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**INDIVIDUAL  
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PREPARED BY  
ASSISTANT CHIEF OF AIR STAFF  
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The Commanding General	
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	Jan 1945

INDIVIDUAL TRAINING OF NAVIGATORS IN THE AAF

Prepared by  
Assistant Chief of Air Staff, Intelligence  
Historical Division  
January 1945

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

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. To this end perforated sheets, properly addressed, may be found at the back of the study.

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

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Individual Training of Navigators in the AAF

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Chapter I  
EXPANSION PROGRAM AND PRODUCTION REQUIREMENTS

Group Programs and Navigator Requirements

The essential function of the training agencies of the Army Air Forces in World War II has been to produce trained personnel to meet the requirements established by planning agencies in headquarters. Up to the time of this writing (April 1944) training requirements had undergone frequent alterations because they were based on numerous factors which were themselves constantly shifting. Among the more important factors governing the requirements for navigators were the types of combat airplanes in use or scheduled for use, the changing tactical employment of the various types of aircraft, changes in the composition of the crews, varying demands for navigators from the different theaters of operation, and the requirements of commands and tactical and nontactical units other than bombardment and reconnaissance.

In addition to these factors which complicated the problem of requirements were the several types of navigation training demanded by the using agencies. For example, the requirements for medium bombardment were principally for dead reckoning navigators, whereas heavy and very heavy bombardment demanded more celestial navigators. As between theaters of operation, a much larger percentage of navigation was based on celestial means in the Pacific than in the European areas. Still another factor affecting requirements in the production of navigators was the use to be made of navigators who were returned to the United

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States after serving a tour of duty in the combat theaters. Many of these men were used in the training program, and some of them were scheduled for a second tour of combat duty, but in either case they filled what otherwise would have been additional production requirements. The effects of all these and other factors on both the establishment of navigator requirements and the conduct of navigation training will be indicated throughout this study.

It appears that prior to 1933 there was no requirement in the Air Corps that a separate member of an aircrew be trained as a navigation specialist, all navigation training being a part of pilot training. From 1933 to 1939 the tactical units performed a varying amount of specialized navigation training. With the inauguration in 1939 of the Air Corps expansion program, however, the demand for this type of training was accentuated, because of the increasing number of tactical units, the long-range employment of such units, and the decision to include a competent officer navigator in the crew of each airplane of heavy and medium bombardment squadrons and the attached reconnaissance squadrons. The plans to employ navigators on the above basis constituted a program requirement, in September 1939, of 506. To be applied against this program requirement there were 166 qualified navigators on duty with the GHQ Air Force on 31 July 1939.

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1. Memo for C/AC by Chief of Plans Div., 20 Sep. 1939, in AAG 352.01C, Establishment of Air Service Schools and Staff Colleges; R&R, Plans to Exec., 27 July 1940, in AAG 353.9, Specialized Training.

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By the spring of 1940 the navigator requirements had increased to 925 with the Plans Division of the Office of the Chief of the Air Corps (OCAC) considering it essential that such personnel be dually trained as bombardiers and navigators.<sup>2</sup> With the adoption of the 41 Group Program (7,000 pilot program) the navigator requirement was increased to approximately 1,800.<sup>3</sup> At this time navigator training was still confined to that given in the tactical units, since the first specialized navigation school under the Chief of the Air Corps (the civil contract school at Coral Gables, Fla.) was not opened until 10 August 1940.

The 54 Group Program (12,000 pilot program) was approved about the middle of 1940. The total navigator requirement under this program has not been ascertained, but on the basis of the navigator-pilot ratio which generally prevailed, the navigator requirement should have been approximately 2,400 per year. In June 1940, however, the navigator requirements for the medium and heavy bombardment units planned under the 54 Group Program were 1,030.<sup>4</sup> But it was characteristic of all programs during the period of the expansion program that before any goal had been attained the authorized objective had been superseded by still another. It was also true that specific and short-term requirements were established as well as the long-range program requirements. As an example of this, about the same time that the 54 Group Program was authorized, a directive was issued stating two short-term navigator

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- 2. R&R, No. 2, Plans to T&O, 15 May 1940, in AAG 352.01C, Establishment of Schools.
  - 3. WD Press Release, 14 June 1940.
  - 4. R&R, No. 1, Plans to T&O, thru Exec., 28 June 1940, in files of A/C Br., Military Personnel Div., AC/AS, Personnel.

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production requirements. This directive required that 749 navigators  
should be graduated by 1 April 1941 and 1,269 by 1 November 1941.  
<sup>5</sup>

The existing schedule of production indicated that only 1,030 navi-  
gators would graduate between 2 November 1940 and 27 December 1941.  
<sup>6</sup>

Although training to meet the goals of the 54 Group Program was not to be initiated until March 1941, the three training centers were directed, in December 1940, to initiate planning for the 84 Group Program (30,000 pilot program). The annual production rate for navigators  
<sup>7</sup> to be attained under this program was 5,187. As was true in all directives on training requirements sent to the three training centers, the total requirements exceeded what was to become the over-all rate required of all Air Corps schools (later Flying Training Command).

The established ratio of navigators to American pilots in the production  
<sup>8</sup> program was 188 to 1,000. Since the 30,000 pilot program included the training of 4,000 foreign pilots, the total navigator requirement under this program was 4,888, which figure was used by the Plans and Training  
<sup>9</sup> and Operations divisions. Actual production, however, naturally trailed far behind the goals set up in the various programs. It was planned that training to meet the goal of approximately 2,400 navigators per year should be initiated in March 1941; training to meet the 4,888

- 
- 5. R&R, No. 4, Plans to T&O, 26 Sep. 1940, in AAG 353.9C, Training Programs and Directives.
  - 6. 1st Ind., OCAC to Parks Air College, 27 Aug. 1940, in AAG 353.9, Specialized Training.
  - 7. T&O to CG of each training center, 17 Dec. 1940, in AAG 353.9B, Training, General.
  - 8. Project Book of CG, Flying Training Command, Navigation Sec.,  
of Historical Div., AC/AS, Intelligence <sup>25 March 1942</sup>, in files
  - 9. R&R, No. 2, Plans to T&O, 8 May 1941, in AFHII files.

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requirement was initiated in December 1941. In relation to these requirements, however, the actual estimated production for the period 11  
1 July 1941 to 30 June 1942 was a total of 2,060.

About two weeks before training to meet the 4,888 goal was begun, the three training centers were directed to submit plans for the 50,000 12 pilot program under which 9,400 navigators were to be produced annually. Two weeks later the training centers were informed of still another directive calling for plans to attain the 9,400 rate between 1 May and 1 October 1942 and establishing a 70,000 pilot program, the production 13 rates of which were to be attained between 1 March and 1 August 1943. The navigator requirement under the latter program was approximately 13,500 annually. Navigation training to correspond with the 4,888 goal was initiated on 27 December 1941, while training to meet the 9,400 goal was scheduled to begin on 4 July 1942. Training under the latter 14 program, however, was not initiated until the following September.

Navigation training under the 13,500 annual production program 15 (70,000 pilot program) was scheduled to begin in March 1943. The required rate of production was attained in June, and the total production for the calendar year 1943 was 14,351 as against the Training Command goal of 13,598, the goal during the first half of the year.

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- 10. Project Book of CG, AFFTC, Navigation Sec., 25 March 1942.
  - 11. Fiscal Office to Budget and Legislative, 26 Aug. 1941, in AAG 353.9C, Air Corps Training Directives and Programs.
  - 12. Asst. C/AC to CG of each TC, 10 Dec. 1941, in AAG 353.9C, Training General; Project Book of CG, AFFTC, Navigation Sec., 25 March 1942.
  - 13. Acting C/AC to CG of each TC (radiogram), 26 Dec. 1941, in AAG 353.9C, Training, General.
  - 14. Project Book of CG, AFFTC, Navigation Sec., 25 March 1942.
  - 15. Ibid.

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During the last half of 1943 the production program constantly mounted.

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In August it stood at 18,900 and in September it was 20,000. By the end of 1943 it appeared that the program would be at least stabilized and possibly reduced somewhat.

From 1939 to the end of 1942 the problem of meeting navigator requirements was principally that of expanding physical training facilities and procuring the materiel and personnel necessary to produce trained navigators to meet the minimum needs of the tactical units. During this period the chief demand of the tactical units was for crew members for the rapidly activated groups which were going through OTU (group) training. It was not until nearly mid-year of 1943 that the number of combat groups approached the plateau stage and training turned predominantly to RTU (replacement) training. Also, it was not until 1943 that the operations of the AAF in the theaters of combat assumed full proportions. It was in the period following 1942, therefore, that the navigation schools felt the full impact of combat operations. Several factors affected the quantity of navigators to be trained. The RTU system processed crews more rapidly and in larger numbers than did the OTU system. Large-scale combat operations also entailed a greater navigator demand from using agencies other than the bombardment units, for example, the Air Transport and Troop Carrier Commands. Combat experience also resulted in numerous changes in the tactical employment of aircraft by the using agencies, which changes were reflected in the training program. The result of these developments

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The problem was that the problem of navigator requirements became more complex after 1942. Under these circumstances there was a tendency to put requirements on a demand basis and to abandon the navigator-pilot ratio basis. There was, of course, no alternative to this policy when toward the end of 1943 the requirement for pilot production was reduced while at the same time there was a shortage of navigators--either real or apparent.

Problems, Factors, and Procedures of Expansion

The above summary of the large and over-all program requirements for navigator training is only an introduction to the experience of the AAF in its struggle to produce an adequate number of proficient navigators. There follows a more detailed account of the expansion of training facilities, the expedients resorted to in order to meet demands which were more immediate than any long-term group program, the demands of the various using agencies, and the varying degrees of success experienced in meeting both the immediate and long-term requirements.

Initiation of Civil Contract Training. The original plans for the expansion program contemplated the accomplishment of all navigator training in specialized flying schools under the Chief of the Air Corps. A year after the program was launched, however, no such specialized schools were in operation, and it was decided that such training could be accomplished "more expeditiously and with greater economy by utilizing the experience, organization and facilities" of Pan-American Airways,  
<sup>17</sup> Inc. A contract was entered into with PAA by which the company was

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17. C/AC to AG, 18 July 1940, in AAG 353.9, Advanced Aviation Training.

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to train 850 students at Coral Gables, Fla., during the period of August 1940 to December 1941. With the first three classes of 50 students each and subsequent classes of 100 students each, PAA was expected to graduate, from a 12-week course of instruction, 150 navigators by 3 March 1941 and 850 by 27 December 1941.<sup>18</sup>

Initiation and Expansion of Training in Air Corps Schools. It was not contemplated, however, that all navigator training should be performed in civil contract schools. Plans in early 1940 called for the training of navigators at Barksdale and Maxwell fields. The training at Maxwell failed to materialize, but Barksdale entered the first of its three classes about 1 November 1940. By the middle of July 1941 Barksdale had graduated 52 students and PAA had graduated 287. This total of 339 fell far short of the 749 which was the production goal for 1 April 1941 and was hardly a beginning on the 4,888 annual rate which was the new program rate authorized in the first part of 1941. Furthermore, no increase in production could be expected from Barksdale and PAA. In May 1941 arrangements were made whereby the British government was allowed to contract with PAA for training of United Kingdom students at the rate of 150 per class.<sup>19</sup> This limited the number of United States students to 50 per class. In addition to this curtailment in navigator production, it was found impracticable to expand navigation training at Barksdale. Weather conditions at that field were not conducive to navigation training. Bombardier and pilot training also were being conducted there, and facilities could not be expanded sufficiently

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18. R&R, T&O to Personnel Div., 18 Sep. 1940, in ibid.

19. T&O to CG, SEACTC, 20 May 1941, in AAG 353.9B2, Training, General.

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to meet the demands for the enlarged navigator program. Thus it was necessary to inaugurate such training at other stations.

The need for specialized schools devoted entirely to the training of navigators was apparent, but the acute shortage of training materiel made it necessary to operate navigation schools in conjunction with advanced pilot schools. Consequently, the navigation school at Barksdale was divided three ways, each part being the nucleus for the navigation schools opened at Turner Field, Ga., Kelly Field, Tex., and Mather Field, Calif., in July 1941. Advanced pilot training was conducted at each of these fields. Effective 1 July 1941 training was discontinued at Barksdale and was scheduled to begin at each of the three new schools on  
20  
1 August 1941.

Turner, Kelly, and Mather fields opened with classes of about twenty students each, with classes of this size scheduled to enter each three weeks for the remainder of 1941, after which time the size of classes was scheduled to increase to 114, or a total school enrollment of 1,710  
21  
by 21 March 1942. Although the directive of 26 September 1940 called for the production of 1,269 navigators by 1 November 1941, only 460 had  
22  
been graduated from Air Corps and civil contract schools by that date.

During November and December 1941 steps were taken to accelerate the production of navigators. In the Southeast Training Center plans were made to increase the size of the classes in the navigation school

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- 20. R&R, No. 1, T&O to Exec., 16 July 1941, in AAG 352.11 H, Courses of Instruction.
  - 21. Training Report, Instruction of Air Corps Enlisted Men and Aviation Cadets (non-pilot), Air Corps Expansion Program, 9 Aug. 1941, in AFIHT files; "Report" attached to AAF Bulletin No. 41-1, 10 Oct. 1941, in AAG office files.
  - 22. See Chart 1, following p. 23.

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at Turner Field and to establish a second navigation school in that  
23 training center. In the Gulf Coast Training Center the navigation  
training at Kelly Field was handicapped because of the many other func-  
tions performed there. Plans were made to alleviate this situation by  
concentrating all navigation training at Brooks Field, an auxiliary of  
24 Kelly. In the West Coast Training Center navigation training was ex-  
panded by removing the pilot school from Mather Field and thus utilizing  
the entire station capacity for an expanded navigation school with classes  
25 being increased to 240 students.

Navigation training to meet the 30,000 pilot program was started  
on 27 December 1941. The navigator requirement under this program  
was a training rate of 4,888 per year with the first graduation sched-  
26 uled for 11 April 1942. It appears that the expansion of facilities  
as indicated above would have been approximately adequate for the 4,888  
program, but when plans were made to initiate training on 4 July 1942,  
under the 50,000 pilot program, which called for a navigator production  
rate of 9,400 per year, a further expansion of facilities was essential.

With new and larger objectives to be attained it was obvious that  
the navigation schools would have to be divorced from other types of  
specialized training and made into single-purpose training establishments.  
This had already been accomplished at Mather Field, and plans were made

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23. CG, SEACTC to C/AC, 27 Nov. 1941, in files of Historical Sec.,  
Training Command.  
24. CG, GCACTC to C/AC, 22 Dec. 1941, in AAG 353.9C2, Training, General.  
25. CG, WCACTC to C/AC, 20 Dec. 1941, in ibid.  
26. Project Book of CG, AFFTC, Navigation Sec., 25 March 1942.

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in March 1942 to establish a new navigation school at Monroe, La., to replace the one at Turner Field, and likewise a new one at Hondo, Tex., to replace the one at Kelly Field. The new school at Hondo alone was to have an enrollment of 1,800.  
27

The training centers had been advised in December 1941 that the 28 9,400 rate was to be attained by 1 October 1942. Because of shortages of materiel and personnel and delays in construction, the two new schools could not be opened by 4 July 1942, the date training under the 9,400 program was to have been initiated. Instruction at Hondo did not begin 29 until 15 August, and it was 14 September before training began at 30 Selman Field, Monroe, La. This delay in beginning training under the 9,400 program occasioned the loss of approximately 780 navigator 31 graduates.

The navigator requirements established under each of the over-all training programs were essentially "goals to be shot at." The factors which really determined the number of navigators were the capacity of schools, the availability of training materiel, and the supply of instructor and supervisory personnel. While every effort was made to meet the program requirements, the essence of directives to the Flying Training Command, and in turn to the training centers, was that training must

- 
- 27. "Report" attached to AAF Bulletin No. 41-1, 10 Oct. 1941, in AAG office files; Project Book of CG, AFFTC, Navigation Sec., 25 March 1942.
  - 28. Acting C/AC to CG of each TC (radiogram), 26 Dec. 1941, in AAG 353.9C, Training, General.
  - 29. Project Book of CG, AFFTC, Navigation Sec., 14 Aug. 1942. The "History /of/ Hondo Army Air Field, Activation to 1 January 1943," p. 7 (in AFHHI Archives), indicates, however, that the move was made on 8 August.
  - 30. "History of Selman Field, Monroe, Louisiana, 15 June 1942 - 31 December 1942," in Historical Sec., AFTRC.
  - 31. Project Book of CG, AFFTC, Navigation Sec., 25 June 1942.

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be expanded to the "maximum capacity commensurate with equipment and  
32 personnel provided." In August 1942 the command was informed that  
33

The need for combat crew personnel of all categories far exceeds the current and contemplated output of flying training schools. The current shortage is extremely acute, and . . . unless drastic corrective action is immediately taken the existing shortages will reach dangerous proportions in the near future. . . . The need for an immediate and sustained effort to improve the quantity and quality of graduates of Air Force schools must be forcibly impressed upon every individual concerned. Personnel, equipment, and facilities of all categories must be used to the maximum.

It appears that the command took every action possible to meet the increasing demand for navigators. In July the Southeast Training Center was directed to enter the "maximum possible" number of trainees into the navigator preflight school at Ellington Field and to do so "as soon as possible to take care of increased demands anticipated in the"  
34 near future." By October navigation training was "all out" insofar  
35 as equipment would permit.

Expansion of Civil Contract Training. In June 1942 when Air Corps navigation school facilities were being expanded, attempts were made to increase training in civil contract schools. Such training for navigators had been confined to that conducted by the PAA at Coral Gables, Fla. Throughout June and July negotiations were conducted with the Transcontinental and Western Airlines in an attempt to initiate navi-

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- 32. Daily Diary, Directorate of Individual Training, 4 July 1942, in AAG 319.1-3, Daily Diaries; Daily Diary, AFFTC, 4 July 1942, in AC/AS, Training files.
  - 33. AFRIT to CG, AFFTC, 11 Aug. 1942, in AAG 353.9E, Training, General.
  - 34. Daily Diary, AFFTC, 18 July 1942.
  - 35. Ibid, 12 Oct. 1942.

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gator training by that company. The facilities of TWA were so limited, however, that only 12 students per class could be accommodated, and the AAF would be required to furnish training planes to implement this limited program. Also, the cost per student would have been nearly four times as great as that paid to the PAA for comparable training. Though the cost was excessive, it appears that the contract would have been made if TWA had had the necessary equipment. With the existing shortage of planes and other types of equipment in AAF schools, it was not deemed expedient to divert such equipment to TWA.

The failure to inaugurate navigation training by the TWA was more than offset, however, by the increase in such training by the PAA. With the termination of British training at Coral Gables, the AAF was able to increase the size of its classes there from 50 to 200. This increase became effective during either the last part of August or the first part of September.

Demands and Accomplishments, 1943

In October 1942 the Flying Training Command was informed that the navigator requirement for the period from 30 September 1942 to 31 December 1943 was 18,433.<sup>40</sup> This constituted an average monthly rate of 1,229. During the first three months of this 15-month period, however,

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- 36. AFRIT to CG, AFFTC, 19 June 1942, in AAG 353.9B, Navigation and Instrument Training; Daily Diary, AFFTC, 17, 25, 29, 30 June 1942.
  - 37. R&R, No. 3, AFRIT to Materiel Command, 21 July 1942, in AAG 353.9B, Navigation and Instrument Training.
  - 38. Project Book of CG, AFFTC, Navigation Sec., 1 Aug. 1942.
  - 39. Monthly Consolidated Flying Training Reports, in AFHRI files.
  - 40. AFRIT to CG, AFFTC, 20 Oct. 1942, in AAG 353.9G, Training, General.

