear spacing of bombs.
(2) Ability to release bombs in train at desired intervals by manual operation of release switch.
(3) Ability to properly operate intervalometer.

e. Proficient in bombing with defective bombsight, to include the following conditions:
(1) Telescope motor inoperative.
(2) Directional gyro inoperative.
(3) Sight gyro inoperative.
(4) Disc speed tachometer inoperative, disc speed to be determined by stop watch.

f. Instructed in method of computing bombing probabilities.

g. Instructed in current methods of scoring and analyzing bombing results.

h. Proficient in pilotage and map reading.

2. Operation and Adjustment of Equipment.

a. Proficient in use of current type bombing and navigational computers such as the present type C-2, (Altitude Correction Computer), and E-6B, (Aerial Dead-Reckoning Computer), to include proficiency in the following uses of the E-6B or similar type computer.
(1) All used described in TO 05-35-9.
(2) As a circular slide rule, in solving multiplication and division problems as confront the bombardier and navigator.

b. Proficient in the operation and air adjustment of C-1 auto pilot.

c. Familiar with proper methods of operation and adjustment of bomb racks and controls. (Note: To the limits of available training equipment).

d. Instructed in the proper care and handling of bombing equipment.

e. Instructed in performing preflight inspection of bombing equipment.

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f. Proficient in the method of handling, loading and fusing aircraft bombs.

g. Able to properly diagnose any troubles arising in sighting equipment on the ground or in the air, to take such measures as will insure success of the mission and to check the accuracy of the sights calibration.

h. Proficient in the calibration of aircraft instruments.

3. Other:

a. Proficient in sending and receiving radio telegram code signals at the rate of 10 or more words per minute.

b. Proficient in sending and receiving blinker signals at the rate of 5 or more words per minute.

c. Qualified as aerial gunner as prescribed in TM 1-270. (NOTE: To be accomplished up to the limits of the quotas available at the flexible gunnery schools).

SECTION III - Ground Training	Subj. Hours	Phase Hours	Total Hours
1. Bombing			46
a. Basic Theory and Bombsights		29	
(1) Theory of Bombing and Bombsights	13		
(2) M-Series Sight (Pre-Flight, construction and operation)	15		
(3) D-8 Bombsight	1		
b. Bombing Accessories		17	
(1) Bomb Racks and Controls	5		
(2) Bombs and Fuses	5		
(3) Intervalometers	1		
(4) Computers - C-2, E-6B (Problems peculiar to bombing)	4		
(5) Aerial Cameras	2		
(a) When the proficiency of a student as a photographer drops below 75%-this figure to be arrived at by including all missions upon which the student rode as photographer, when bombs were released-it will be brought to the attention of the faculty board.			
2. Bombing Procedure.			60
a. Trainer Theory		1	

	Subj. Hours	Phase Hours	Total Hours
b. Trainer Operation		26	
c. Trainer operation Combat (Evasive action using automatic Bombing Computer)		12	
d. Conduct of missions		4	
e. Fixed angle Bombing		4	
f. Tactical Bombing (1) To include thorough knowledge of train bombing. (2) Defective sight Bombing.		4	
3. Bombing Analysis			12
a. Scoring methods and forms		2	
b. Causes of errors. (Analysis of results should be taught on the flying line)		8	
c. Probabilities		2	
4. Bombardment Aviation.			8
a. Bombardment Objectives and Objective Folders		6	
b. Combat Procedure		2	
5. C-1 Pilot			10
6. Bombsight Calibration and Trouble Shooting			35
7. Allied Training.			63½
a. Blinker and Code (Proficiency Basis)		3	
b. Aircraft identification		4½	
c. Athletics			54
d. First Aid		3	
8. Review and Examination			32
9. Critiques			83
TOTAL			329½

	Subj. Hours	Phase Hours	Total Hours

SECTION IV - Flying Training

1. Flying training will consist of a minimum of 73 hours: 73

a. Dry Runs (Tracking) 3

b. Bombing 70

2. Advantage will be taken of every opportunity to further the experience of the student in map reading and pilotage. Missions will be flown whose basic purpose is target identification in unfamiliar territory. Dry runs on this unfamiliar target will be made employing evasive action combat procedure.