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the average monthly rate of production was far below this rate.<sup>41</sup> It was obvious that navigator production during 1943 would have to be greatly increased. To meet the above requirement an average monthly production rate of approximately 1,400 for the year 1943 would have to be attained. The difficulties to be encountered in the attainment of this goal were enormous.

The dual training of bombardier-navigators had been started on a small scale in October 1942.<sup>42</sup> When graduate bombardiers were sent to navigation schools, the enrollment in such schools was correspondingly reduced, and when the flow was reversed, as it was after July 1943,<sup>43</sup> the output from the navigation schools which was available to the using agencies was correspondingly reduced. Approximately 1,400 bombardier-navigators were trained during 1943.<sup>44</sup> A still more important effect of the program of dual training on navigator production, however, was the unsettled status of the possible demands of the tactical units for such personnel and also the divided opinion of training agencies relative to the feasibility of such training. In transmitting to the Directorate of Individual Training the navigator requirements for 1943, the Directorate of Bombardment submitted five different bases for requirements and indicated the desired order for these goals to be attained.<sup>45</sup>

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- 41. Monthly Consolidated Flying Training Reports.
  - 42. AFIT to CG, AFFTC, 2 Oct. 1942, in AFIG 353.9, Specialized Training; Daily Diary, AFFTC, 16 Oct. 1942.
  - 43. Daily Diary, AFTRC, 24 July 1943.
  - 44. See Chart 3 following p.
  - 45. R&R, No. 2, Directorate of Bombardment to AFIT, 26 Dec. 1942, in AFRC files.

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In January 1943 the estimated navigator production for the ensuing year was sufficient to meet only the requirements of the Directorate of Bombardment. If the demands of this directorate were to be fully met, there would be no graduates available for the Director of Photography, the Air Transport Command, the Troop Carrier Command, and the Flying Training Command.<sup>46</sup> These three commands had requirements of approximately 2,500 in January, which rose to about 4,500 two months later.<sup>47</sup> In the face of these demands, Individual Training directed the Flying Training Command to "expans<sup>48</sup> to the maximum immediately" and authorized the use of any Technical Training Command stations in order to augment navigator production.

An additional strain was imposed on the training program in January of 1943 when the program of instruction in the navigation schools was extended from 15 to 18 weeks.<sup>49</sup> By the end of 1942, however, trainer airplanes and other equipment were being delivered on a more satisfactory basis which facilitated further expansion of training.<sup>50</sup> In order to meet the pressing demands for increased production, an additional navigation school at San Marcos, Tex., was scheduled to open in March 1943. Also, an overload of students was entered in the various schools.<sup>51</sup> On 29 December 1942 the Flying Training Command directed a

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- 46. R&R, No. 1, AFRDB to AC/AS, A-1, 15 March 1943, in MAG 211B, Titles and Grades.
  - 47. Ibid.
  - 48. Daily Diary, AFFTC, 6 Dec. 1942. It appears that no Technical Training Command stations were ever employed in the navigation program.
  - 49. See Chap. IV for treatment of navigation programs of instruction.
  - 50. See Chap. VII for treatment of materiel problems.
  - 51. Daily Diary, AFFTC, 15 Dec. 1942.

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further overloading of the schools. The size of classes at PAA was increased from 200 to 250. The entrance of double classes at Hondo (500) on 7 January, at Monroe (480) on 6 February, and at Luther (apparently 480) on 27 March, and also an initial class of 300 at San Marcos was ordered. In order to fill these classes the training centers were authorized to increase the number of navigator trainees entering preflight in January, to bypass preflight for all pilot eliminates assigned to navigator training if they had completed pilot preflight, and to graduate preflight trainees prior to completion of the full nine-week course, if necessary to meet the above quotas for the advanced navigation schools. Partially to meet these quotas approximately 400 bombardier graduates were to be entered in the advanced navigation schools.

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As a result of the above measures the enrollment in the navigation schools, which stood at 3,287 on 1 January 1943, was expected to increase to 7,700 by 1 July 1943 with production for 1943 expected to reach 13,598.<sup>53</sup> These measures were still inadequate, however, and about 1 March there was a demand for an additional increase of approximately 1,000 graduates by mid-July.<sup>54</sup> During March conferences were held for the purpose of exploring the possibilities of still further increasing production. Use of the four-engine transition schools, continued overloading of classes in the navigation schools, reverting to a 15-week program of instruction, lowering the elimination rate "due to

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52. Ibia., 29 Dec. 1942.

53. Project Book of CG, AFFTC, Navigation Sec., 6 April 1943.

54. Daily Diary, AFFTC, 9 March 1943.

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better material and better instruction," and the lowering of the instructor-student ratio were all considered. It was estimated that an additional 1,500 graduates could be produced if all of these steps were taken. The Flying Training Command was opposed to abandoning the 13-week program and after further consideration did not recommend the use of the four-engine schools. The lowering of the elimination rate and the instructor-student ratio were contingent on time and other factors.

Beginning in April and May the size of entering classes was increased slightly—by about 10 to 15 students.<sup>55</sup> Trainer airplanes and other equipment still constituted the basic limiting factor. By July, however, the monthly rate of production had passed the 1,300 mark,<sup>56</sup> and plans were made to increase the school enrollment to 8,156 by 9 December 1943.<sup>57</sup>

Air Transport Command and Troop Carrier Command Requirements. One of the most important problems encountered in meeting the requirements for individually trained navigators was that of the demands of using agencies other than the training air forces and the Flying Training Command. The demands for trained navigators for use as instructors and for supervisory duties in the navigation schools of the command and the crew and staff officer requirements of the OTU and RTU programs in the Second and Third Air Forces were fairly well established factors, subject to a normal amount of shifting crew requirement for medium bombardment.

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55. Ibid., 20 March 1943.

56. Monthly Consolidated Flying Training Reports.

57. Ibid.

58. Project Book of CG, AFFTC, Navigation Sec., 13 July 1943.

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The needs of the Air Transport, Troop Carrier, and Antisubmarine Commands seemed to make the difference between success and failure in meeting the over-all navigator requirements. The expected requirements of the Directorate of Bombardment and the Flying Training Command for 1943, as indicated on 15 March 1943, totalled 14,404.<sup>59</sup> The Flying Training Command graduated during 1943 a total of 14,351,<sup>60</sup> leaving a shortage of only 131 for those using agencies.<sup>61</sup>

In January 1943 the Air Transport Command informed Individual Training of its estimated 1943 navigator requirement which totalled 3,553.<sup>62</sup> About the same time the Troop Carrier Command's requirement was indicated as 3,093, of which 1,035 should receive first priority, the remaining 2,063 to be assigned as available.<sup>63</sup> The navigator requirement of the Troop Carrier Command had been only recently established and therefore had not been included in earlier planning. As late as July 1942 it was not expected that troop carrier squadrons in combat theaters would use navigators, and it was not until February 1943 that navigators were included in the tables of organization of troop carrier squadrons.<sup>64</sup> The requirement from this date was 13 navigators per squadron. There was also at this time an acute shortage of navigators in the Antisubmarine Command, that command having only 33 per cent of its approved navigator strength.<sup>65</sup> In reply to the urgent request of this command for more

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- 59. RMR, No. 1, AFROB to AC/AS, -1, 15 March 1943, in AIG 211B, Titles and Grades.
  - 60. Monthly Consolidated Flying Training Reports.
  - 61. RMR, CG, AFMTC to AFMFT, 7 Jan. 1943, in AIG 211A, Titles and Grades.
  - 62. RMR, Directorate of Air Support to AC/AS, -3, in ibid.
  - 63. Ibid.
  - 64. T/O 1-317, 3 Feb. 1943.
  - 65. CG, AFSUB to AFROB, 11 Feb. 1943, in AIG 211A, Titles and Grades.

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navigators, the Directorate of Bombardment points out that "Navigators represent the greatest personnel shortage confronting" the AF; the anti-submarine Command could not expect any immediate assignments, but an effort would be made to provide some out of the March promotion.  
<sup>66</sup>

No evidence has been found which would indicate only a "paper shortage" of navigators in the antisubmarine Command. Relative to the requirements of the Air Transport and Troop Carrier Commands, however, there is considerable evidence that their demands went beyond their actual operational needs. In September 1943 there was an apparent shortage of navigators, varying from 4,887 to 5,771.  
<sup>67</sup> In the following month AC/IS, Training received, through the commanding officer of Solman Field, a strong complaint from a number of navigators on duty with the Fifth Air Force. These "members of Classes 43-3 and 43-9 in AFPO 929" described the almost complete inactivity which they had experienced since being assigned to the Troop Carrier Command. According to these navigators they had volunteered for "immediate overseas action," but had remained idle at Baer Field for 10 weeks. They were then assigned to an Air Transport Command group which already had about 30 navigators. From June till 25 September they had "only navigated on one trip--to [their] present theater of operations." The letter continued that since the Troop Carrier Command "doesn't need navigators once it is in the theater, and because the Bomber Command has [sic] many navigators unemployed as navigators, we have been assigned to jobs which are really too technical"

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66. 1st Ina., AFIBD to CG, AFSUB, 16 Feb. 1943, in ibid.

67. Memo for Gen. Harper, thru Col. DuBois, by Lt. Col. Herzog, 12 Sep. 1943; memo for Gen. Harper by Col. R. H. Montgomery, 30 Sep. 1943, in AFAC files.

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for men without prior training. They felt that "just one trip across the ocean" did not justify all the training they had undergone, and they desired either to be transferred to another theater, returned to the United States for reassignment, or returned for training as bombardier-navigators.

<sup>68</sup>

When this matter was called to the attention of the AC/AS, Training, he was informed also that the Air Transport Command was cancelling navigation training contracts with the commercial airlines. This was taken as evidence that the command had sufficient navigators. Otherwise it would not cancel such contracts. At the same time, however, the command had a requirement which called for about 4,600 navigators by 1 September 1944. An overproduction was feared and it was recommended that <sup>69</sup> the navigator requirements of the Air Transport Command be re-evaluated.

The advisability of scrutinizing the requirements of these two using agencies was increased by information from the Training Command to the effect that "continued reports" from navigators returned from combat indicated a "non-utilization of navigators" in Air Transport and Troop Carrier Command units.

<sup>70</sup>

When, therefore, data compiled in the latter part of October indicated an over-all shortage of 8,396 navigators for the 12-month period ending with September 1944, the AC/AS, Training conveyed the following information to the AC/AS, CG&R. The table of organization requirements

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68. "Members of Classes 43-3 and 43-9 in AF0 929" to CO, Selman Field, 25 Sep. 1943, in AFACT files.

69. Memo for Gen. Harper by Col. DuBose, 21 Oct. 1943, in AFACT files.

70. CG, AFTRC to CG, AF, 16 Dec. 1943, in AFACT files.

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or the Troop Carrier Command called for 2,739 navigators. In the light of the above reports of the non-utilization of Troop Carrier navigators, it was believed that one navigator for every four Troop Carrier airplanes would be adequate. A change to this basis would reduce Troop Carrier requirements by 2,055. Similarly, the requirements of the Air Transport Command, which showed an increase of about 400 per cent (from 1,392 to 5,674) in this 12-month period, were questioned. The capacity of the navigation schools had been expanded to the maximum, and the only alternative, if production were to be increased, was to revert to the former 15-week program of instruction. Such a change would endanger the standards of navigator proficiency, and this was considered "especially important in view of the fact that when the number One theater becomes the Far East, the proficiency of our navigators will become even more necessary than today." In the light of all these factors, it was felt that "careful scrutiny should be given to these suspect requirements."<sup>71</sup> This questioning of requirements resulted, by January 1944, in a drastic downward revision of Air Transport and Troop Carrier Command quotas.<sup>72</sup> Beginning in April 1944, Troop Carrier Command and Air Transport Command requirements were to be 50 and 200 per month respectively.<sup>73</sup>

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71. R&R, No. 1, AC/AS, Training to AC/As, CG&R, 1 Nov. 1943, in AFACT files.

72. AC/AS, Training to CG, 1 TCC, 20 Jan. 1944, in AFACT files.

73. Memo for Gen. Harper by Lt. Col. Herzog, 25 Jan. 1944, in AFACT files.

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Production and Shortages, 1943. In the meantime, there was an actual shortage of navigators in the Second and Third Air Forces. In March 1943 the Directorate of Bombardment indicated that the expected progress in dual training could not be realized, and he announced a downward revision of the requirements of the training air forces from 13,618 to 10,353 for the remainder of 1943. This still left a monthly shortage that rose from 636 in March to 1,823 in November.<sup>74</sup> The navigator shortage in these air forces had been so acute that navigators very seldom joined their crews in the first phase of operational training, and in many cases crews were in the last phase of operational training before they secured navigators. In fact, it was not until approximately the era of 1943 that the flow of navigators to the Second Air Force was sufficient to shift the average entrance date of navigators from the first week of third phase to the first week of second phase training.<sup>75</sup> In July 1943 the Second Air Force had a navigator shortage of approximately 1,400, and even after the planned expansion of Training Command production and the transfer of navigators from the Third Air Force, many crews were expected to go through first phase training without navigators.<sup>76</sup> Furthermore, as late as 26 February 1944 there were 793 Second Air Force crews to which navigators had not been assigned.<sup>77</sup> It should be pointed out, however, that the absence of navigators in crews in first phase training in the tactical units was not,

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74. R&R, No. 1, AFMFB to AC/AS, A-1, 15 March 1943, in AMG 211B, Titles and Grades.
75. CG, 2d AF to AFIT, 5 March 1944, in AFAC files.
76. CG, 2d AF to CG, AF, 14 July 1943, in AMG 353, Navigation Training.
77. CG, 2d AF to AFMP, 5 March, 1944, in AFAC files.

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prior to about the middle of 1943, as depicted as it would appear. This was true because of the fact that until the Training Command began to meet the requirements of the tactical units for pilots who had had transition training on combat-type aircraft, there was virtually no aerial training available for the non-pilot crew members during the first phase of operational training. The Training Command began to meet these requirements in the summer of 1943 in the case of medium bombardment and in the fall of 1943 in the case of heavy bombardment.<sup>78</sup> The loss to both navigator and crew occasioned by the late arrival of navigators was nevertheless substantial and doubtless accounts for many of the complaints received from the combat theaters on the lack of proficiency of navigators.<sup>79</sup>

The navigator production of the Training Command averaged 845 per month during the first half of 1943, but rose to a monthly average of 31,437 in July, August, and September. By the end of September, however, future requirements showed an anticipated shortage of 4,487 for the period ending 31 August 1944. The command was therefore requested to submit plans for increasing production accordingly.<sup>80</sup> The plan submitted by the command provided for reverting to a 15-week program and transferring the school at Mather Field to Ellington Field in order to increase facilities and concentrate all navigation training in the

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- 78. See AF Historical Studies: No. 13, Pilot Transition to Combat Aircraft, 68-75, 78-91.
  - 79. CG, 2d AF to CG, AF, 14 July 1943, in AG 353, Navigation Training.
  - 80. See Chap. IV for some reports from theaters.
  - 81. See chart 1 following this page.
  - 82. Daily Diary, AFTC, 29 Sep. 1943.

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Central Flying Training Command. These stops were expected to increase output by 3,750, leaving a shortage of 1,157 which could be reduced to zero by utilizing returned combat navigators to replace instructor personnel released to the tactical units. The accomplishment of this plan was, of course, contingent upon the Training Command securing additional instructors, pilots, and planes.

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It will be observed from the above account of attempts to meet navigator shortages that virtually every plan which would approximately meet the desired flow involved the abandonment of the 18-week program of instruction and returning to the 15-week program. Neither the AC/AS, Training nor the Training Command desired to resort to this. In fact, in March and April 1944 plans were made to extend the period of instruction to 20 weeks.<sup>84</sup> Consequently, every other possible alternative was resorted to in order to meet the expected requirements. Beginning in September 1943 the dual training of bombardier-navigators in the navigation schools was terminated, thus leaving the full capacity of these schools to be utilized for celestial navigator production. Since there was an adequate supply of bombardiers throughout 1943, one of the bombardier schools (Roswell, N. M.) was set aside for the sole purpose of training graduate navigators as precision bombardiers.<sup>85</sup>

In order to expand further the capacity of the navigation schools, it was finally decided in October 1943 to move the school at Nather

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- 83. Memo for Gen. Harper by Col. R. H. Montgomery, 29 Sep. 1943, in AFAC files.
  - 84. Memo for Col. R. H. Montgomery by Maj. H. C. McAllif, 6 March 1944 in AFAC files.
  - 85. Project Book of CG, AFIRC, Navigation Sec., 4 Sep. 1943.

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Field to Ellington Field. This move, authorized on 14 October 1943,  
86 was to be effected on 5 November 1943. A few days prior to the above  
authorization the Training Command approved a revised contract with the  
PAA to increase the size of entering classes at its school from 200 to  
87 a maximum of 270. Beginning in January 1944 the size of classes at  
88 the PAA school was increased to 250. By the middle of January 1944  
the enrollment of the navigation schools stood at 8,000, with the es-  
89 tablished annual rate of production being 20,000. With the require-  
90 production for 1944 being variously estimated at from 20,000 to 22,000,  
there were good reasons for believing that during 1944 production would  
meet contemplated requirements. In addition to the navigation training  
to meet all the AF requirements, including a small number of Negro  
also  
91 navigators, arrangements were made to train 60 Chinese students as navi-  
gators. By the end of March 1944 enough navigators and bombardier-navi-  
gators to meet the requirements of the Second Air Force for April and  
92 May were already on hand in that air force.

Complicating Factors in Early 1944

There remained, however, several variable factors which might at  
any time throw production and requirements out of balance. The most

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- 86. Ibid., 21 Oct. 1943.
  - 87. Daily Diary, AFTEC, 4 Oct. 1943.
  - 88. Monthly Consolidated Flying Training Reports.
  - 89. Project Book of CG, AFTEC, Navigation Sec., 14 Jan. 1944.
  - 90. R&R, No. 4, AG/AS, Training to Air Gunnery Officer, AG/AS, MM&D, 18 Oct. 1943; memo for Gen. Harper by Lt. Col. Herzog, 25 Jan. 1944, in AFCT files.
  - 91. Project Book of CG, AFTEC, Navigation Sec., 29 Feb. 1944.
  - 92. AG/AS, Training to CG, AFTEC, 27 March 1944, in AFCT files.

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important of these were the fluctuating crew requirements of medium and very heavy bombardment. In the case of medium bombardment there was the problem of the ratio of crews to be supplied with celestial navigators, bombardier/dead-reckoning navigators, and celestial navigator-cannonners. These ratios were contingent not only upon training facilities, but also upon varying requirements from the several theaters of combat. Some theaters required no celestial navigators, one theater required one celestial navigator-bombardier for each crew, and the others appear to have found the ratio of one celestial navigator-bom-  
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bardier to three bombardier/dead-reckoning navigators satisfactory.

The unsettled factor in the very heavy bombardment program which affected navigator requirements was that of the desirable versus the possible amount of dual and triple training for the bombardier-navigator members of the crew. The standard crew requirement under this program operating throughout 1943 was that of two precision bombardier-celestial navigators per crew. When the requirements of this program were applied to those of medium bombardment, which required dually trained men for 25 per cent of their crews, it was difficult to meet the demand. It appeared, however, that this demand could have been met. When the very heavy crew requirement which called for two precision bombardier-celestial navigator-radar officers was established, however, both the capacity

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93. CG, 3d AF to AC/AS, Training, 5 Feb. 1944, and 1st Ind., 16 Feb. 1944; R&R, No. 1, Requirements Div., AC/AS, OGR, to AC/AS, Training, 25 Jan. 1944, in AG 353B, Bombsight and Navigation Training; Daily Diary, Unit Training Div., AC/AS, Training, 24 April 1944, in AFHII files.

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of trainees and all training facilities were overtaxed. One way by which this training could be effected was to assign bombardier/dead-reckoning navigators to the tactical units and hold such units responsible for giving sufficient on-the-job training to bring this personnel to a proficiency basis as celestial navigators. Or the Second Air Force could give on-the-job training on return to graduate navigators, graduate bombardiers being assigned to Boca Raton, Fla., for radar training, and it was this procedure which became established policy since the time and facilities available in the tactical units were inadequate for the other. In the light of these conditions the dual training of bombardier-navigators by the Training Command was waived until such time as it was found possible to resume such training on a satisfactory basis.

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94. Report on "Training Conference—Headquarters Army Air Forces Training Command, 10-13 January 1944"; "Sub-committee Report on Bombardier-Navigator Training," in AFAC files; CG, 2d AF to AC/IS, Training, 10 Feb. 1944; 1st Inv., 19 Feb. 1944; 2d Inv., 1 March 1944; IAFR, No. 1, AC/IS, Training to AC/IS, CC&R, 14 Feb. 1944; IAFR, No. 2, AC/IS, CC&R to AC/IS, Training, 17 Feb. 1944, in AFAC files.

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Chapter II

PROCUREMENT AND PREFLIGHT TRAINING OF NAVIGATORS

Procurement of Navigation Trainees

Sourcing Trainees. Up to the spring of 1944 there were three sources from which navigation trainees could be procured. Prior to the establishing of specialized navigation schools, when all navigation training was conducted in the tactical units, all trainees were officers already trained in some other specialty. After the inauguration of the navigation training program in specialized schools other sources were utilized.<sup>1</sup> The two sources utilized during this period were aviation cadets and former aviation cadets, who had been eliminated from pilot training, and selected civilians.<sup>2</sup> Of these two types of personnel, preference was given to eliminated pilots.<sup>3</sup>

During the first year of training in the specialized navigation schools, the number of trainees procured through these two sources appears to have been adequate. Beginning in the fall of 1941, however, a shortage of applicants appeared, and it was necessary to resort to

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1. No officers were given in-grade training in the navigation schools prior to November 1941. 2d Ind., C/A/C to AG, 24 Sep. 1941, in AG 353.9, Navigation (Advanced Aviation) and Instrument Training.
  2. Exec. to JAG, 28 May 1940, in AG 353.9C, Training Directives and Programs; R&R, TSO to Plans, 17 June 1940, in AG 353.9, Navigation and Instrument Training.
  3. See a study on the use of civilians from aircrew training in preparation in Administrative History Branch, AFHHL.

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other means. One of the steps taken was to allow officers to undergo <sup>4</sup> in-grade training in navigation, beginning in November 1941. At about <sup>5</sup> the same time the educational requirements were lowered, and an intensive advertising program was employed in order to stimulate applications for non-pilot training. The shortage of navigator trainees <sup>6</sup> was so acute that Military personnel proposed to take approximately 1,000 bombardier applicants who had two years of college education, but were lacking in the required mathematics, give special mathematics courses to them in preflight, and train them as navigators. This proposal was disapproved, due partly to the results expected from the <sup>7</sup> advertising program.

Immediately after the United States entered the war, the demand for navigation trainees became still more acute. Maj. Gen. Henry H. Arnold instructed Brig. Gen. Walter R. Weaver to "Get in touch with Hans Adamson, who is in the War Department, and secure from him the names of all amateur navigators and give them a 'get rich quick' course. It sounds reasonable that we can train an amateur navigator who has sailed a boat by using navigation instruments much quicker than a <sup>8</sup> new man who never had any navigation." Brig. Gen. George E. Stratemeyer

4. 2d Ind., ("Smith" to AG (telegram), 20 Sep. 1941), C/G to AG, 24 Sep. 1941, in AG 353.9, Navigation and Instrument Training; AG 210.4 (10-14-41) IBM, 25 Oct. 1941.
5. Chief of Air Staff to C/GC, 24 Oct. 1941, in AG 353.9, Specialized Training.
6. Memo for AG by Military personnel, 14 Oct. 1941, in AG 353.9, Navigation and Instrument Training.
7. R&R, Nos. 1, 2, and 3, Military Personnel to AG, to Sec., to Military Personnel, 14, 16, 17 Oct. 1941, in ibid.
8. Maj. Gen. Henry H. Arnold to Brig. Gen. Walter R. Weaver, 15 Dec. 1941, in ibid.

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secured the names of a number of young men from liaison. Letters were written to them, and within two weeks a few applications had been received from students in the Marine Navigation Training School in New York. Military personnel was directed to process the applications and order these trainees to a navigation school. Their progress was to be checked against that of other trainees who had had no previous training or experience.

In addition to the above type of individual recruiting, General Stratemeyer sent letters to 145 astronomical associations, colleges, and universities enlisting their assistance in recruiting navigation trainees. The response to this request for cooperation was very satisfactory, and Technical Manuals 1-205 and 1-206 were sent to many of these institutions to serve as an indication of the materials which should be included in a college course designed to equip students for aviation cadet training as navigators and also to be used as textbooks in such courses. It was apparently assumed that these associations and colleges would stimulate interest in navigation among students and encourage their graduates to apply for navigation training.

The quality of the product of all types of training in the AF was determined by numerous factors. The effects of insufficient time, materiel, and instructor and supervisory personnel on training efficiency were constantly emphasized. Of equal importance with these

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9. R&R, Brig. Gen. George L. Stratemeyer to Chief, Training Div., 16 Dec. 1941; R&R, Training Div. to Military Personnel, 31 Dec. 1941, in ibid. No record has been found of this experiment in navigation training.
  10. R&R, Training Div. to Military Personnel, 16 Jan. 1942, in ibid.
  11. See Chap. VII on materiel factors and Chap VI on instructors.

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conditioning factors was that of the qualities of the trainee himself. General ability and aptitude for and interest in a particular type of training were necessary if the desired product was to be secured. The personnel functions of selection, classification, and assignment to training were therefore of vital concern to all training agencies.  
<sup>12</sup>

Use of Eliminees. More navigation trainees were procured from eliminees than from any other source. Prior to the inauguration of the aviation crew classification program in January 1942,  
<sup>13</sup> virtually all navigation trainees were cadets and former cadets who had been eliminated from pilot training. When the navigation training program was launched in August 1940, it was expected that 70 per cent of all pilot eliminees would be available for training as bombardiers and  
<sup>14</sup> navigators. Since the number of pilot eliminees was expected to be  
<sup>15</sup> 5,000 and the bombardier-navigator requirement at that time was 3,600,  
it appears that virtually all such trainees were expected to be personnel  
<sup>16</sup> who had been eliminated from pilot training.

The policy of relying almost entirely on eliminees to fill the quota of navigation trainees was modified somewhat when the new policy was adopted of classifying cadets for aircrew training rather than for pilot training alone. Owing to the predominance of pilot training,

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- 12. For detailed treatment of these personnel functions consult the studies prepared by the Personnel Section of AFHQ.
  - 13. See AF Historical Studies: No. 2, Initial Selection of Candidates for Pilot, Bombarier, and Navigator Training, Chap. IV.
  - 14. Rec. to JAG, 25 May 1940, in AMG 353.9C, Training Directives and Programs; RAO to Plans, 17 June 1940, in AMG 353.9, Navigation and Instrument Training.
  - 15. RAR, Plans to Exec., 3 Aug. 1940, in AMG 211E, Cadets.
  - 16. Memo for Chief of Staff, by C/A/C, 24 May 1940, in AMG 353.9C, AC Training Directives and Programs.

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both as to requirements and exact preference, however, the number of new cadets classified for and assigned to navigation training was inadequate. The required ratio of navigators to all pilots was approximately 1 to 5<sup>17</sup> while the ratio of preference was about 1 to 18.<sup>18</sup> Consequently, it was necessary to continue to assign eliminated pilots to navigation training. The training of eliminated pilots was, for a period at least, less satisfactory than the training of new cadets. During the year from March 1941 to March 1942 the elimination rate among navigation trainees who had had previous aircrew training was 15.5 per cent. During the same period the elimination rate among such trainees without previous training was 12.8 per cent.<sup>19</sup>

In spite of the fact that there was no apparent alternative to utilizing pilot eliminates as navigation trainees, proposals were made at various times to discontinue the practice. In August 1941 the Air Inspector made a recommendation to this effect.<sup>20</sup> One month later a similar, though less positive, suggestion was made to the training centers by the Assistant Chief of the Air Corps.<sup>21</sup> In the following March the Directorate of Military Requirements recommended to the Air Staff that the practice be discontinued.<sup>22</sup> A recommendation to this

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- 17. Project Book of CG, AFFTC, Navigation Sec., 25 March 1942.
  - 18. 1st Ind. (C/AS to CG, AFFTC, 10 Sep. 1942), 2 Oct. 1942, in AFMCT Files.
  - 19. Director of Personnel to Col. Charles R. Glenn (Surgeon of AFFTC), 22 May 1942, in MG 353.9, Specialized Training.
  - 20. Memo for Gen. Arnold by Air Inspector, 19 Aug. 1941, in MG 352.01D, Establishment of Schools.
  - 21. Asst. C/A to CG of each TC, 19 Sep. 1941, in MG 353.9, Specialized Training.
  - 22. Daily Diary, AFMCT, 20 March 1942, in MG 319.1-3, Daily Diaries.

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same effect was made by the Directorate of Bombardment in June 1942.<sup>23</sup>

Individual Training did not concur in these suggestions, but in July 1942 the Flying Training Command adopted the policy of not assigning cadets eliminated from one category of training to training in another category unless they had a high aptitude rating for the second type of training.<sup>24</sup>

The ratio of newly classified cadets to trainees in navigation training varied within certain prescribed limits. In June 1943 the established ratio was 2 to 3, that is, "Three eliminated pilots will be trained for every two new aviation cadets."<sup>25</sup> In the following August the decision was made that at least 20 per cent of the trainees should be new cadets.<sup>26</sup> In actual practice, however, the ratio was about 1 to 1 in October 1943.<sup>27</sup>

Qualifications of Trainees. The standards of qualification for assignment of new cadets to navigation training were higher than those for any other member of the aircrew. During the first year of training in the specialized navigation schools a degree from an accredited college was a prerequisite to such training.<sup>28</sup> This requirement was lowered in June 1941 to the completion of two years of college and in the following October was further reduced by requiring only that appli-

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- 23. Daily Diary, AFIT, 19 June 1942, in ibid.
  - 24. Daily Diary, AFITC, 23 July 1942, in ibid.
  - 25. Daily Diary, Office of the Surgeon, AFITC, 2 June 1943, in AFTRC files.
  - 26. Ibid., 6 Aug. 1943; Project Book of CG, AFITC, Freiflight Sec., 30 Sep. 1943.
  - 27. Daily Diary, AFTRC, 1st Div., 12 Oct. 1943, in AFTRC files.
  - 28. 1st Ind. (basic unknown), CG.C to Parks Air College, 27 Aug. 1940, in AG 353.9, Specialized Training.

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cants be graduates of an accredited high school and pass the prescribed  
 29 battery of tests. When the new aviation cadet classification program was placed in effect in early 1942, the aptitude score required for assignment to navigation training was higher than that required for bombardiers and pilots. The comparative standards which were required  
 30 at various times were:

<u>Date</u>	<u>Navigator</u>	<u>Bombardier</u>	<u>Pilot</u>
July 1942	5	1	1
Dec. 1942	5	3	3
July 1943	6	4	4
10 July to 23 August 1943	6	6	3
24 August to 1 November 1943	6	6	4
1 to 23 November 1943	6	5	4
23 November 1943	7	5	5
2 February 1944	6	5	5

Preflight Training

Evolution of Preflight Schools. Non-pilot aircrew training had not been under way very long before the need of instruction preliminary to that given in the specialized schools became apparent. The length of the course in the advanced specialized schools was inadequate to

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- 29. C/AS to C/A.C., 24 Oct. 1941, in ibid.
  - 30. "Standards & Procedures for Recommending Assignment to Aircrew Training," 20 Nov. 1943, AFTAS, Psychological Dr., in AFHQ files. The data for 2 Feb. 1944 were taken from Daily Diary, AFTRC, 1st Div., 2 Feb. 1944, in AFTRC files. This reduction, which appeared to be only temporary, was made in order to enter a double quota of trainees into preflight. This was necessary in order to give all navigators flexible gunnery training by 1 June 1944.

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provide the basic military and primary academic training in addition to the advanced instruction. This condition was also true to a degree of pilot training. As early as October 1940 the Training and Operations Division proposed the establishment of a special type of school  
31 to meet this need. In January 1941 the Chief of the Air Corps issued a directive for the initiation of such training for "Non-Pilot Com-  
missioned Members of Combat Crews."  
32 Pursuant to this directive a bombardier-navigator replacement center was established at Maxwell Field. Eliminated pilots were sent to the replacement center where they were given five weeks of instruction in "combat crew duties." Following this training they were given five weeks of flexible gunnery training and then entered into either specialized bombardier or navi-  
33 gation schools.

The bombardier and navigator training in the replacement center was found to be inadequate, and in June 1941 the commanding officer at Maxwell Field was instructed to establish within the replacement center a reconnaissance school to give an eight-week course for eliminated pilots and "selected civilians." The curriculum was to include maps and charts, photography, communications, meteorology, naval forces, ground forces, air forces military administration, and military

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- 31. R&R, T&O to Exec. thru Plans, 17 Oct. 1940, in AAG 353.01C, Establishment of Schools.
  - 32. CG, SEACTC to C/AC, 1 July 1941, in AAG 353.9C, Training, General.
  - 33. CG, SEACTC to C/AC, 16 March 1941, in AAG 353.9P2, Training, Gen-  
eral; CG, SEACTC to CO, AC Advanced Flying School, Maxwell Field,  
12 June 1941, in AAG 353.9C1, Training, General.

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<sup>34</sup>  
training.

A further indication of the emphasis being placed on non-pilot aircrew training was the redesignation, in September 1941, of the three Air Corps Replacement Centers as Air Corps Replacement Training Centers (Aircr<sup>35</sup>ew). Plans were also made to conduct preliminary training for bombardiers and navigators at Ellington Field, where instruction was scheduled to begin on 11 October 1941. The navigators trained at Ellington were to receive advanced training at Kelly Field.<sup>36</sup> There was thus established the equivalent of the later preflight bombardier-navigator schools. In the following April the replacement training centers were redesignated "Preflight" schools. The three bombardier-navigator preflight schools were at Macmill<sup>37</sup>, Ellington, and Santa Ana, Calif. In October 1942 the preflight school at Macmill was moved to Selman Field, La.<sup>38</sup> After a month of bombardier-navigator training it became a preflight school for navigators only.<sup>39</sup>

Since the purpose of preflight navigation training was to provide the basic academic and military training requisite for instruction in advanced specialized schools, it differed very little from bombardier and pilot preflight instruction. The official preflight programs of instruction for bombardiers and navigators were identical. Like all

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- 34. CG, SEACCTC to CO, AC Advanced Flying School, Macmill Field, 12 June 1941, in AG 353.931, Training, General.
  - 35. AG 320.2 (CR-M-1F), 30 Sept. 1941.
  - 36. Asst. C/C to CG, GSCCTC, 10 Sep. 1941, in AG 353.93, Training, General.
  - 37. AG 320.2 (3-24-42) LR-M-1F, 30 April 1942.
  - 38. AG 320.2 (10-21-42) OB-I-F-1, 22 Oct. 1942.
  - 39. "History of Selman Field, Monroe, Louisiana, 15 June 1942 to 31 December 1942," 15, in IFRG files.

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other programs of instruction in Air Corps schools, they represented minimum requirements, and individual schools varied the emphasis placed on certain phases of instruction. Usually this was done by giving the minimum amount of instruction on some topics and extra hours to other topics. Also, instruction in some courses was made more thorough and placed on a higher level than in others. An example of these procedures was that of emphasizing physics for bombardiers and mathematics for navigators.

Program of Instruction. The program of preflight instruction for bombardiers and navigators in July 1943 consisted of 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	3-1/2 (in chamber)
11. Physical training	54 "
12. Military training	113 "

The length of the preflight course varied from the 8-week course in the reconnaissance school in the summer of 1941; to the 12-week course in the replacement training centers (aircrew) in the fall of 1941; to the 10-week

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40. "Master Schedules," AF Pre-Flight School (Bombardier-Navigator), Ellington Field, Tex., in AFHQ files. A new program of instruction for the preflight schools was approved in March 1944, but was not available at the time of this writing. Project Book of CG, AFRC, Pre-flight Sec., 14 March 1944.

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course in January 1942; to the 9-week course in February 1942; and to the 10-week course established in March 1944. The lengthening of the course to 10 weeks, effective 14 March 1944, was for the purpose of increasing the tempo of instruction. No additional hours of instruction or other activities were included.

41

In the early months of 1943 two significant changes were made in preflight training. Though the pilot and bombardier-navigator preflight courses had been very similar from the beginning, they had been set up in separate programs of instruction. In February 1943 all preflight training was standardized with the pilot program of instruction becoming the program for all preflight schools.

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The second change was made in order to eliminate unnecessary duplication of training for some personnel. Heretofore all bombardier and navigator trainees were required to undergo the entire preflight course, regardless of previous training. A new policy, adopted in April 1943, provided that student officers who were found proficient in ground school and military training might be advanced to specialized schools after only six weeks of preflight training. Also, any aircrew trainees eliminated after the preflight stage could be assigned directly to the advanced stage of another category of training. Eliminees from one type of training who were reclassified for another category of training had heretofore been required to undergo preflight training.

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41. Commanding Officers Official Bulletin No. 12, 16 Jan. 1942; CG, AFMTC to CG of each TC, <sup>16 Feb. 1944</sup> AFMTC 353.9I, Aviation Pilot Training; Daily Diary, AFMTC, 8 March 1944.
  42. F. T. C. Memo 50-43-1, 19 Dec. 1943.

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in the second category.<sup>43</sup>

By April 1944 preflight training had become almost completely standardized. At that time the Training Command requested authority to discontinue the schools at Selman and Ellington Fields and to redesignate the school at San Antonio as an "AIF Preflight School, without reference to type or training," since all three types of preflight were being conducted at that school.<sup>44</sup>

Fluctuations in Requirements and Production. The preflight navigation schools existed for the purpose of providing basically trained personnel to the agencies which conducted advanced navigation training. The accomplishment of this mission was often very difficult because of several varying factors. The principal complicating factors were the various attempts to supply tactical organizations with preflight graduates; the difficulties encountered in giving flexible gunnery training to navigation trainees; and the expanding capacity of the advanced schools. These conditions made it impossible to maintain an adequate and even flow of preflight graduates. There were frequent alterations or shortages and surpluses accompanied by overloading of the schools.