3. Briefing periods will be held prior to each mission and critiques will be held immediately after landing. (Bombing analysis will be included in the critique period.)

a. Combat bombing will include the following basic features: (See attached diagrams, Inclosures #1 and #2)

(1) Each approach will vary in direction from any other on the same mission by at least 30 degrees (where local conditions prohibit this on certain targets, the airspeed or altitude will be varied so as to preclude the utilization by the student of the experience gained from previous releases. When more than one bombardier is to release bombs on a given mission, the instructor, or pilot if no instructor is available, will be responsible that no interchange of information is permitted between students).

(2) Objective folders will be used on a minimum of ten bombing missions. Where the objective folders include maps of cities and towns, and where the target objective precludes the actual dropping of bombs, dry runs will be accomplished by using objective folders. The use of objective folders must insure practice in map reading and target identification and the use of evasive action within definite defended areas.

(3) The student will, invariably, be given an opportunity to find the wind direction and velocity outside the defended area. (A-B) An opportunity will be given the student to make a dry run in the contemplated direction of approach, or at the new airspeed or altitude if these factors only are changed, this to be performed outside the defended area. (B-C)

(4) Final approaches to the target will be straight

and level for not exceeding 45 seconds. Every effort will be made to reduce this time.

(5) During that portion of the approach which lies within the defended area, (C-D), evasive action will be continuous. A minimum of 50% of these missions will be flown with the airplane controlled by the C-1 pilot. The bombardier will control 50% of these missions with the sight gyro uncaged. The pilot will fly 50% of these missions while the sight gyro is caged. In both instances, the bombardier will be responsible for timing the start of the straight and level final approach.

(6) Low altitude combat missions will place an emphasis on high ground speeds. Combat bombing will be conducted as prescribed in TM 1-250.

(7) Each bomb will be released under such conditions as will insure the maximum benefit to the student.

(8) No bomb will be released utilizing data from previous releases unless such data is utilized to recompute a triple drift solution.

b. Proficiency in the operation of air adjustment of automatic pilots will be required.

c. The flying time allotted to each student by this training program is adequate to enable each bomb released under combat conditions to be solved as a separate problem. It is the intent that the procedure on each combat bombing run follow the diagram attached to this Memorandum.

d. All instructional, combat and qualificational bombs are to be dropped at altitudes not to vary over 500' from true prescribed altitude.

e. Pilots and instructors are to be present at all briefing of missions in which they participate.

4. Scoring Accuracy. It is of the utmost importance that each bomb impact be scored accurately and honestly. To accomplish this, the following will govern:

a. The provisions of TM 1-250, 15 January 1943, specifies in paragraph 13 that scoring estimates, in the absence of photographs, be accomplished by a trained disinterested observer. It is the opinion of this Headquarters that bombardier students are in no manner disinterested observers and that their estimates of scores will not be accepted.

b. Under any conditions where less than 100% of all bomb impacts are photographed, estimates will be accepted only when accomplished by a trained, disinterested observer.

c. Circular errors greater than 700 ft. will be scored as 700 ft.

d. All combat bombs will be dropped on actual silhouettes on targets. The use of an overlay is prohibited.

e. It is possible that some schools will desire to utilize pilots in the capacity of scorers and observers, but it is not felt that this is conducive to flying safety.

f. The policy of scheduling solo missions as prescribed by the latest amendment to TM 1-250 will not be considered violated if there is a bombardier instructor in the airplane whose sole function is scoring and observation and who does not offer any assistance of any kind to the student bombardiers.

By command of Major General YOUNT:

WALTER H. KRAUS
Brigadier General, General Staff Corps
Chief of Staff

Official:

J. H. HILLS
Colonel, Adjutant General's Department
Adjutant General

2 Incls.
Incl #1 - Combat Bombing Approach
Incl #2 - Combat Bombing Approach

DIAGRAM - Combat Bombing Approach

A. Triple drift solution should always be made to obtain drift and ground speed.

Two 45 and one 90 degree turns. B.

Bombardier positions telescope index to indicate position of start of 20 second run.