In July 1942 it was decided to send preflight graduates to the training air forces for advanced instruction. The Flying Training Command was requested to increase the number of trainees in preflight to the maximum.<sup>45</sup> It was found difficult, however, to enter extra

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43. F. T. C. Memo 50-23-3, 21 April 1943.

44. Daily Diary, AFTRC, 10 April 1944.

45. Daily Diary, AFTRC, 27 July 1942, in AG 319.1-3, Daily Diaries.

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trainees for the training air forces because of the overload which  
already had been entered for advanced navigation schools.<sup>46</sup> The number  
of students under instruction was increased from approximately 1,250  
on 5 July to over 3,000 by the end of September 1942.<sup>47</sup> Any excess  
graduates who could not be accommodated in the advanced schools and  
the air forces were to be sent to flexible gunnery schools.<sup>48</sup>

By the end of September 1942 there was an excess of preflight  
graduates. These had been prepared for assignment to the training  
air forces which later found it impossible to undertake the instruc-  
tion.<sup>49</sup> A month later this surplus had reached approximately 1,600,  
about half of which consisted of eliminated pilots, and a conference  
of representatives of the training centers was called to work out a  
solution of the problem.<sup>50</sup> In order to liquidate this backlog, the  
following steps were taken. Those cadets who desired pilot training  
and who could be so classified were given priority for such training.  
Those who could not be reclassified as pilots were entered into advanced  
navigation schools in the order of their graduation, with furloughs  
granted in the meantime. The training centers were also authorized  
to discontinue classifying cadets as navigators "except when mandatory."  
Other graduates with the desired qualifications were to be used as  
assistant ground school instructors or as drill masters in military

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- 46. Daily Diary, AFITC, 23 July 1942, in ibid.
  - 47. See Chart 1 following p. 23.
  - 48. Daily Diary, AFITC, 27 July 1942, in AMG 319.1-3, Daily Diaries.
  - 49. Daily Diary, AFITC, A-3 Div., 29 Sep. 1942.
  - 50. Daily Diary, 7/29 Oct. 1942, in AFITC files.

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<sup>51</sup>  
training. Part of the surplus also was taken care of by sending men  
<sup>52</sup> to the flexible gunnery school. Others were absorbed by the in-  
creased capacity of the advanced schools, in which the number of students  
under instruction increased from about 2,700 in October 1942 to approx-  
<sup>53</sup> imately 5,000 in March 1943.

In June 1943 there was again a surplus of navigation trainees.  
There were 1,500 on awaiting assignment either to preflight or advanced  
training. To dissipate this surplus the training centers were directed  
to suspend, until further notice, the assignment of personnel, including  
<sup>54</sup> eliminated pilots, to navigation training.

In the following October there was a shortage of preflight navi-  
gator graduates which was caused by a decline in the elimination rate  
in the primary pilot schools. At that time the preflight schools were  
depending on eliminated pilots for about 50 per cent of their trainees.  
<sup>55</sup>  
This shortage did not prevent the filling of classes in the advanced  
schools, but it did affect the number going to gunnery schools from  
<sup>56</sup> preflight. In February 1944 the preflight schools were directed to  
enter double quotas of students "to assure that all bombardier and  
navigator graduates, subsequent to 1 June 1944, will have had Flexible  
<sup>57</sup> Gunnery Training."

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- 51. Daily Diary, AFPTC, A-1 Div., 21 Nov. 1942, in AFTRC files.
  - 52. Daily Diary, AFPTC, A-3 Div., 18 Dec. 1942, in AFTRC files.
  - 53. See Chart 1 following p. 23.
  - 54. Daily Diary, AFPTC, A-1 Div., 3 June 1943, in AFTRC files.
  - 55. Daily Diary, AFTRC, 12 Oct. 1943.
  - 56. Ibid.
  - 57. Daily Diary, AFTRC, 3 Feb. 1944.

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Prior to 3 June 1942, only 1,432 navigation trainees had been graduated from preflight training. By the end of 1942 this number had increased to 8,050, by the end of 1943 to 24,832, and by the end of April to 1944 to 33,554.<sup>58</sup> The flow of preflight graduates to advanced schools had not always been even, but steps had been taken to insure that enough navigation trainees would be entered into preflight schools to meet the heavy requirements for navigators.

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58. See Chart 1 following p. 23 for monthly and cumulative flow of graduates.

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Chapter III

INDIVIDUAL TRAINING IN TACTICAL UNITS

Early Training, 1933 to 1936

Inclusive of the navigation training begun by the PAA civil contract school at Coral Gables, Fla. in August 1940, there was no training of navigation specialists in the special service schools of the CGAC prior to November 1940 when such training was initiated at Barksdale Field, La. By the end of 1940, although the expansion program had been in effect for 18 months, there had been no navigator graduates from Air Corps schools and only 44 from the civil contract school. Furthermore, prior to Pearl Harbor the civil contract school had graduated a total of 454 navigators while Air Corps schools had produced only 150. Virtually all of the training of navigation specialists in the AF prior to 1942 was conducted in the tactical units of the GH Air Force and its successor, the Air Force Combat Command.

The training of navigation specialists to function as separate members of the aircrrew was not begun, even in the tactical units, until October 1933. Prior to this date all navigation training conducted in the Air Corps was that given as part of pilot training. Increasing attention to the importance of aerial navigation, however, dates from the late 1920's, when several notable long-distance flights demonstrated

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1. See Chart 1 following p. 23.

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the marked increase in the radius of action of airplanes. The first of such flights in Army aircraft was made from Oakland, Calif., to the Hawaiian Islands on 28-29 June 1927. This was the "first long distance flight, at least by the army, on which celestial navigation and one radio beam were used."<sup>2</sup>

In the following year, 1928, consideration was given to the advisability of establishing a separate school for training aerial navigators. Such a school was considered impracticable at that time, but the conference at which the matter was discussed agreed that a small beginning should be made and that either four or six "selected officers" might be detailed to the Materiel Division at Wright Field where equipment and tents for an intensive course in aerial navigation were available. It was contemplated that the graduates of such a course would then be used as instructors in a navigation school to be established at either Langley Field or Mitchel Field or assigned to "coast and foreign stations" to assist in training observation units.<sup>3</sup> It appears that these proposals failed to materialize, and specialized navigation training languished until October 1933.

In September 1933 plans were made to begin specialized navigation training at Langley Field, Va. and Rockwell Field, Calif.<sup>4</sup> On 12 October 1933 The Adjutant General approved the request of the Chief of the Air Corps to train 80 officers at these fields (two groups of 20 each).

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- 2. Memo for Brig. Gen. Oscar Estover by Chief, Information Div., 30 Sep. 1935, in MSG 353.91, Navigation (Advanced Navigation) and Instrument Training.
  - 3. Memo for Gen. Foulois by Capt. Harold M. McCollum, 2 Oct. 1928, in ibid.
  - 4. Memos for C.A.C by Chief, TCO Div., 29 Sep. and 3 Oct. 1933, in ibid.

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at each of the bases). The course of training was to begin about 25 October, extend over four weeks, and be completed by about 23 December<sup>5</sup>. Shortage of equipment and the content of the course later caused the period of instruction to be extended to two months.<sup>6</sup> The units conducting this training were not designated as "schools," however, but were referred to as "advanced aviation training units."<sup>7</sup> The training at Rockwell Field was conducted by the 19th Bombardment Group which is considered the pioneer in MF navigation training.

Navigation training at Rockwell and Langley continued until 1 July 1935, with the exception of the period of the Army air mail operations in 1934.<sup>8</sup> After the termination of the advanced aviation training units, such training became the function of the individual bombardment groups as a part of their unit training. At the same time, however, the Commanding General, GHQ Air Force directed the Commanding General, 1st Wing to assign the responsibility for developing methods and equipment for advanced navigation training to the 19th Bombardment Group.<sup>9</sup> This special function was performed by this group until June 1936, after which time it continued to operate as a group navigation training unit.<sup>10</sup> It appears that prior to 1 July 1935 the Chief of the Air Corps was allowed to assign students to the classes

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- 5. C/AC to AG, 5 Oct. 1933; 1st Ina., 12 Oct. 1933, in ibid.
  - 6. C/AC to AG, 7 Nov. 1933; AG to CG's of Corps areas, (radiogram) 10 Nov. 1933, in ibid.
  - 7. 1st Ina. (CO, Rockwell Field to C/AC, 13 Oct. 1933), Acting Exec., C/AC to CO, Rockwell Field, 17 Oct. 1933, in ibid.
  - 8. Memo for C/AC by Chief, T&O Div., 20 Sep. 1939, in AG 352.01C, Establishment of Air Service Schools and Staff Colleges.
  - 9. C/S, GHQ AF to CG, 1st Wing, 3 July 1935, in ibid.
  - 10. Ibid.

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conducted at Langley and Rockwell air bases that after this date such training was limited to personnel assigned to the units which were conducting the training. This was definitely the policy for the remainder of  
11  
1935.

Attempts to Establish a Specialized School

The individual training of navigators in the tactical units was subject to certain handicaps. The individual training of the non-pilot specialists demanded specialized schools whose program of instruction, personnel, and equipment were procured and organized for a single-purpose mission and whose location was also conducive to such a function. Special projects, regular tactical operations, and bad weather at many bases seriously interfere with the training of navigation specialists in tactical organizations. Consequently, the Commanding General of  
in April 1936  
the GHQ Air Force indicated the undesirability of conducting such training in the tactical units and recommended the "establishment of a centralized school to perform this function for the GHQ Air Force." Even before this date, however, on 30 August 1935, the Chief of the Air Corps had suggested the advisability of "establishing an Air Corps special service school" similar to that at Rockwell Field "but in no way connected with a tactical organization, for the purpose of training  
12  
aerial navigators."

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11. C/AC to CG, GHQ AF (radiogram), 11 June 1935; CG, GHQ AF to C/AC (radiogram), 13 June 1935, in 1610.
  12. Memo for C/C by Chief, R&O Div., 20 Sep. 1939, in 1010.

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ith both the Chief of the Air Corps and the Commanding General, GMC, Air Force desiring to establish a specialized navigation school it seems that the essential deterrent to such action was the shortage of necessary equipment and the lack of funds with which to procure the equipment. Prior to the Army operation of the air mail service the Air Corps had plans to procure "suitable navigation instruments" but lacked the necessary funds. A full contract of \$7,500,000 in 1934 and estimated funds for the fiscal year 1936 were expected to facilitate the procurement of equipment. But as late as April 1936 the establishment of a centralized navigation school was "deferred by lack of funds necessary to provide a suitable station for this purpose."<sup>13</sup> About the middle of 1935 consideration was given to plans for the initiation of a navigation course at Randolph Field for Air Corps officers not assigned to the GMC Air Force. These plans too were abandoned because of the shortage of personnel and equipment.<sup>14</sup>  
<sup>15</sup>

Supplementary Training and Problems Encountered

The individual training of navigators, consequently, remained the responsibility of the combatant groups. The accomplishment of this mission was made still more difficult when, with the inauguration of the expansion program in July 1939, the tactical units were charged

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- 13. AD Press Release, 20 Sep. 1934.
  - 14. Memo for C/MC by Chief, T&O Div., 20 Sep. 1939, in AG 352.01C, Establishment of Air Service Schools and Staff Colleges.
  - 15. Memo for C/MC by Acting Chief, T&O Div., 6 Aug. 1935, in AG 353.9, Navigation (Advanced Navigation) and Instrument Training.

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with the transition stage of advanced pilot training, heretofore conducted in the Air Corps Training Center. The time and equipment devoted to transition pilot training effected a corresponding reduction in opportunity to conduct navigation and other specialized non-pilot training.<sup>16</sup> In September 1939, therefore, there was not only no centralized agency in the Army "for the development of methods and equipment for advanced aerial navigation" training, but the effectiveness of the tactical units which conducted such training was further limited by the responsibility for additional individual training of pilots.<sup>17</sup> In fact, as late as March 1940 it seems that the establishment of single-purpose navigation schools under the Chief of the Air Corps was not contemplated.<sup>18</sup> Navigation training in Air Corps schools was to be conducted at schools engaged in one or more types of other specialized training.

Navigation training was begun in one civil contract and one Air Corps school in 1940, the number of Air Corps schools being increased to three in 1941. In March 1941 the Chief of the Air Corps informed the Commanding General, GMC Air Force that the training of navigators in Air Corps schools consisted of short and intensive courses, to be followed by five weeks of aerial gunnery instruction, and that the training would "not by any means prepare this personnel to the extent that would enable them to undertake the responsibilities that would

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16. Memo for C/AC by Chief, T&O Div., 20 Sep. 1939, in AG 32.01C, Establishment of Air Service Schools and Staff Colleges.
  17. Ibid.
  18. C/AC to AG, 14 March 1940, in ibid.

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naturally be assigned to them in combat units, and that a considerable amount of individual training would necessarily be required in the tactical organizations.<sup>19</sup> Before 1942 it was the established policy to assign navigator graduates to duty with tactical units for approximately six months before they were commissioned.<sup>20</sup> During this period of duty the trainees continued in cadet status and completed their individual training.

The rapid increase in the number of combat units under the expansion program and the delay in establishing adequate specialized schools for individual training, made it necessary to delegate a large part of advanced pilot training and a still larger part of the specialized non-pilot training to the tactical organizations. This policy was also partly due to the shortage of training aircraft in Air Corps schools, as tactical organizations had priority on these. It was contemplated that this undesirable situation would be gradually dissolved by the process of transferring training equipment, especially planes, from the tactical units to the Air Corps schools as the former organizations received new equipment. Concurrently, the production of the Air Corps schools would increase, and the necessity for individual training in the combat organizations would gradually be eliminated. The established policy of the AF was that individual training in the tactical organizations should merely supplement rather than duplicate or replace that of

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- 19. C/A.C to CG, GHQ AF, 24 March 1941, in AG 353.9B, Training, General.
  - 20. C/A.C to AG, 12 Aug. 1940, in AG 211E, Cadets; R.O to CG, GHQ AF, 20 November 1940, in AG 353.9, Specialized Training; A-3 Diary, Training Sec., 19, 20 Dec. 1941, in AFM files.

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the training centers.

Training on Preflight Graduates in Tactical Units

Prior to about the middle of 1942 the individual training of navigators in the tactical units was almost entirely confined to the training of personnel already assigned to such units. In August 1942, however, a decision was made to send preflight navigator graduates to various air forces for advanced navigation training. The Flying Training Command and the air forces were informed that the first students for this training would be obtained from the preflight classes scheduled to graduate about 10 August 1942. The training was to be confined to those preflight graduates for whom the facilities of the command were inadequate. Trainees were to be assigned to the tactical organizations on a ratio of not more than one cadet for each rated navigator on duty with the unit which was to conduct the training. The air forces were requested to ascertain the number of navigators which could be trained on this basis, and the Flying Training Command was likewise requested to inform the Directorate of Individual Training of the number of preflight graduates which would be available for such training. The number of students in preflight was to be increased in order to meet this enlarged demand.

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In accordance with these instructions the command informed Individual Training of the number of preflight graduates which would be available

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21. Daily Diary, FMIT, 21, 27 July 1942, in AG 319.1-3, Daily Diaries; AF Reg. No. 50-15, 20 Aug. 1942.
  22. FMIT to CG, FFIC, 8, 19 Aug. 1942, in AG 353.9B, Navigation and Instrument Training.

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for assignment to the air forces for the period 3 October 1942 to 19  
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June 1943. Meanwhile, plans were made to sent 51 navigation crews  
graduating from preflight in August to the Caribbean and Hawaiian  
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departments.

The training of navigation crews in tactical organizations was  
accompanied by abnormal difficulties in getting trainees to the right  
place at the right time and with the necessary personnel and equipment.  
This is well illustrated by the problems encountered in navigator train-  
ing in the Sixth Air Force (Caribbean Department). As noted above, the  
Flying Training Command was instructed, in August 1942, to select pre-  
flight graduates to be sent to this air force. In the following month  
the command was informed that no navigators would be trained in the  
Caribbean Department. Furthermore, it was "expected" that the only  
training of this nature which would be conducted outside the Flying  
25  
Training Command would be that performed in the Hawaiian Department.  
About 1 November 1942, however, new plans were made to train 50 navi-  
gation crews in the Sixth Air Force. This air force, however, was  
short of the necessary navigational equipment and requested that the  
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crews and equipment be sent at the same time. For nearly three  
months Individual Training and the Flying Training and Air Service

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- 23. 1st Ind. (AFIT to CG, AFFTC, 8 Aug. 1942), AFFTC to AFIT, 11 Sep. 1942, in LIG 353.9G, Training, General.
  - 24. AFIT to CG, AFFTC, 19 Aug. 1942, in LIG 353.9B, Navigation and Instrument Training.
  - 25. 2d Ind. (AFIT to CG, AFFTC, 8 Aug. 1942), AFIT to CG, AFFTC, 17 Sep. 1942, in LIG 353.9G, Training, General.
  - 26. CG, 6th AF to CG, AF, 6 Nov. 1942, in LIG 353A, Bombsight and Navigation Training.

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commander tried to get students and the necessary material ready for  
27 ship sent. After the lapse of another month Military Personnel  
28 directed the Flying Training Command to arrange for shipment of the  
50 cadets. The date of shipment has not been ascertained, but nearly  
three months before the training of this first group of cadets was  
completed the Sixth Air Force informed the AC/AS, Training that it  
would be unable to train navigation cadets after the current class  
29 graduated, about 4 September 1943.

The experience encountered in training navigation cadets in the  
30 Hawaiian Department appeared to be somewhat more successful. In  
September 1942 it was decided to send 12 cadets to this department every  
three weeks, the first group to arrive and begin training on 17 October  
31 1942. In compliance with this directive, the Flying Training Command  
authorized the West Coast Training Center to maintain the necessary  
32 flow of cadets to the Hawaiian Department. By March 1943, however,

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- 27. AFIT to CG, AFFTC, 12 Nov. 1942 and 6 Jan. 1943; 1st Ind. (AFIT to CG, AFFTC, 6 Jan. 1943), CG, AFFTC to AFIT, 23 Jan. 1943, in AG 353.1, Bombsight and Navigation Training; AFIT to Chief of Field Services, AFSC, 13 Nov. 1942; 1st Ind., AFSC to AFIT, 23 Nov. 1942; 2d Ind., AFIT to CG, AFFTC, 1 Dec. 1942; 1st Ind. (AFIT to CG, AFFTC, 12 Nov. 1942), CG, AFFTC to AFIT, 2 Dec. 1942; 2d Ind., AFIT to CG, AFFTC, 10 Dec. 1942; R&R, No. 1, AFIT to AFDP, 25 Jan. 1943, in AFAC files.
  - 28. Daily Diary, AFFTC, 22-24 Feb. 1943.
  - 29. AC/AS, Training to CG, AFFTC, 12 June 1943, in AG 353, Navigation Training.
  - 30. A navigation school was in operation in the Seventh Air Force as early, at least, as the spring of 1942. AFIT to CG, Hawaiian Department, 2 May 1942, in AG 353.9D2, Training, General.
  - 31. 2d Ind. (AFIT to CG, AFFTC, 6 Aug. 1942), AFIT to CG, AFFTC, 17 Sep. 1942, in AG 353.9G, Training, General.
  - 32. Daily Diary, AFFTC, 10 Sep. 1942, AG 319.1-3, Daily Diaries.

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the Directorate of Personnel could find the record of only three groups or cadets having been transferred to this department.<sup>33</sup> In the following month navigation training in Hawaii was "discontinued due to assignment of instructor personnel to other duties." Twenty-four cadets who were awaiting training were to be returned and entered in advanced navigation training at Ladd Field.<sup>34</sup>

With the return of the untrained cadets from the Hawaiian Department it appears that navigation training in tactical units came virtually to an end. There is no record of the authorized sending of navigation cadets to organizations outside the Training Command for advanced training after this time. The individual training and qualification of navigators in various tactical organizations, though on a very limited scale, continued until about the end of 1943. It seems to have been confined, however, to giving navigation training to personnel already trained and qualified in another specialty, and the greater part of individual training in tactical units was given to bombardiers in order to qualify them as bombardier-navigators, since the Training Command had never been able to meet the demands for this category of personnel. By November 1943 even this type of training was disapproved by the AC/AS, Training, who indicated that bombardiers and navigators could be sent to the Training Command schools to be trained in the second category of training and for refresher courses leading to certificates

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- 33. AFOP to CG, Hawaiian Dept., 5 March 1943, in AMG 3531, Bombsight and Navigation Training.
  - 34. Daily Diary, AFMC, 5 April 1943, in AFCT files.

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of proficiency. All individual training of navigators in tactical organizations was definitely terminated in January 1944. At this time the Commanding General of the Second Air Force requested information on the existing AF policy on the issuance of certificates of proficiency, and also whether the Second Air Force was authorized to qualify military personnel as dead reckoning and celestial navigators. To this request the AG/S, Training replied that:

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1. All existing instructions pertaining to the issuance of certificates of proficiency to celestial and dead reckoning navigators are hereby rescinded.
2. AF Navigation Schools are the only agencies authorized to train and qualify individuals as navigators.

Programs of Instruction, Standardization, and Testing

Programs of Instruction. The programs of instruction employed in conducting individual training of non-pilot specialists in tactical organizations differed basically from those employed in the Air Corps schools. Those followed in the latter schools were detailed and extensive in scope, essentially academic, and prepared for use at establishments designed to train a particular type of specialist. On the other hand, the training programs followed in the tactical organizations were intended for use in training of military personnel who were, theoretically, already proficient in a particular specialty. These programs of instruction were, therefore, less detailed, less academic, consisted

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35. Daily Diary, Air Crew Div., S/S, Training, 20 Nov. 1943, in FIMI files; RAR, No. 1, Requirements Div., S/AS, CGS to S/S, Training, 27 Nov. 1943, in AG 353B, Bombardier and Navigator Training.
  36. CG, 2d AF to CG, AF, 15 Jun. 1944; 1st Inst., 31 Jun. 1944, in AG 211, Navigation Officers.

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mostly of air training, and were calculated to effect the earliest possible attainment of combat proficiency by the tactical group. In July 1941 more than 500 hours were allotted to ground training in the Air Corps navigation schools, whereas a total of only 162 hours were allotted to all ground training in the tactical units.<sup>37</sup> The essential differences in both mission and nature of these two training agencies, the Air Corps schools and the tactical units, account for most of the difficulties encountered in conducting individual navigation training in the tactical organizations and in the attempts to standardize courses of instruction in both in order to facilitate the rating and commissioning of personnel trained in the tactical units.

The navigation training conducted in the group schools of the GNAF Force from 1933 to 1936 was essentially experimental and developmental. The program of instruction under which navigation training at Langley and Rockwell Field was begun in October 1933 consisted of 160 hours allocated as follows:

Ground instruction in aviation	59 hrs.
Radio	4 "
Meteorology	10 "
Airmanship at sea	4 "
Air training	77 "

The care, use, and calibration of navigational instruments were emphasized,<sup>38</sup> and all air training consisted of over-water flights. Soon

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- 37. R.R., No. 2, C/13 to CG, AFCC, 20 Aug. 1941, in AG 353.91, Navigation (Advanced Aviation) and Instrument Training.
  - 38. Acting Exec., CG.C to AG, 18 Oct. 1933, in ibid. It should be borne in mind that the students who underwent this training were officer pilots who were already proficient in instrument flying before taking this course.

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After this training was begun the time allocated was found inadequate  
39 and was increased from one month to two.

After the training conducted at Rockwell Field by the 19th Bombardment Group was discontinued on 1 July 1935, navigation training became a part of the unit training of each bombardment group. Aerial celestial navigation was still in its infancy, however, and little was known relative to the equipment and materiel to be used and the method of instruction to be followed in the training of navigators. In order that "the most important feature in future operations of the Air Force . . . not be allowed to languish," the 19th Bombardment Group was assigned the mission of instituting "an Air Force program for the development of the art of celestial navigation and its application to long range bombardment operations." In accordance with this directive the Commanding General of the 1st Wing made plans to establish a "Celestial Navigation School," the operation of which 40 would be the major mission of the 19th Bombardment Group. This development program continued from 1 August 1935 to 30 June 1936 and provided, it appears, the basic information on the techniques to be employed in aerial navigation and the instructional methods later employed in the navigation schools of the AF.

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- 39. C/A/C to AG, 7 Nov. 1933; AG to CG's of Corps Areas, 10 Nov. 1933, in ibid. No record has been found of any later changes in this program of instruction nor many of the programs subsequently used by the group schools of the CH Air Force.
  - 40. C/S, CH AF to CG, 1st Ing, 3 July 1935; 1st Ing., 22 July 1935, in AMG 353.94, Navigation (Advanced Navigation) and Instrument Training.

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The programs of instruction used in the tactical units were related to navigation training in Air Corps schools in two important respects. In the first case the agencies responsible for the individual training of navigators followed the policy of keeping abreast of the experience of the tactical organizations both in operational training and combat experience. In the second case, since individuals trained as navigators in tactical units were to be rated and/or commissioned, it was desired that their training closely parallel that of the navigation schools. To this end there was a continuous interchange of information on programs of instruction, training methods, and training aids.

As early as June 1941 the Training and Operations Division of the C.C.C requested the defense air forces (Caribbean, Alaskan, and Hawaiian) to submit reports on navigation difficulties encountered in tactical operations and suggested changes in the techniques of training combat navigators. During the following July and August the requested reports were received and forwarded to the navigation schools for their information and guidance. This same procedure was repeated in October 1941 and again in October 1942. These reports and the accompanying recommendations were considered valuable and were welcomed by the navigation schools, but they do not appear to have caused any

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41. T&O to CG's of Caribbean Defense Air Force, Alaskan Defense Air Force, Hawaiian Defense Air Force, and CMC Air Force, 11 June 1941, in AMG 353.9C, Training, General.
  42. T&O to CG's of Caribbean Defense Air Force, Hawaiian Air Force, and Alaskan Defense Command, 31 Oct. 1941, in AMG 353.9, Navigation Training; CG, 7th AF to CG, AF, 21 Oct. 1942, in AMG 353.9F, Training, General.

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radical changes in the instruction in the Air Corps schools.

Another channel through which the training experience and operational demands of the training air forces reached the navigation schools was that of the visits made by instructor and supervisory personnel of the navigation schools to the tactical organizations.

As early as November 1941 a board of officers from the navigation school at Kelly Field was sent "to several tactical outfits for the purpose of co-ordinating their course of instruction . . . and the actual application of that instruction with tactical outfits."<sup>43</sup>

This and numerous other such visits were made, and reports, including recommendations, were submitted and circulated to the navigation schools for their information and necessary action.

Standardization and Rating. One of the problems encountered in training navigators in the tactical organizations was that of rating and/or commissioning personnel who had completed a course of instruction. Difficulties encountered in this respect apparently increased at about the same rate as did the ability of the navigation schools to meet the demands of the using agencies. One of the first instances of a conflict over certifying personnel of tactical units as navigators arose in August 1941 when it came to the attention of the Chief of the Air Corps that the training program of the 16th Reconnaissance Squadron allotted only 30 hours of training in order to qualify as a dual reckoning and celestial navigator. In calling this to the attention of the

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43. 3d Ind. (Report, CO, Advanced Flying School, Kelly Field, to C/A.C., thru channels, 5 Dec. 1941), CG, CGACTC to C/A.C., 14 Dec. 1941, in AG 353.91, Navigation (Advanced Navigation) and Instrument Training.

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Chief of the AF, it was pointed out that approximately 500 hours of instruction were required in Air Corps schools and that it was impossible for an individual to qualify with only 30 hours of instruction. In this connection it was also pointed out by Air Corps Circular 50-10, of 30 June 1941, that any commissioned pilot could be rated as a navigator if he were certified as competent by his commanding officer. It was then recommended that a standard curriculum be adopted for the training air forces and that such a curriculum should follow closely that used in the Air Corps schools.  
<sup>44</sup>

The subsequent discussions of this problem brought out all of the essential difficulties of attempting to conduct comparable training in Air Corps schools and tactical units. It seemed obvious that 30 hours of instruction were inadequate for the purpose of qualifying an individual as a dead reckoning and celestial navigator, even when the individual was a pilot who had already had 62 hours of navigation training. At the same time it was equally patent that a tactical organization whose entire program included only 182 hours of ground instruction could not give 403 hours of ground instruction to personnel undergoing navigation training.  
<sup>45</sup> The Chief of the Air Staff indicated that military personnel should be rated as navigators only if the training was "substantially as comprehensive" as that given in Air Corps schools, although it was conceded that such training would have to be within the capabilities of the tactical unit conducting it. How this circle

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44. RRR, No. 1, C/AF to CG, 20 Aug. 1941, in ibid.

45. RAR, No. 2, C/AS to CG, AFOS, 20 Aug. 1941, in ibid.

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was to be squared was not indicated.

One of the most essential differences in the nature of the training conducted in the tactical organizations and in the Air Corps schools was brought out in the discussions on the above problem. The Commanding General of the Air Force Combat Command indicated that it was the policy of his organization to prescribe the objectives of training and not to specify a curriculum; that is, the essential aim was the attainment of proficiency in navigation irrespective of the completion of hour requirements of a course of instruction. The existing standard of proficiency required for the rating of navigator of the Air Force Combat Command was the ability to navigate within an error limit of 1-1/2 minutes in estimated time of arrival (ETA) for each hour flown, with a lateral deviation of not more than one degree, and ability to establish position within 25 miles by celestial means. It was further suggested by the Combat Command that Air Corps Circular 50-10 be revised so as to require only that the commanding officer certify that an individual was qualified "to carry out the function of navigator in the combat crew of bombardment and reconnaissance aircraft at time of application" for rating. The Chief of the Air Staff concurred with the Commanding General of the Combat Command both as to the principle of setting objectives rather than a fixed curriculum and also as to the proposed revision of Air Corps Circular 50-10, subject to the additional requirement of having "qualified as expert aerial gunner or aerial

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46. Ibid.

47. 1st Inu. (basic unknown), CG, FCC to C/LAF, 8 Sep. 1941, in ibid.

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48 sharpshooter." These became the standard requirements for rating  
49 navigators in tactical organizations.

A somewhat different problem was faced when from April to July 1942 plans were being made to establish group schools in various air forces for the purpose of giving advanced navigation training to graduates of the preflight navigation schools. The Directorate of Individual Training informed the Flying Training Command of the plans to establish such schools, but indicated that "high standards must be maintained" and requested the command to indicate the requirements that must be met by a group school to enable its graduates to "merit a navigation rating." Factors to be determined were the number and qualifications of instructor personnel, the prerequisites to be required of trainees, and the  
50 program of instruction to be followed. These requirements were furnished by the command, but before training was inaugurated the command indicated its non-concurrence with such a policy and requested that all  
51 preflight graduates receive advanced training in the Air Corps schools. This type of training was performed in various air forces for approximately a year, October 1942 to September 1943, but during that period it appears that requirements established by the Flying Training Command were followed in the group schools.

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- 48. R&R, No. 3, C/W to C.A.C., 22 Sep. 1941, in ibid.
  - 49. "Notes for Formulation of Policies," 25 Nov. 1941, in AAG 321.9-1; see also A-3 Diary, item 11, 23 July 1942, and item 10, 25 July 1942, in AFM 1 Miles.
  - 50. AFM 1 to CG, AFFTC, 29 April 1942, in AAG 211C, Titles and Grades.
  - 51. 1st Ind., AFFTC to AFM, 11 May 1942, in ibid; Daily Diary, AFFTC, 22 July 1942, in AAG 319.1-3, Daily Diaries.

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Using agencies other than the training air forces also conducted navigation training, for example, the 1st Sea Search Attack Group at Langley Field and the Antisubmarine Command. The training conducted by these agencies, however, seems to have been confined to training bombardiers as navigators. In February 1943 the 1st Sea Search Attack Group indicated a desire to institute a group school for such training and requested information on the requirements set up by the navigation schools. This information was forwarded by Individual Training. In March 1943 the Antisubmarine Command, which had already been operating a group school, requested that graduates of the school be rated as aerial navigators. Apparently the command had not coordinated with Individual Training when this training was initiated, and when the request for rating the graduates reached the AC/AS, Training, it was rejected on the ground that the course of instruction had not been equivalent to that of the navigation schools in the Flying Training Command.

The Tactical Units and Dual Training, 1944

As previously indicated, the conduct of individual training in tactical organizations was intended as a temporary expedient to be continued only as long as the facilities of the training air forces were not being fully utilized and the capacity of Air Corps schools

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- 52. CO, 1st Sea Search Attack Group to AFIT, 25 Feb. 1943; 1st Ind., 22 March 1943, in AFCT files.
  - 53. In the 29 March 1943 reorganization of the AF, AFIT was succeeded by AC/AS, Training.
  - 54. CG, AFSUB to AFIT, 29 March 1943; 1st Ind., AC/AS, Training to CG, AFSUB, 6 April 1943, in AFCT files.

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was inadequate for supplying the individually trained personnel required by the tactical units. Therefore, as the production of the navigation schools increased, especially during 1943, steps were taken to restrict the amount of such training outside the Training Command schools. Not only was the training of cadets terminated by September 1943, but on-the-job training also was restricted. By November 1943 AC/IS, Training objected to the training of bombardiers as navigators in the Second Air Force and indicated that such personnel could be sent to the navigation schools in the Training Command. Two months later the AC/IS, Training informed the Commanding General of the Second Air Force that all previous instructions relating to air forces commanders issuing certificates of proficiency to navigators were rescinded and that the AF navigation schools were the only agencies authorized to train and qualify navigators.

Hardly had all individual training of navigators become confined to the specialized schools when there arose a training requirement which it was impossible for these schools to meet. By the middle of March 1944 the requirement for bombardier-navigator-radio personnel for the very heavy bombardment program was such that the Training Command specialized schools could not process trainees through all three stages of training rapidly enough to meet the requirements of the very heavy units. It became necessary, therefore, to suspend the usual bombardier-

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- Daily Diary,  
55. Air Crew Div., AC/IS, Training, 26 Nov. 1943, in AFHII files.  
56. 1st Ina. (A.G., 2d AF to CG, AF, 15 Jan. 1944), 31 Jan. 1944, in  
AMG 211, Navigation Officers.

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navigator training in the Training Command and to assign personnel trained in only one of these specialties, plus radar, to the Second Air Force. The second category of dual training, plus the radar training for the specialist who was not sent to Boca Raton, was to be conducted as on-the-job training in the Second Air Force.  
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Evaluation of Policy of Training in Tactical Organizations

The number of navigator cadets trained in tactical units after July 1942 has not been ascertained, but available records indicate that it was small. Because of the difficulties encountered, the quality of the training performed, and the relatively small number of navigators produced by this means, there are grounds for questioning whether or not it was a profitable venture for the AF.

It is true that the rate of navigator production in the Flying Training Command from May to August 1942 was not up to expectations. At that time training was still being conducted at stations occupied by advanced flying schools, with the exception of Hunter Field which had been converted to a single-purpose school. Delays were experienced in initiating training under the 9,400 navigator program, and a surplus of preflight graduates was being accumulated. The logical solution appeared to be to send part of the excess preflight graduates to the tactical units for their advanced training; but the procedure was surrounded by several rather serious difficulties.

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57. Memo for Gen. Harper by Col. L. O. Ryan, 30 March 1944, in <sup>FACT</sup> ~~Training~~ files; Daily Diary, Individual Training Div., AC/AS, 20 March and 5 May 1944, in AFHQ files.

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One of the first problems encountered was that of time lost in travelling from preflight to the various training air forces. This was especially true of those crews sent to the Caribbean and Hawaiian departments. Still more serious was the lack of navigation training equipment. It was this factor, more than all others combined, which limited production in the navigation schools. It was the shortage of equipment which delayed the shipment of the crews destined for the Caribbean Air Force until about March 1943, though the decision was made in August 1942. With production directly dependent upon the training personnel and training equipment, it appears that production was retarded rather than accelerated by the dispersal of these items. This was pointed out b. Individual Training when in February 1943 the shipment of a navigator training squadron to the Seventh Air Force was  
58 approved.

Furthermore, the tactical organizations found it difficult to conduct this type of training in addition to their regular OTU and RTU missions. In fact, these units found it impossible to provide adequate operational training for the navigator members of their combat crews. Also, throughout the summer and fall of 1942 there was an acute shortage of instructor and supervisory navigation personnel in the training air forces which necessitated the sending of such personnel from the navigation schools to the Second and Third Air Forces. Another factor, directly related to these conditions which prevailed in the air forces

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58. RMR, No. 1, AG/AS, Program Planning to AFMT, 27 Feb. 1943; RMR, No. 2, AFMT to AG/AS, Program planning, 4 March 1943, in AFCT files.

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and which weighed heavily against the practice of sending cadets to tactical units for advanced training, was the seemingly rather general belief that the "individually trained school graduate is . . . superior to the individual who is trained 'on-the-job'."<sup>59</sup>

The time element was also important in planning such training. School enrollment and production were behind schedule in the summer of 1942 when it was decided to send cadets to the tactical units. By September, however, all the navigation schools had been converted to single-purpose schools with the transfer of navigation training at Turner and Kelly fields to Monroe, La. and Monro, Mex., respectively. By 1 January 1943 total school enrollment had reached 3,237, and by 1 July 1943 it stood at 7,700.<sup>60</sup> Production increased in approximately the same proportion. Therefore, by the time cadets had completed training in the air forces, production in the navigation schools had been greatly increased. The average monthly graduation rate of the navigation schools during the months when such training in the tactical organizations was planned was about 365. During the first three months of 1943 this rate increased to approximately 750.

The program requirement for 1943, as indicated in February 1943, was 13,200. At that time Individual Training requested a reconsideration and disapproval of the plan to send a navigation training squadron to the Seventh Air Force. In support of this request the above require-

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59. RMR, AG/C-3, Training to C/S, 28 Sep. 1942, in AG 353.9-1B, Bombsight Training.