In the event a triple drift solution is impractical, a trial run should be made in the intended direction of target approach. Synchronize for rate and course. C.

Defended Area

Defended Area

Begin evasive action. Sight gyro is caged if pilot is controlling airplane or uncaged if bombardier controls airplane.

Turns should be limited to change headings not over 10 or 15°.

Target is picked up in sight

Limit turns to retain target in optics

Bombardier turns airplane into heading which will utilize data obtained previously. D.

Straight run with final refinements of course and rate. E.

Enclosure No. 1 (TC Memo 50-11-2)

DIAGRAM - Combat Bombing Approach

A. Triple drift solution should be made to obtain drift and ground speed. In using bombsights other than M-series, this is the only method that may be used.

Triple drift solution is easily accomplished by two 45° turns and one 90° turn. When using M-Series sights a dry run will be made before initial point is reached to obtain data for ASC computer.

B.

Bombardier positions lateral cross-hair on target as soon as possible and starts optics to drive.

C.

Defended Area

Defended Area

Begin evasive action Turns should be limited to change in headings not over 10 or 15°.

Bombardier notes position on tangent index that indicates a 30-second run and levels out for the bombing run as the telescope index reaches this prescribed point on the tangent scale.

Bombardier turns airplane into planned heading if possible.

Straight run with final refinements of course and rate.

D.

E.

NOTE: Procedure will follow methods outlined in "High Altitude Combat Procedure" prepared by Central Instructors School (Bombardier) paying especial attention to correct use of Automatic Bombing Computer.

Inclosure No. 2. (TC Memo 50-11-3)

Appendix 6

Programs of Instruction in AAF Instructors' School (Bombardier)

I. As of 5 July 1943:

1. Ground training

		Hours
a.	Orientation Lecture	2
b.	Orientation Examinations (These are given to determine the knowledge level of the incoming class)	3-1/2
c.	A. B. Publications	1
d.	Bombing Analysis	18
e.	S-1 Bombsight	16
f.	Blinker	9
g.	Teaching Methods and Technique (Additional instruction in this subject is included in all courses)	1-1/2
h.	Military Conduct and Customs	5
i.	Intelligence Bulletins	4
j.	Computers	12
k.	Trainer	10
l.	M-Series Bombsights	27
m.	Preflight Procedure	1/2
n.	Navigation	9
o.	Aircraft Armament	9
p.	Critique (covering curriculum)	4
q.	Rating Procedure	2
r.	Duties of Staff Bombardiers	1
	Total Academic Hours	134-1/2

2. Air Training

a.	Norden Bombing Missions	9-1/2
	(1) No evasive action (refresher) medium altitude. (1-1/2 hours)	
	(2) Evasive action, medium altitude. (6 hours)	
	(a) 1 - Manual mission	
	(b) 2 - C-1 pilot missions	
	(3) Service ceiling (C-1 pilot) (2 hours)	
b.	Sperry Bombing Missions	12
	(1) Medium Altitude, manual mission (3 hours)	
	(2) Low Altitude, manual mission (fixed angle) (3 hours)	
	(3) High Altitude, manual missions (2) (6 hours)	
c.	D-8 Bombing Missions	1-1/2
	(1) Low Altitude - high speed - fixed angle	

	HOURS
d. Instrument Calibration	5
(1) Airspeed, Altimeter, Free air thermometer (2-1/2 hours)	
(2) Compass, Drift Indicator (2-1/2 hours)	
e. Navigation Mission	3-1/2
f. C-1 Auto Pilot (adjustment only)	
(1) 2 missions - each 2-1/2 hours	5
Total Air Training Hours	36-1/2

II. On 14 July 1943 the program of ground training was replaced by the following program of instruction.

War Department Publications	1
M-1 Bombsight	16-1/2
Teaching Methods & Technique	1-1/2
Military Conduct & Customs of the Service	4-1/2
Computers (C-2 and E-6B)	15
C-1 Automatic Pilot	16-1/2
Blinker Code	10
Bombing Trainers	15
Bombing Analysis	18
Instrument Calibration	9
M-Series Bombsights	26-1/2
Navigation	9
Aircraft Armament	10
Intelligence Bulletins	6
Rating Procedure	2-1/2
Duties of Staff Bombing Officers	1-1/2[2]
Total hours	162-1/2

III. In November 1943, after the Bombardier Instructors' School was moved from Carlsbad to Midland on 6 August 1943, the statement of the mission of the school and the program of instruction were revised. T. C. Memorandum No. 50-11-6, 12 November 1943, containing these revisions, follows:

1. The mission of the Army Air Forces Instructors School (Bombardier) is to accomplish the following objectives:

   a. Conduct advanced training of bombardier instructors assigned or to be assigned to the bombardier schools of the Training Command.

   b. Conduct refresher courses for bombardiers returning from combat zones and other personnel as may be authorized by this Headquarters.

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1. T. C. Memo 50-11-6, 5 July 1943, in AFHHI files.
2. Unnumbered memo of AAF Instructors School (Bombardier), Carlsbad, N.M., dated 14 July 1943, in ibid.

c. Prepare personnel, by familiarization with teaching methods and through practice teaching, to assume their duties as instructors.

d. Test, evaluate, and publish after approval by this Headquarters, methods and procedures of instruction in accordance with the policies outlined in F. T. C. Memorandum No. 5-2.

e. Test and evaluate training aids submitted for approval.

f. Evaluate rated bombardiers in such instances where the ability of those individuals as bombardiers is questioned. This action will be conducted in the following manner:

(1) Any commanding officer within the Training Command who has under his command a rated bombardier whom he believes incapable of fulfilling his duties as such, will present the facts concerning each case to the Commanding General, Army Air Forces Training Command, in writing and request that this officer be brought before the evaluation board, Instructors School (Bombardier) for a test of his ability. This Headquarters will indicate by indorsement whether or not the circumstances warrant the bombardier being placed on temporary duty at the Instructors School (Bombardier) for the purpose of such evaluation.

(2) The Instructors School (Bombardier) will determine the suitability of any bombardier, placed on temporary duty at that station for such purpose, to retain his aeronautical rating and will limit its action to one of the following:

(a) Initiate proceedings to recommend disrating of the bombardier under the provisions of AAF Reg. 60-2

(b) Return the bombardier to his original station for continuation of duty.

2. Proficiency of student officers will be determined by the faculty of the Army Air Forces Instructors School (Bombardier).

3. The Army Air Forces Instructors School (Bombardier) will be under the direct administrative supervision of the Army Air Forces Central Flying Training Command, and the requirements of this school, personnel, and equipment will be made a matter of first priority.

4. For changes in assignment of officers assigned, see F. T. C. Memorandum 35-10.

5. The size of classes and flow of students will be as prescribed by this Headquarters.

6. At the conclusion of each class training period, a report will be submitted to this Headquarters. (See attached form.)

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7. Recommendations and comments on the adequacy of the course, with suggested changes, may be submitted at any time. Direct correspondence with this Headquarters in matters of this nature is authorized.

8. The training period, under this directive, is of six weeks' duration.

9. The Ground Training of the Army Air Forces Instructors School (Bombardier) will employ 269 hours of instruction as follows:

a. Administration (Orientation, Graduation)- - - - - - 12 hours

b. Sperry Bombsights - - - - - - - - - - - - - - - - - - 16 hours

c. Instrument Calibration - - - - - - - - - - - - - - - 3 hours

d. Blinker Code - 3 hours

e. Military Courtesy - - - - - - - - - - - - - - - - - - 5 hours

f. Trainers (1 hour Norden ABC - 5 hours Sperry - Individual Operation) - - - - - - - - - - - 6 hours

g. Computers - C-2, ABC and S-6B - - - - - - - - - - - - 15 hours

h. M-Series Bombsights - - - - - - - - - - - - - - - - - 24 hours

i. Navigation -24 hours

j. Bombing Problem - - - - - - - - - - - - - - - - - - --18 hours

k. C-1 Auto Pilot -17 hours

l. Instructional Analysis - - - - - - - - - - - - - - - -18 hours

m. Physical Training (36 hours actual exercise in accordance with F. T. C. Memorandum 50-21-2) - - - -54 hours

n. Evening Study Period (one and one-half (1-1/2) hours during evening hours)- - - - - - - - - - - - - - - - -54 hours

TOTAL GROUND HOURS - - - - - - 269 hours[1]

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[1] T. C. Memo 50-11-6, 12 Nov. 1943, in Ibid.