60. Project Book of CG, AFTRC, Navigation Sec., 6 April and 13 July 1943.

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ment was pointed out and compared with the scheduled production of the navigation schools which indicated a production of 14,292 as against the 13,200 requirement. <sup>61</sup> Navigator graduates in 1943 actually exceeded 14,292, running well ahead of the schedule for the first half of the year. It was also pointed out by Individual Training that before any navigators could be trained by the squadron in question the monthly rate of production would exceed 1,500. In the meantime the navigation schools, where all such training should be conducted, would be deprived <sup>62</sup> of valuable equipment and personnel. This opposition by Individual Training to the plan to train navigators in the Seventh Air Force was only a part of a general opposition to this type of training. About the middle of February 1943 this directorate, in a strongly worded R&R to the Directorate of Military Requirements, called attention to the fact that "Due to the present shortage of navigators, a serious situation of uncoordinated, half-baked training in the Air Forces is arising." It has been learned that the antisubmarine Command was starting a 12-week course, that Maj. Gen. Millard F. Harmon was setting up a school in New Caledonia, and "verbal" information from the Directorate of Bombardment indicated that the IV Bomber Command also was establishing a school. Replacement navigators were already on the way to General Harmon, and by the time navigators could complete training in the other organizations school production was expected to be in

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61. R&R, No. 2, AFRT to AC/AS, Program Planning, 4 March 1943, in AFCT files.

62. Ibid.

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excess of 1,400 per month.<sup>63</sup>

While there was an excess of 640 preflight navigator graduates at the end of September 1942 and about 1,000 one month later,<sup>64</sup> it does not appear that any sizeable portion of the surplus was sent to the training air forces. When all of the practical and inherent disadvantages of attempting to conduct individual navigator training in tactical organizations, therefore, are compared with the comparatively insignificant results obtained, it seems doubtful that it was a profitable procedure for the AF.<sup>65</sup>

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- 63. AFM, No. 1, AFTR to AFDR, 19 Feb. 1943, in AG 52.11., Courses of Instruction; Maj. Gen. Villara F. Harmon to Lt. Gen. H. H. Arnold, Message No. 3315, 8 Feb. 1943, CM-IN-4652 (9 Feb. 1943), in AF Message Center.
  - 64. Daily Diary, AFIC, about 30 Sep. 1942 and 29 Oct. 1942, in AG 319.1-3, Daily Diaries.
  - 65. Data were not available on the number of navigation crews trained in tactical organizations. The only references found were to the one group, apparently of 50 crews, sent to the Caribbean Department and three groups of 12 each which were sent to the Hawaiian Department. It was also impossible to ascertain the number of navigators trained in the disbanded groups of the GHQ Air Force and its successor, the Air Force Combat Command. The monthly Training and Operations Report of these organizations contains data on "Celestial Navigators—Trained and Number [of] Combat Crew as Nav." and "Under Training for Assignment to Combat Crew." These are status reports and do not reveal the production flow of trained personnel.

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Chapter IV

ADVANCED TRAINING IN AIR CORPS SCHOOLS

Inauguration and Early Training in Air Corps Schools

In the early stages of the expansion program it was contemplated that navigation training under the CGAC would be given in specialized navigation schools which would be located at some of the advanced pilot schools.<sup>1</sup> The first of these schools was scheduled to open at Burksdale Field, although training there of necessity would be very limited. Not only was there an acute shortage of necessary personnel and equipment which seriously curtailed navigation training prior to 1943, but four types of training were conducted at that station: pilot, pursuit<sup>2</sup> instructor, bombardier, and navigator.

With navigation training confined to that conducted in tactical organizations and with no large-scale production to be expected at Burksdale, it was decided in July 1940 that such training could be accomplished more expeditiously and more economically by utilizing "the experience, organization and facilities of the Pan-American Corporation." The Chief of the Air Corps, therefore, took the necessary steps to initiate navigation training by the PAA at Coral Gables, Fla.<sup>3</sup>

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1. C/AC to AG, 16 July 1940, in AG 353.9A, Navigation (Advanced Navigation) and Instrument Training.
  2. R.O to PAA, 24 May 1940, in AG 353.9F, Training in Aviation, Pilot.
  3. C/AC to AG, 16 July 1940, in AG 353.9A, Navigation (Advanced Navigation) and Instrument Training.

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Training began at Coral Gables in August and at Barksdale in November 1940. By July 1941, however, the location and facilities at Barksdale had proved inadequate, and training was terminated after the graduation of only 52 students. At the same time that training was terminated at Barksdale the Air Corps enrollment at Coral Gables was cut in half because of the initiation of British navigation training by the R.A.F. At this time only 339 navigators had been trained in specialized schools.<sup>4</sup>

A program requirements in mid-1941 called for an annual production rate of about 2,400 navigators, and the 30,000 pilot program which called for an annual navigator production rate of 4,800 had been approved. Navigation training under the latter program was to be initiated in December 1941. It was essential, therefore, that additional navigation schools be opened. Heretofore all navigation training had been performed in the Southeast Training Center, but with the discontinuance of this type of training at Barksdale, it was decided to open a navigation school in each of the three training centers.<sup>5</sup> Accordingly, the personnel and equipment used at Barksdale were divided three ways and new navigation schools opened at Turner, Kelly, and Kather Fields. Instruction was scheduled to begin at these schools on 1 August 1941.<sup>6</sup>

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- 4. See Chart 1 following p. 23.
  - 5. P.R., No. 1, TAC to Exec., 10 July 1941, in AG 352.11H, Courses of Instruction.
  - 6. Ibid.

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The three navigation schools were operated in connection with the advanced twin-engine pilot schools at these locations. The conduct of different types of training at the same bases constituted a continuous limitation on the expansion possibilities of the navigation establishments. There was a critical need for single-purpose navigation schools, but their establishment was precluded by the shortage of equipment and the time required to construct new fields. It was a year later, August and September 1942, before single-purpose navigation schools were finally set up.<sup>7</sup> On 9 August 1941, after the opening of the three Air Corps navigation schools, there was a total of only 199 students under instruction, including those at Coral Gables. One year later this number had increased to 1,372. Within three months after single-purpose schools were established, however, there were more than 3,000 students under instruction.<sup>8</sup> This transfer of navigation training to single-purpose schools was effected by the construction and activation of two new fields, Belvoir Field at Monroe, La. and Hondo Army Air Field at Honado, Tex., to which the navigation schools at Turner Field and Kelly Field were respectively moved. At about the same time the pilot school at Mather Field was transferred elsewhere, leaving only navigation training at that field.<sup>9</sup>

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- 7. Project Book of CG, AFTRC, Navigation Sec., 25 March to 25 June 1942.
  - 8. See Chart 1 following p. 23.
  - 9. Project Book of CG, AFTRC, Navigation Sec., 25 June 1942; CG, AFTRC to C/S, 20 Dec. 1941, in AG 353.032, Training, General.

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Facilities for navigation training in AF schools were expanded further in February 1943 with the opening of a new school at San Marcos,  
10 Tex. Within two months after opening, this one school had more students under instruction than all the other schools had in February 1942. Further to facilitate training and to simplify administration all navigation training was concentrated in the Central Flying Training Command. In August 1943 jurisdiction over the schools at Coral Gables, Fla. and  
this 11 Monroe, La. was transferred to command, and in November 1943 the  
12 school at Kather Field was transferred to Ellington Field. Two months after this transfer was effected the number of students under instruction  
13 stood at 8,424.

Instruction in Advanced Navigation Schools

Factors Conditioning Instruction. There was a critical shortage, until 1943 at least, of every means necessary for the accomplishment of the assigned mission of the specialized navigation schools. Instructor and supervisory personnel, trainer aircraft, navigational instruments, training aids and materials, and physical accommodations were constantly inadequate in either quantity or quality or both. The character of instruction was the resultant, therefore, of all these factors plus the almost insatiable demands of the using agencies and the cumulative experience acquired in the navigation schools and in

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10. Project Book of CG, AFTRC, Navigation Sec., 14 Nov. 1942.
  11. Daily Diary, A-3 Div., AFTRC, 21 Aug. 1943, in files of AFTRC.
  12. Ibid, 29 Sep. 1943.
  13. See Chart 1 following p. 23.

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the tactical and combat units. Any evaluation of the various programs or instruction, the quality of instruction given, and the proficiency of graduate navigators must be made in the light of the interplay of all these limiting factors. It was never possible to conduct training on the basis of what was desirable or theoretically possible, but on the basis of what was expedient in order to meet the pressing demands of the various using agencies.

Programs of Instruction. The length of courses of instruction for navigators varied from the "tentative" 10-week program of 8 July 1940 to the 13-week program approved in January 1943. Early in 1944 it appeared that the course would soon be extended to 20 weeks.<sup>14</sup> The content of programs of instruction varied in accordance with the time allotted, new navigational equipment and its availability in the navigation schools, and the experience gained in the training air forces and in the theaters of combat. It was established policy to keep instruction in the navigation schools closely coordinated with the demands of using agencies.

Including the tentative program of 8 July 1940, there were five different programs of instruction in effect in the navigation schools up to the spring of 1944. These were: (1) the 10-week tentative program of 8 July 1940; (2) a revised program of 30 September 1940, which appears to have been a 12-week program; (3) a further revision of the

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14. "Tentative Program of Instruction, Training of Aerial Navigators for Military Students to be Given in Air Corps Flying Schools," 8 July 1940, U-1337, AG, in AF Library; Project Book of CG, AFLAC, Navigation Sec., 29 Feb. 1944.

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July 1940 program dated 3 February 1941 or 15 weeks' duration; (4) another revision dated 15 July 1941, the length of which remained at 15 weeks; and (5) the 13-week program which was approved on 7 January 1943 and subjected to slight changes on 22 July and 22 November 1943.

The detailed contents of the programs of instruction underwent the normal changes occasioned by additions, deletions, changes in allotted time, rearrangements of topics, and modifications due to changes in materials covered by certain topics. The essentials of instruction offered, however, remained fairly constant. The basic phases of instruction were as follows:

1. Ground instruction (covering calibration, pilotage, radio, and celestial navigation).
2. Air training (covering the above topics on day and night missions).
3. Meteorology (later listed as "weather").
4. Allied training (military, physical, code, identification, first aid, and administrative; weather is included in this phase in some programs).

The changes made in time allotted to the various phases of training under the different programs are indicated in tabulated form as follows:

Phase of training	Program of 5 July 1940 10 weeks	Program of 3 February 1941 15 weeks	Program of 15 July 1941 15 weeks	Program of 7 January 1943 13 weeks (23 July revision)
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Ground training	210 hrs.	253 hrs.	403 hrs.	369 hrs.
Air training	72	31	100-1/2	100

15. The program as revised on 30 September 1940 has not been found. Neither was the program approved on 7 January 1943 and issued as F. T. C. Memo 50-12-1, 15 April 1943, located. It appears, however, that the latter program was essentially the same as the 22 July 1943 revision which was available. The programs of 15 July 1941 and 22 July 1943 are given in Appendices 1 and 2.

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Phase of training	Program of 8 July 1940 10 weeks	Program of 3 February 1941 15 weeks	Program of 15 July 1941 15 weeks	Program of 7 January 1943 18 weeks (3 July rev.)
Meteorology (weather)		65 hrs.	65 hrs.	42 hrs.
Allied training	100 hrs.	50	50	203
Gunnery	48			
Total	430	449	513-1/2	714

In June 1940, prior to the initiation of navigation training in Air Corps specialized schools, there was submitted to the Chief of the Air Corps a "Report of Committee on Training in Specialized Schools." This report, which indicated the length and contents of various programs of training, provided for a 10-week navigation program.<sup>16</sup> It appears that the program for navigation training submitted by this committee became the tentative program of 8 July 1940. Before training was begun at Barksdale Field in November 1940, this program had been revised on 30 September and extended, apparently, to a 12-week course. However, there was very little training conducted under this program. One class of 21 students entered Barksdale in November, and a second class of 20 entered about 1 February 1941. In the meantime a revised program had been approved. This program, dated 3 February 1941, added meteorology, increased the time allotted to celestial navigation and air training, reduced the time devoted to athletics and military training,

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16. Memo for C/AC by Committee, 19 June 1940, in AG 352.11G, Courses of Instruction. The committee was composed of Maj. Isiah Davies and John A. Morgan, and Capt. L. S. Harbold, S. G. McLennan, and D. R. Ryan.

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and eliminated flexible gunnery.

The program of February 1941 was not considered entirely adequate, but was based on the availability and expected availability of personnel and material.<sup>17</sup> The navigation program of instruction became reasonably well stabilized in July 1941. At this time training at Barksdale was terminated, and three schools were established, one in each training center. These schools began training under the revised program,<sup>18</sup> dated 15 July 1941, which remained in effect for the ensuing 18 months.

By the end of 1942 the program of instruction was badly in need of revision. During the period since July 1941, when the program had last been revised, new navigational equipment had come into use, new instructional methods, aids, and devices had been perfected, and combat experience had revealed the need of certain changes. Some of these demands had been met by additions, deletions, and changes in emphasis in the old program. Others had been met by offering instruction without including it in the official program. The result was a patchwork program of instruction and a lack of uniformity among the various navigation schools.

Still more serious were the effects on the trainees and the quality of instruction. The addition of instruction on new equipment and increased allotment of time to certain phases of training in response to demands of the using agencies had resulted in a heavy overload on the students. The Flying Training Command pointed out that navigation

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17. Brig. Gen. Miltor R. Caver, CG, AFMTC, to C/AC, 2 Jan. 1941, in AFM 353.91, Navigation (Advanced Navigation) and Instrument Training.  
18. See Appendix I for the outline of this program.

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students were "under approximately twice as much daily schedules instruction throughout the course, as the pilot student." <sup>19</sup> Trainees were finding it impossible to absorb the vast amount of instruction; the elimination rate was rising; there was an increase in the number of holdovers; and there was a "decrease in quality of the navigator produced." A further result of the crowded schedule, in addition to the impaired health and morale of the students, was that there was insufficient time to be spent on synthetic training equipment. This further lowered the proficiency of trainees. At about the same time that this condition was recognized, <sup>20</sup> a directive was issued to add 20 hours of instruction in first aid.

The directors of training in the navigation schools had been insisting for a long time that the length of the course should be increased. In October and November 1942 conferences were held to discuss the problem <sup>21</sup> of revising and standardizing the program of instruction. As a result of these conferences and the pressing need for a new program of instruction, the Commanding General of the Flying Training Command strongly recommended that the course be extended from 15 to 18 weeks and submitted a plan whereby it could be accomplished without a loss in navigator production. <sup>22</sup> Individual Training concurred in the proposed extension with the exception of the proposal that the flying time given

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19. CG, AFFTC to CG, AF, attn. FDR thru AFRT, 20 Nov. 1942, in AG 352.11, Navigation Schools.
  20. Ibid.
  21. Daily Diary, A-3 Div., FFTC, 8 Oct. and 19 Nov. 1942, in FTAC files; Project Book of CG, FFTC, Navigation Sec., 30 Oct. 1942.
  22. CG, AFFTC to CG, AF, attn: FDR thru AFRT, 20 Nov. 1942, in AG 352.11, Navigation Schools.

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at Coral Gables be increased from 50 to 60 hours since this would  
23 require additional airplanes. The Directorate of Bombardment, how-  
ever, disapproved the extension because of the planned conversion of  
bombardier and navigator training to a dual program. The dual train-  
ing program was only in the planning stage, and the conditions in the  
navigation schools were too urgent to be subjected to any long delay.  
Consequently, Individual Training approved the extension in January  
1943. This approval, however, was based on certain conditions: there  
was to be no reduction in the flow of graduates; the additional three  
weeks were to be used for the relief of pressure on trainees rather  
than for adding new material to the course; there was to be no increase  
in flying time; no buildings beyond those already authorized were to be  
constructed; and the program might apply to the school at Coral Gables  
24 provided there was an increase of 50 students per class.  
25

In preparing the new program of instruction, it was found to be  
impossible to avoid adding some new materials to the program. As new  
equipment was placed in use, it was necessary to give instruction on  
it without deleting instruction on old equipment. This was due to the  
fact that the old equipment remained in use in some of the theaters of  
26 operation. The important changes effected by the new program of

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- 23. RMR, AFMFT to AFDB, AFBS, and AFBO, 24 Nov. 1942, in AFCT files.
  - 24. RMR, No. 2, AFDB to AFMFT, 29 Nov. 1942, in AFCT files.
  - 25. 1st Ind. (CG, AFFTC to CG, AF, 20 Nov. 1942), 9 Jan. 1943, in LIG 352.11, Navigation Schools.
  - 26. CG, AFFTC to AFMFT, 12 Jan. 1943, in ibid.

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instruction were:

1. In air training:

Four hours were added to the time allotted to calibration of instruments.

2. In ground training:

a. Code and aircraft identification, which had been taught though not included in the program of instruction, were now included.

b. Lectures on astrophraph, astrocompass, and new charts were added.

c. The hours allotted to radio navigation were increased from 10 to 45.

d. Meteorology, which had been taken out of the program in the advanced navigation schools and placed in the preflight program in the spring of 1942, was put back into the course, but with 42 hours instead of the 65 formerly allotted to this subject.

The increase in hours, it was explained by the Flying Training Command, was devoted to instruction on new instruments and to "practical problems." In the preparation of the new program it was the policy to integrate it as closely as possible with both the preflight and bombardier programs of instruction and to design it so as to facilitate the proposed bombardier-navigator training.  
27

On 7 January 1943 the Flying Training Command was authorized to place the <sup>new</sup> program in effect immediately, pending formal approval.  
28

The program was formally approved for issuance to the navigation schools on 15 January 1943. Meanwhile, it had already begun at Hondo on  
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27. Ibid.

28. Daily Diary, AFMTC, 7 Jan. 1943, in AG 310.1-3, Daily Diaries.

29. 1st Inu. (CG, AFMTC to AFIT, 12 Jan. 1943), 15 Jan. 1943, in AG 352.11, Navigation Schools.

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7 January 1943, and was started at Coral Gables on 30 January 1943, at Selman Field on 6 February 1943, at San Marcos, Tex. on 20 February 1943 (the date on which this school began operations), and at Mather Field on 27 February 1943. In order to maintain the established flow of graduates, two classes were entered at Homestead, Mather, and Selman on the dates indicated above. One of the new classes at each of these schools began training under the old program and one under the new.  
30

The 18-week program underwent only two minor revisions and was still in effect in the spring of 1944 when its extension to 20 weeks was under consideration. This change was desired in order to put all aircrew training "in phase," that is, to have pilot, bombardier, and navigation classes enter and graduate simultaneously and in cycles in such a manner as to effect an even flow of entrance and graduation. These categories of personnel had flowed on a three-week cycle, but when pilot production was cut back, the 10-10-10 program of instruction (10 weeks in each of the three stages of pilot training) replaced the 9-9-9 program. Under the 10-10-10 pilot program of instruction it was necessary to adopt a five-week cycle in order to maintain the in-phase flow. It was, therefore, necessary either to reduce the bombardier and navigation programs to 15 weeks or extend these courses to 20 weeks. The Training Command preferred the 20-week program which was approved and scheduled to  
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- 30. La Ind. (CG, in AFIT to CG, AF, 20 Nov. 1942), CG, AFIT to AFIT, 15 Jan. 1943, ibid; Project Book of CG, AFIT, Navigation Sec., 26 January 1943.
  - 30a. T. C. Memo 50-12-1, 22 July 1943 and 22 Nov. 1943.
  - 31. Memo for Col. A. L. Montgomery by Maj. H. C. Leulani, 6 March 1944, in AFIT files.