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10. The Air Training of the Army Air Forces Instructors School (Bombardier) will have seventeen (17) four-hour periods (to include briefing and flying time). During this time a student will fly a minimum of thirty and five-tenths (30.5) hours. The periods are outlined as follows:

a. Norden Familiarization Mission.

b. Sperry Mission - Ground and Air Check.

c. Sperry Mission.

d. Sperry Mission.

e. Alidade Calibration.

f. Bombsight Calibration.

g. C-1 Automatic Pilot, Air and Ground Check.

h. Short Combat - Photo Mission, Pilotage, Bomb, etc.

i. Local Combat Type Norden, AB0 and E-6B Computer.

j. Short Combat - Photo Mission, Pilotage, Bomb, etc.

k. Short Combat - Photo Mission, 3 Ship Formation.

l. Short Combat - Photo Mission, 3 Ship Formation.

m. Long Combat - Photo Mission, D. R.

n. Long Combat - Photo Mission, D. R.

o. D-8 Bombsight Low Altitude Mission.

p. Local Combat - Type Norden, (optional).

q. Lecture on Anti-Aircraft and practical application of this knowledge in using Evasive Action.

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Appendix 7

Deficiencies of Sperry Bombsight

"1. The following facts and opinions with regard to Sperry bombsight equipment is expressed for your information:

a. The Sperry sight has long been known to be inferior to the Norden sight with regards to combat type operation; that is, for the evasive action approach to the target and a short bombing run. Although a short [run] is possible with the Sperry sight, very definite limits are imposed. Once the heading is decided upon, it will be necessary to make the run within a 5° variance. On manual pilotage the turns required would have to be directed by interphone. Considerable prejudice against Sperry equipment has long existed both in the Training Command and in the Second Air Force. Pre-setting drift in the Sperry sight requires a series of gyrations and timing operations that will require the average bombardier from 1-1/2 to 2-1/2 minutes to perform.

b. The optional [optical] system of the Sperry sight is such that great difficulty is experienced in trying to locate an unfamiliar target. This difficulty operates against the bombardier when the approach is made within 30° of the sun at any altitude, when the approach is made at a high altitude, or when there is any ground haze present. Although not certain, I think that the light rating transmitted through the optics of the Sperry sight is at least 30% less than in the Norden system.

c. There is no provision for clearing the sight of fog during the run. It is impossible for the bombardier to get at the front optics or the viewing optics to clear them of fog.

d. Time and time again criticism has been made of the critical voltage tolerance in the Sperry equipment. The sight will not operate, or what is worse yet, will give a false picture if the voltage output deviates slightly from the amount required to operate this sight. Also, there is no way for the bombardier to determine what is the actual output voltage reaching the sight.

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e. The lack of a turn control with Sperry equipment is a very serious disadvantage. It is believed that this point has been covered quite thoroughly in the frequent reports made by the Bombardment Division of O.C.&R.

"2. Although the Air Forces have used Sperry equipment for some time, as yet no acceptable procedure for combat type operation has been decided upon. Its many difficulties has built up prejudice in the minds of practically everyone concerned with bombing. Informal comment from Lt. Colonel Broadhurst of the Second Air Force indicated that this Organization is reluctant to send crews to combat equipped with Sperry equipment only. Assistant Chief of Air Staff, Operations, Commitments and Requirements of Army Air Forces Headquarters have reprieved the expressed opinion that the Sperry sight is inferior for combat conditions to the Norden sight. Recommendations have been made by OC&R that all heavy bombardment and 25% of medium bombardment be equipped with Norden equipment. Materiel Division has estimated that it will be possible by January of 1944 to expand Norden production facilities to the extent that the needs of all heavy bombardment can be outfitted with Norden equipment."[1]

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[1] Memo for Lt. Col. L. R. Herzo; by Capt. M. O. McTague, 13 Aug. 1943, in files of AC/AS, Training—Air Crew.

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