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begin with class 44-12, entering training in May 1944, with conversion  
to this program to be complete in August 1944.  
<sup>32</sup>

Ground Training. The overwhelming portion of the individual training of navigators was ground training. The percentage of time allotted to this phase, including "allied" training, was approximately 62 to 67 per cent of the total hours in the curriculum. The allied curriculum consisted of athletics, military training, and beginning in 1943, such subjects as code, identification, first aid, oxygen indoctrination, and army administration. <sup>33</sup> The academic ground training, including meteorology or weather, made up approximately 75 per cent of navigation instruction.

This allotment of time is understandable in the light of the instructional procedure used in navigation training. First, the basic material was presented in the form of lectures which were followed by the solution of basic problems. The next step was the solution of ground problems followed by the performance of ground missions. After the student had successfully negotiated these stages of instruction in a particular phase of navigation, he performed a flight mission during which he employed the knowledge and skill attained on the ground. Due to the nature of the navigator's performance and the numerous synthetic devices used, a relatively large part of the navigator's proficiency could be attained on the ground.

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32. Project Book of CG, AFTB, Navigation Sec., 14 April 1944.  
33. See Appendix 2.

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Ground instruction in the four types or methods of navigation was conducted in the following manner. Familiarization and an introduction to the basic theories and principles of navigation were first given to the student. These were followed by instruction on such instruments as compasses, uritimeters, and altimeters, and training in their care and calibration. Materials to be used by the navigator, such as maps, charts, diagrams, and plotting sheets were taught along with log books and other records he would be required to keep. Next the student was given ground problems and instructed in the procedures to be followed in solving them. The next stage consisted of ground missions and critiques on the student's performance. Examinations and examination analyses concluded the ground instruction.

The amount of theoretical instruction required in the navigation schools was not extensive.<sup>34</sup> The primary need of the student was indoctrination in procedure. This need was met by the use of ground problems which were essentially a teaching device to prepare the student for the ground mission. The 16-week program of instruction provided for 26 ground problems, which were followed by approximately the same number of ground missions. The ground missions were simulated flight missions and were so conducted as to utilize all necessary data and student skill from the flight briefing stage, through the conduct of the mission and the critique following the mission. By means of this procedure and the use of synthetic devices, such as the D. R. T. (area reckoning trainer) and the C. N. T. (celestial navigation trainer), the trainee could apply virtually all navigational techniques on the ground

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34. CG, AFITC to AFMIT, 12 Jun. 1943, in AG 352.11, Navigation Schools.

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and do so approximately as well as in the air. The ground problem was essentially instructional, the ground mission mainly a testing procedure, and the flight mission the laboratory phase of training.

The measurement of proficiency in ground training was on the 100 per cent basis with examinations weighted 25 per cent and performance of ground missions 75 per cent. The minimum grade requisite to passing was 70. This applied, however, only to the over-all grade. On certain or the most basic procedures the student was required to approach the  
35  
100 per cent level.

36

Air Training. The air training of navigators was conducted concurrently with the ground training, beginning usually in the fourth week of the course. Though this phase of training occupied only a small portion of the total training time, it was the phase in which all prior training was put to the final test. Also, all types of navigation were progressively combined on single missions and applied on simulated day and night combat missions. Under the 18-week program of instruction 21 flights were scheduled, to which approximately 100 hours were allotted.  
The first 17 missions were either day or night missions of four hours each.  
The next three were day-night missions (two-legger missions with the out-leg flown in daytime and the return leg at night) of eight hours each. The last mission was a 14-hour day-night mission. The last three missions were conducted under simulated combat conditions, and the last two missions required a combination of all types of navigational techniques.

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- 35. This description of the essential procedures in ground training is based on navigation syllabi in AFCT files.
  - 36. See "Flight Missions" in syllabi in AFCT files.

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Air training was conducted with three trainees, and usually an instructor, in each airplane. The navigators were designated first, second, and third, and they rotated in such a manner as to give each one equal experience in each of the three positions. The first navigator performed "direct-the-pilot" navigation, relying on dead reckoning methods alone on the first 10 missions and combining this method with one or more methods on the remainder. The second navigator performed "follow-the-pilot" navigation, relying on dead reckoning on the first six missions and combining dead reckoning with one or more other methods on the others. The third navigator followed an extremely varied procedure, performing one type of navigation on two missions, two on five, three on five, and two plus "follow-the-pilot" on seven. The first two missions were familiarization flights, and the first and second navigators combined all types of navigation in the last two missions.

The progress of navigation trainees in air training was not measured or recorded on a percentage basis as in ground training. Proficiency in the air was based on sheer accomplishment. In this phase the trainee  
37  
was required to demonstrate his ability to

navigate during daylight hours by dead reckoning means with a maximum course error of  $1 \frac{1}{2}$ ° and a maximum E.T.A. error of  $1 \frac{1}{2}$  minutes per hour of flight from the last known position, [and] to navigate during darkness by celestial means to within fifteen miles of [the] objective over distances up to the full range of training type aircraft.

There was a fairly close correlation between ground and air perform-

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37. T. G. Memo 50-12-1, 22 Nov. 1943

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ance of navigation trainees. However, some students were unable to adapt themselves in the air and to exercise the independent judgment necessary to meet the complications which arose. Trainees failing to meet any one basic requirement were eliminated.  
39

Instruction in Relation to Tactical Experience

From the beginning of navigation training in Air Corps schools the content of navigation instruction and training procedures was closely coordinated with the experience and demands of the tactical organizations. The first program of instruction was largely based on the experience obtained by the 19th Bombardment Group from 1933 to 1936 and of that and other bombardment groups from 1936 to 1940. Just prior to the opening of the three navigation schools in the summer of 1941, the GND Air Force and the defense air forces in the Hawaiian and Caribbean departments and Alaska were requested to submit certain information on navigation training. To insure that graduates of Air Corps schools would be "fully equipped to carry out the various Air Force missions," it was considered necessary that any changes in navigation technique which were found essential in tactical operations be made known to the navigation schools. It was requested, therefore, that any "difficulties experienced in tactical operations, and any suggested changes in navi-  
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gation technique" be reported to the Chief of the Air Corps. Even

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- 38. Research Notes 44-4, Psychological Sec. AFT.S, 17 Feb. 1944; "Memo-  
randum on Navigator Proficiency Grades," by Dr. M. O. Jenkins,  
Psychological Br., AFT.S, 19 April 1944, in AFHQ files.
  - 39. See "Grading System," in syllabi in AFAC files.
  - 40. TMO to CG's of Alaskan Defense Air Force, Hawaiian Defense Air Force,  
Caribbean Defense Air Force, and GND Air Force, 11 June 1941, in  
LG 353.91, Navigation (Advanced Navigation) and Instrument Training.

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before this request was made, however, the Commanding General of the GHQ Air Force had requested at least some of the tactical organizations under his jurisdiction to "check the present approved methods and any future proposed methods with a view to improving or eliminating those which are found inapplicable" in order to "insure that the navigation schools are presenting the latest information in clear course."<sup>41</sup>

During the months of July and August 1941 the Chief of the Air Corps received the reports requested and after analysis and consideration transcribed them to the three training centers for their information and comments.<sup>42</sup> The training centers submitted their comments in September. From the suggestions contained in the reports from the tactical organizations and the comments by the training centers it appears that there was virtually no training required which was not already provided for in the program of instruction. Some of the reports complained of a lack of proficiency in certain skills, but it was the consensus of opinion in the navigation schools that the existing program of instruction and the growing efficiency of the schools would rectify these weaknesses. At the time, however, there were virtually no graduates of Air Corps navigation schools in tactical units. Most of the graduates of the navigation schools had thus far come from the AM school at Coral Gables.<sup>43</sup>

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- 41. CG, GHQ AF (?) to CG, 23d Composite Group, Orlando, Fla., 5 May 1941, in ibid.
  - 42. C/A.C to CG of each TC, 27 and 28 Aug. 1941, in AG 353.901, Training, General.
  - 43. 3d Ind. (AMO to CG, MACC, 27 Aug. 1941), 20 Sep. 1941, in AG 353.90, Training, General.

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Dead Reckoning. The basis of all navigation is dead reckoning—celestial, pilotage, and radio navigation being simply supplementary means of establishing fixes by which further dead reckoning calculations can be made. This fact was emphasized from time to time,<sup>44</sup> but there were relatively few complaints on the lack of proficiency in dead reckoning when compared with other weak points in navigation training.

Pilotage and Map Reading. Beginning in the early part of 1942 there were occasional complaints made to the effect that navigators lacked proficiency in pilotage and map reading. Most of these reports came from the combat theaters, especially the European. Unusual proficiency in pilotage and map reading was required in the areas where climatic and topographic conditions were unfamiliar and more difficult than in the United States. Reports of lack of proficiency in pilotage and dead reckoning came from the Eighth Air Force in January 1942 and June 1943.<sup>45</sup> Similar reports came from the African theater in August and October 1943.<sup>46</sup> Surveys conducted in AF navigation schools and the training air forces in continental United States also indicated the need of additional emphasis on pilotage, especially for night flying.<sup>47</sup>

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- 44. CG, VIII Bomber Command to CG, AF, attn. AC/AS, OCAR, 27 June 1943, in AFCT files; CG, 7th AF to CG, AF, 21 Oct. 1942, in AG 353.9F, Training, General.
  - 45. Exec. to C/AF, 17 Jan. 1942, in AG 353.9E, Gunners, Bombardiers; CG, VIII Bomber Command to CG, AF, attn. AC/AS, OCAR, 27 June 1943, in AFCT files.
  - 46. AC/AS, Training to CG, 2d AF, 11 Aug. 1943, in AG 353.4, Tortsight and Navigation Training; AC/AS, Plans to AC/AS, Training, 29 Oct. 1943, in AFCT files.
  - 47. CG, III Air Support Command to CG, 3d AF, 4 Nov. 1942, in AG 353, Navigation Training; Col. John J. Egan to AC/AS, A-3, AFFTC, about 1 Jan. 1943, in AFCT files.

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apparently there was no appreciable increase in the time allotted to pilotage and map reading in the navigation program or instruction to meet these complaints. In order to attain increased proficiency in a particular phase of training, however, it was not necessary in every case to allot additional time in the curriculum. Increased proficiency could be attained simply by applying greater emphasis to the particular type or phase of training. Instruction in map reading at night and at low altitudes was increased in January 1942. In August 1943 the AC/AS, Training informed the Training Command that there was an "urgent need" for more training in map reading and pilotage and recommended that the entire 60 hours allotted to geography in the college training program be devoted to maps and charts. But it seems that this recommendation was never placed in effect. Relative to the complaint received from the African theater, however, action was taken to increase the emphasis on pilotage and map reading in the navigation schools.

Radio Navigation. Training in the use of radio as a means of navigation was a part of the program of instruction from the beginning of navigator courses. Prior to about the end of 1942, however, it seems that it did not receive emphasis in proportion to other navigational methods, primarily because of the lack of equipment. In

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- 43. 1st Ind. (Chief, Intelligence Div. to Chief, Training Div., 31 Dec. 1941), 8 Jan. 1942, in AG 353.9D1, Training, General.
  - 49. AC/AS, Training to CG, AFCT, 26 Apr. 1943, in AFCT files.
  - 50. AC/AS, No. 2, AC/AS, Training to AC/AS, Plans, 30 Oct. 1943, in AFCT files.

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September 1941 - report from Turner Field indicated that "no actual flight training" in radio navigation had been given because of lack of equipment, though the program of instruction called for such training.  
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The original program of instruction of July 1940 allotted 15 hours to radio navigation, but this was soon reduced to nine hours. Throughout 1941 and 1942, however, continued reports from tactical organizations indicated the need for more emphasis on radio training, with the result that the time allotted to radio navigation was increased from 10 to 23 hours in the new program of instruction approved in January 1943. The status of this type of training during 1942 and early 1943 is reflected in the reports received from combat units during the first part of 1943 and from inspections of the navigation schools.  
54 From the Eighth Air Force came reports that radio was often ignored entirely by navigators. Some navigators had not used radio at all since graduation from the navigation schools. Among the crews joining this air force the navigator proficiency in radio was so low that a special course of instruction had to be offered for them. There was an impression that navigators had received instructions at some stage of their training in the advanced school "not to touch the radio  
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- 51. 3d Ind. (TAC to CG, SELTC, 27 Aug. 1941), 20 Sep. 1941, in AFM 353.9G1, Training, General; 1st Ind. (AFRIT to CG, AFFTC, 5 March 1943), 19 March 1943, in AFM 353.1, Bombsight and Navigation Training.
  - 52. See programs dated 3 February 1941, in AFM Library, and 15 July 1941 (Appendix 1).
  - 53. 1st Ind. (C/A to CG, AFCG, 11 June 1941), 7 Aug. 1941, in AFM 353.9G1, Training, General; Col. John J. Egan to C/S, 1-3, AFFTC, about 1 Jun. 1943, in AFM files.
  - 54. F. T. C. Memo 50-1-4, 9 April 1943.
  - 55. CG, 8th AF to AFRDB, 9 Feb. 1943, in AFM 353, Bombaraiier Training.

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compass." Furthermore, complaint was made of what was called a psychological problem in which "navigators tended to regard it as shameful to resort to the use of radio" or to request the cooperation of the radio operator for fear he "might find the radio operator telling the pilot about how he 'got the navigator home'." This lack of cooperation appeared to be mutual since it was also indicated that if the radio operator was called upon and failed to provide the desired information for a fix, the navigator would "classify the operator or the system as 'no good'."

During the early months of 1943 reports similar to those from the European theater were received also from the Pacific theaters. A letter from the regional communications officer in the South Pacific, in emphasizing the importance of radio in navigation in that area, indicated that "every navigator" with whom he had talked "seemed to have been instructed to beware of the radio compass," and some did not even know what it was.<sup>56</sup> With reference to such complaints the Flying Training Command indicated that radio compass training was "now" adequate, but that the navigation schools were handicapped by lack of information on "existing radio aid facilities, their method of use, and general information as to procedures required in theaters of operation." Such information was requested in order that the navigation schools might

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- 56. CG, VIII Bomber Command to CG, AF, attn. AC/5, COMR, 27 June 1943, in AFIC files.
  - 57. AFRT to CG, AFMIC, 5 March 1943, in MAG 353A, Bombsight and Navigation Training.

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bring their training up to the desired standard in this respect.

Loran Training. In the early part of 1943 a method of utilizing radar in establishing navigational fixes was perfected. This new Loran (Long Range Navigation) system resulted in an immediate training requirement of 2,500 navigators trained on Loran receiving equipment by the end of 1943. The initial training to meet this requirement was to be conducted in certain tactical organizations, but all navigators graduating after 1 January 1944 were to be proficient on Loran equipment. Beginning in June 1943 instructor personnel of the navigation schools were sent to Massachusetts Institute of Technology to take the Loran course conducted there under the auspices of the Navy. Loran equipment was expected to be available in all the navigation schools by 1 October 1943. In view of plans for this type of training, the navigation program of instruction was amended to include 10 hours on "Operation of Loran Equipment." In October 1943 the C/S, Training was informed that a requirement existed "for all navigators to be familiar with the operation and use of the Loran receiver" and that navigators for the Eighth, Eleventh, and Twelfth Air Forces were to "be so indoctrinated."

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- 58. CG, AFITC to CG, AF, attn. Director of Communications, 13 March 1943, in AG 353, Navigation Training.
  - 59. AFITC to CG, AFITC, 6 Jan. 1943, in AFITC files.
  - 60. AC/AS, Training to CG, AFITC, 25 April 1943, in AG 353A, Bombsight and Navigation Training.
  - 61. CG, AFITC to CG, AF, 21 May 1943, in ibid; memo for the Bureau of Naval Personnel, Training Div. by AC/AS, Training, 2 June 1943; AC/AS, Training to CG, AFITC, 12 June 1943, in AG 353, Navigation Training.
  - 62. 1st Ind. (CG, AFITC to AC/AS, Training, 12 Aug. 1943), AC/AS, Training to CG, AFITC, 14 Sep. 1943, in AFITC files.
  - 63. T. G. Memo 50-12-1, 22 July 1943.

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nated under a high priority."

Celestial Navigation. In the reports received from surveys and inspections of the navigation schools and in reports from tactical organizations, there were relatively few complaints regarding celestial navigation other than occasional and rather general suggestions that more proficiency in that subject was desired. With the exception of the South Pacific area it appears that celestial means were seldom employed by  
65  
navigators.

Combined Methods. Proficiency in navigation requires the ability to navigate by any and all methods. This is especially true when long overwater flights are to be made. On such flights navigators need to be familiar with all four methods of navigation and all the available navigational aids. This was strongly emphasized by the regional communications office in the South Pacific.  
66  
For a number of reasons, however, many navigators reached the combat theaters unprepared to utilize all navigational methods and aids. This was due partly to factors inherent in the individual, such as peculiar interest and/or ability in certain procedures, and also, apparently, to faulty or misunderstood instruction in either the navigation schools or the training air forces. The best illustration of this was found in the lack of proficiency in radio navigation.

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- 64. AC/A3, CDR to AC/A3, Training, 20 Oct. 1943, in AFAC files.
  - 65. AC/A3, Training to CG, 2d AF, 11 Aug. 1943, in AG 353A, Bombsight and Navigation Training; Lt. Gen. Burton E. Yount to Professor Samuel Herrick, 27 Jan. 1944, in AFAC files.
  - 66. AFAT to CG, AFAC, 5 March 1943, in AG 353A, Bombsight and Navigation Training.

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In December 1942 a survey was conducted to ascertain the proficiency required of navigators for medium bombardment units in relation to the proficiency of those assigned to such units. One of the observations made as a result of this survey was that graduates of the navigation schools were deficient in combining all types of navigation on a single mission. Six months later a report to this same effect was received from the VIII Bomber Command. It was pointed out: "Navigators arriving here seem to have the idea there are several types of navigation. . . . They do not see the picture that all navigation is essentially dead-reckoning, i.e., making good a track by knowing the wind. Celestial, pilotage, radio and all others are simply a means of getting information to do dead-reckoning." Failure to utilize all available means resulted in navigators getting lost in the one method being employed failed.

In an inspection of Second Air Force stations in July 1943 the same conditions indicated above were found to prevail there. It was found that recent graduates of the navigation schools thought "in terms of DR, celestial, radio and pilotage as separate and distinct systems of navigation and [were] unable generally to combine all of these successfully on a flight." They failed to see "the problem of navigation simply as one in which they were required to get the airplane from one point to another using a combination of all possible information which

67. Col. John .. Gym to AC/IS, AF-3, FFTC, about 1 Jun. 1943, in AFCT files.

68. CG, VIII Bomber Command to CG, AF, attn. AC/IS, OCE-R, 27 June 1943, in AFCT files.

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might assist them." This condition was attributed directly to the schools where they were using the flying time to "supplement the progress of ground instruction." Ground instruction in dead reckoning was given, and then a dead reckoning mission was flown. The same procedure was followed in radio and other navigational methods. "Prior to graduation," it was indicated, the student "may get one flight where he can combine anything he likes." It was therefore recommended that instructional procedures in the schools be changed so that all ground instruction would be given prior to any air training.

69

Although this recommendation was not placed in effect, action was taken by the navigation schools to give increased emphasis to the combination of all types of navigation. An examination of revised programs of instruction and syllabi in use in the schools about the end of 1943 indicates that 3 of the 28 ground missions and 14 of the 21 flight missions specifically required a combination of various navigational methods.

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#### Standardization of Instruction and Text Book

In April 1944 navigation training in specialized schools had been in operation for nearly four years. After this lapse of time the instruction conducted in the various schools had still not been standardized.

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69. Memo for Lt. Col. A. H. Herzog by Maj. H. C. McMillin, 29 July 1943, in AFIST files.

70. See syllabi in AFIST files; T. C. Memo 50-12-1, 22 Nov. 1943

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Neither was there a textbook on aerial navigation. Each navigation school determined the manner in which it would conduct the training prescribed by the officially adopted program of instruction and prepared its own syllabus and many of the other instructional materials used. Regardless of the merit or lack of merit in standardizing instruction in all the schools from the point of view of sound educational procedure, it was the unvarying policy of both AF Headquarters and the Training Command to try to effect such standardization.

As early as December 1941 a revised program of instruction was prepared, approved, and sent to the three training centers in an attempt to effect standardization.<sup>71</sup> Apparently this was ineffective, since a year later a navigation conference was held in the headquarters of the Flying Training Command to "standardize the navigation curriculum and to tie in the navigation program with preflight and bombardier training."<sup>72</sup>

Following the December 1942 navigation conference the 16-week program of instruction was approved and put into effect. But this program did little to effect standardization of instruction. The published program was broken down in a more detailed manner than previous programs, and it indicated procedures to a limited extent. It contained the provision, however, that it was to be "followed explicitly in the manner best suited to the local conditions and the equipment and other training

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- 71. TMO to CG of each TC, 2 Dec. 1941, in WIG 352.11H, Courses of Instruction.
  - 72. Project Book of CG, WFRC, Navigation Sec., 11 Dec. 1942.

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facilities available at the individual stations." In May 1943 the C/3, Training directed the Flying Training Command to take immediate steps to standardize the course of instruction. Nevertheless the remainder of 1943 passed without standardization being accomplished.

Standardization was contingent upon two conditions, neither of which existed prior to the fall of 1943 and one of which did not exist as late as April 1944. One of the factors which would have greatly facilitated standardization was a central navigation instructors school comparable to those for pilot and bombardier instructors. The processing of all navigation instructors through this type of school would have effected a marked degree of standardization of instruction. Also, such a school would have been the logical agency to coordinate the instructional materials of all navigation schools into a common textbook and syllabus. Not until October 1943 was a central navigation instructors school established. The other prerequisite for standardization called for a standard textbook, syllabus, and other instructional materials. Based on the official program of instruction, which was simply a full outline of topics to be taught, each navigation school prepared its own syllabus and other instructional materials, and no two were alike.

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- 73. T. C. Memo 50-12-1, 22 July 1943.
  - 74. C/3, Training to CG, AFMTC, 27 May 1943, in MAG 352.11, Navigation Schools.
  - 75. Memo for Brig. Gen. Robert M. Harper, thru Col. T. J. DuBose, by Capt H. C. McAlpin, 27 Aug. 1943, in AFMTC files; Daily Diary, AFMTC, 14 Dec. 1943.
  - 76. Project Book of CG, AFMTC, Navigation Sec., 4 Sep. 1943; Daily Diary, AFMTC, 22 Oct. 1943.
  - 77. Memo for Brig. Gen. Robert M. Harper, thru Col. T. J. DuBose, by Capt. H. C. McAlpin, 27 Aug. 1943, in AFMTC files.

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Pursuant to the directive from the A.C./S, Training of 27 May 1943 to the Flying Training Command, a committee composed of all the interested agencies, including a representative of the Central Instructors School (Bombarer), was assembled at Hitler Field for the purpose of preparing a textbook and a navigator's handbook.<sup>78</sup> This attempt proved abortive, and it appears that nothing was done until after the establishment of the Central Instructors School (navigator) at Selma Field in October 1943. In the following month the task of preparing a navigation handbook was assigned to this school, with little prospect of early accomplishment "due to a large number of higher priority projects at that school."<sup>79</sup> In December 1943 efforts at standardization were renewed. The instructors school was requested to examine the programs of instruction, training literature, and training aids in use at the various schools and to prepare a standard set of publications which would replace those issued by individual schools.<sup>80</sup>

After considerable work on the problem of standardizing the program had been done at the instructors school, a conference on the subject was held at Selma Field on 17-19 February 1944. The program submitted at this conference was not acceptable to all the schools, and a second conference was scheduled for 1 March 1944.<sup>81</sup>

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- 78. Daily Diary, -3 Div., AFFTC, 3 June 1943, in AFTRC files; CG, AFFTC to A.C./S Training, 23 June 1943, in AFCT files.
  - 79. CG, AFTRC to A.C./S, Training, 29 Nov. 1943, in AFTRC files.
  - 80. Daily Diary, AFTRC, 14 Dec. 1943; Project Book of CG, AFTRC, Navigation Sec., 17 Dec. 1943.
  - 81. Daily Diary, AFTRC, 11 and 23 Feb. 1944; memo for Col. A. M. Longmire by Capt. Walter E. Semon, Jr., 24 Feb. 1944, in AFCT files.

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Gunnery Training for Navigators

The original plans for navigation training contemplated flexible  
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gunnery as well as bombardier training for all navigators. But the ne-  
cessities growing out of the entry of the United States into war in  
December 1941 forced the abandonment of these second and third cate-  
83  
gories of training for navigators. Not until the spring of 1942  
could consideration be given to providing flexible gunnery training  
for navigators. This delay was occasioned both by the urgent demand  
for navigators and by the limited capacity of the flexible gunnery  
84  
schools, the first of which was not opened until December 1941.

The early combat experience of the AAF emphasized the urgent need  
of gunnery training for all members of bombardment crews. Consequently,  
by March 1942 navigator graduates were "scheduled" for five weeks of  
85  
training at flexible gunnery schools. Serious problems were encoun-  
tered, however, in giving this training. The shortage of navigators  
was acute, and the capacity of the gunnery schools was entirely in-  
adequate for the training of career gunners, to say nothing of providing  
such training for bombardiers and navigators. Because of the demand  
for graduate navigators, the only feasible procedure to be followed was  
to send navigator trainees to flexible gunnery schools either prior to  
or immediately following preflight training.

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- 82. R&R, No. 1, R&O to Plans, 15 July 1940, in AG 353.981, Training, General; Military Personnel to AG, 19 Nov. 1941, in AG 353.9, Specialized Training; AD Press Release, 5 Dec. 1941.
  - 83. Memo for AG by Military Personnel, 13 Dec. 1941, in AG 353.9, Specialized Training.
  - 84. Report, "Accomplishments of Army Air Forces Flying Training Command from July 1, 1941 to June 30, 1943," CG, AFTEC to CG, AAF, attn. AG/AS, Intelligence, 19 April 1943, in AFHQ files.
  - 85. Project Book of CG, AFTEC, Navigation Sec., 25 March 1942.

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In July 1942 it was decided that navigation students would be sent to gunnery schools prior to entrance into preflight training. This policy could not be followed in every case, and navigators were actually sent to gunnery schools at whatever stage it was expedient. At some times there was a surplus of navigation trainees awaiting assignment to preflight, while at others the backlog was between preflight and advanced training. In either case assignment to gunnery training was contingent upon vacancies in the flexible gunnery schools. On 27 July 1942 there were 4,300 students awaiting assignment to navigation preflight. Two months later there was a surplus of 646 preflight graduates, which number rose to 1,600 by 29 October. The status of preflight graduates shifted from surplus to shortage from month to month with the result that assignment to gunnery continued to be made on the basis of expediency. There were times, however, when bombardier and navigator quotas at the gunnery schools were suspended entirely because of the shortage or other types of runners.

By the first part of 1943 the capacity of the gunnery schools had been greatly expanded. The Flying Training Command therefore requested that a regular weekly quota be allotted for bombardier and navigator

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- 86. AFMTR to CG, AFITC, 27 July 1942, in AMG 353.93 Gunnery, Bombardiers.
  - 87. Ibia; AFMTR to CG, AFITC, 10 Aug. 1942, in Ibia.
  - 88. AFMTR to CG, AFITC, 27 July 1942, in AMG 353.93, Gunnery, Bombardiers.
  - 89. Daily Diary, -3 Div., AFITC, 29 Sep. 1942 and 29 Oct. 1942, in AFITC files.
  - 90. Daily Diary, -1 Div., AFITC, 7 Oct., 3, 9 Nov. 1942; 22 Jun., 20 Feb. 1943, in AFITC files.
  - 91. Daily Diary, AFITC, 20 Aug. 1942, in AMG 319.1-3, Daily Diaries.

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trainees. Effective on 24 May 1943 a quota of 1,200 bombardier-navigator preflight graduates every three weeks was established at the gunnery schools.<sup>92</sup> With the establishing of this quota the flow of navigation trainees to gunnery schools became stabilized. This training came after the preflight and prior to the advanced stage. The entrance dates of classes in the advanced navigation schools were adjusted in order to put the entrance dates of gunnery and navigation schools "in phase."<sup>93</sup>

It was the established policy to send all bombardier-navigator trainees to flexible gunnery schools as soon as the capacity of the latter schools became adequate. In accordance with this policy the bombardier-navigator quota at the gunnery schools was increased to 1,300 every three weeks, effective 15 July 1943.<sup>94</sup> In September 1943 it was expected that all bombardiers and navigators would be receiving gunnery training within the next six weeks.<sup>95</sup> In classes 43-17 to 44-4, 24 December 1943 to 18 March 1944, however, only about 50 per cent or the graduate navigators had received gunnery training.<sup>96</sup> On 29 January 1944 the Training Comptroller directed the three flying training commands to take all the necessary steps to see that all trainees entering advanced navigation schools after 10 June 1944 had gunnery.<sup>97</sup>

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- 92. AFMTR to CG, AFFTC, 10 Feb. 1943, in AFCT files; Daily Diary, AFFTC, 20 Feb., 20, 27 March 1943, in AG 319.1-3, Daily Diaries.
  - 93. CG, AFFTC to CG, AF, 14 April 1943; 1st Ind., AC/S, Training to CG, AFFTC, 19 April 1943, in AG 359.11, Navigation Schools.
  - 94. AC/S, Training to CG, AFFTC, 15 April 1943, in AFCT files.
  - 95. Memo for Brig. Gen. Edwin C. Merrin by AC/S, Training, 3 Sep. 1943, in AFCT files.
  - 96. Daily Diary, AFTRC, 31 Dec. 1943, 14 Jan., 10 Feb., 21 March 1944.
  - 97. Ibid.

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Navigators and bombardiers received preflight training at the same schools, and the quotas at the gunnery schools were for bombardier-navigator trainees. Navigators and bombardiers, however, were not sent to gunnery schools on an equal ratio. The ratio in August 1942 was 57 navigators to 43 bombardiers, though in at least one class the ratio was 98 to 27. Of all personnel receiving flexible gunnery training in August 1942, 13 per cent were to be navigators and 10 per cent bombardiers. By December 1942 the percentages for these categories of personnel were identical, being 14 per cent or 11,062 each. After December 1943 the percentage of bombardiers receiving gunnery training exceeded that of navigators. From December 1943 to March 1944, when about 50 per cent of graduate navigators had received gunner training, about 75 per cent of bombardiers had been so trained. This same general ratio was maintained when the bombardier-navigator quota at the flexible gunnery schools was increased to 1,300 every three weeks.

102

Advanced Navigation Training by PAA

Inauguration of PAA Training. The first specialized navigation training conducted under the CGAC was that conducted by the AF Flying Training Detachment at the Pan-American Airways, Inc., Coral Gables, Fla.

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- 98. AFIT to CG, AFTE, 10 Aug. 1942, in AG 353.9B, Gunners, Bombardiers; Daily Diary, AFTE, 22 Aug. 1942, in AG 319.1-3, Daily Diaries.
  - 99. RER, No. 2, AFIT to AFPLP, 29 Nov. 1942, in AG 353.9B, Gunners, Bombardiers.
  - 100. RER, AFIT-2 to AFPLP-1, 3 Dec. 1942, in AFCT files.
  - 101. See Daily Diary, AFTE, 31 Dec. 1943, 18 Feb., 21 March 1944.
  - 102. Project Book of CG, AFTE, Preflight Sec., 26 April 1943.

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As early as January 1936 it was proposed that the Air Corps utilize PAA's navigational experience and facilities for the training of Air Corps officers in aerial navigation. An officer at the Air Corps Tactical Center, Maxwell Field, after commenting on the national policy of defense, pointed out the necessity of going out over water to meet any enemy attacking the United States. For this reason it was necessary for the Air Corps to keep abreast of all known means and methods of aerial navigation. It was felt that the experience of, and training conducted by, the PAA in long over-water flights in the Caribbean and the Pacific could be utilized by the Air Corps. This officer suggested that the detaining of "a reasonable number of Air Corps officers to the PAA for a period of training and participation in some of their long flights . . . would be of inestimable value to the Air Corps." He asked  
103 to be considered for such an assignment.

The Chief of the Air Corps requested the comments of the Commanding General, CG Air Force on this proposal and also indicates that "a consensus of opinion of officers of the 19th Group who have had extensive  
104 experience in aerial navigation would be appreciated." The CG Air Force had only recently made arrangements for an officer of the 19th Group to fly one of the Pan-American flights from San Francisco to Manila, P. I., "for the purpose of observing and reporting the navigation  
105 methods of this company on long overwater flights." Apparently,

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103. Capt. James E. Parker to C/AC, thru channels, 24 Jan. 1936, in AAG 353.9.1, Training, General.

104. 2d Ind.(Capt. James E. Parker to C/AC, 24 Jan. 1936), C/AC to CG, CHQ AF, 31 Jan. 1936, in ibid.

105. 3d Ind., 24 Feb. 1936, in ibid.

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however, the idea of utilizing the PAA for navigation training of Air Corps personnel fell into abeyance until the spring of 1940.

The original plans of the Air Corps expansion program contemplated the training of navigators in specialized schools. The establishment of all types of specialized schools was retarded by the shortage of every means necessary for the accomplishing of such training. A year after the inauguration of the expansion program it was decided that navigation training could be economically and expeditiously accomplished by utilizing the facilities of the PAA. On 18 July 1940, therefore,  
106  
negotiate a contract for such training.

The agreement executed with PAA called for the training of 850 students, with an option to increase this number to 900. Instruction was to begin in August 1940 with classes enrolling every six weeks. The first three classes were to consist of 50 students each, after which time the size of classes would increase to 100 students. The course of instruction was to be of 12 weeks' duration with 50 hours allotted to flying time in Pan-American airplanes. The cost of training was to be  
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\$495 per student. This agreement was approved by General Arnold  
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on 20 July 1940. The training detachment was activated and instruction began on 10 August 1940. Of the 50 students who began training in August, 40 graduated on 12 November 1940. These were the first

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106. C/AC to AG, 19 July 1940, in AG 353.9, Navigation and Instrument Training. <sup>Mr. J. E.</sup>  
107. <sup>Mr. J. E.</sup> AG to Gen. H. H. Arnold, 24 July 1940, in AG 353.9, Specialized Training.  
108. Ibid.

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navigators graduated from training conducted under the auspices of the  
109 Chief of the Air Corps.

United Kingdom Training at Coral Gables. From August 1940 to March 1941 training at Coral Gables proceeded according to the original agreement. By 8 February 1941 the first two classes had graduated 91 students out of the 100 entered in these classes, and the size of entering classes was increased to 100 students instead of 50. In the following month, March 1941, an agreement was entered into with the British government whereby RAF classes would be trained at Coral Gables. The number of Air Corps students was to be reduced by the number of RAF cadets entered. In March and May groups of only 10 RAF cadets entered. Beginning in July, however, Air Corps students were reduced 110 to 50 per class to enable the RAF classes to be increased to 150. 111 British training continued until either July or August 1942. This training was scheduled to terminate in October with the first class of 200 RAF students to enter on 29 July 1942. It was 31 August, however, 112 before the first full contingent of RAF students began training.

Though three-fourths of the trainees at Coral Gables were British students, the Air Corps furnished all the equipment not required to be furnished by R.A.F. This arrangement was based on the understanding that

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109. "History of the Army Air Forces Flying Training Detachment, Pan-American Airways, Inc., Coral Gables, Florida, 1 August 1940-1 January 1943," 6, in AFTRC files; O Press Release, 10 Aug. 1940.

110. See Chart 1 following p. 23.

111. RG to CG, AFTRC, 20 May 1941, in A.G. 353.0B2, Training General.

112. Project Book of CG, AFTRC, Revision Sec., 1 Aug. 1942; History of LF Training Detachment, Coral Gables, Fla., 12, in AFTRC files.

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the Air Corps would use all the training facilities then not in use by the British, who were required to give three weeks' notice of the number of students to be entered.<sup>113</sup> This arrangement appears to have been the cause of a misunderstanding as a result of which the Commanding General of the Southeast Training Center ordered the commanding officer of the Air Corps attachment to assume complete supervision over all trainees, including the RAF students. When it was also clear that British training was conducted under a separate contract and was distinct from Air Corps training, the commanding officer was ordered to relinquish control over the RAF students.<sup>114</sup>

Program of Instruction. Instruction at Coral Gables began with a course of 12 weeks' duration. When the 15-week program was put into effect in Air Corps schools in February 1941, it was also adopted at Coral Gables.<sup>115</sup> The program at Coral Gables, however, consisted of 356 hours of allotted time in contrast to the 449 hours in Air Corps schools. A comparison of time allotted to the various phases of instruction is indicated below:<sup>116</sup>

	Coral Gables	Air Corps Schools
Ground training	240 hours	253 hours
Air training	50 "	81 "
Meteorology	60 "	65 "
Allied training	—	50 "
Total hours	356	449

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- 113. CG, SEATC to CO, AC Training Detachment, Coral Gables, 2 Oct. 1941, in AG 353.9G1, Training, General.
  - 114. CG, SEATC to CAC, 17 Sep. 1941; TAO to CG, SEATC, 23 Sep. 1941; CG, SEATC to CO, AC Training Detachment, 2 Oct. 1941, in ibid.
  - 115. Director of Navigation Sec., PAA to Capt. O. L. Henderson, CAC, 15 April 1941, in AG 353.9, Navigation Training.
  - 116. Ibid.

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Instructors at Coral Gables were civilians employed by the P.M. company.

The number of aircraft used in training was very limited. "The maximum amount of aircraft used by the detachment has been 4 Commandos  
117 and one Sikorsky S-40 in training 250 men at one time." The AF  
118 did not supply any trainer aircraft for the school.

Training at Coral Gables had not been under way very long before its effectiveness was questioned. About 1 February 1941 the CGC indicated weaknesses in the instruction. Obviously all phases of the program were considered inadequate since the questions raised dealt with all types of navigation--dead reckoning, celestial, and radio.

The P.M. company was reluctant to make any changes in its own course of  
119 instruction in order to make it conform to that in Air Corps schools.

In June 1941 the Training and Operations Division of the CGC requested comments and suggestions from the tactical organizations on the proficiency of school graduates. Since only 10 graduates of the Air Corps schools were then on duty with tactical units, most of the deficiencies  
120 indicated were applicable to the graduates of Coral Gables.

In commenting on the reports from the tactical units, the Director of Training of the navigation school at Turner Field indicated that the instruction at Coral Gables did not "fulfill the requirements of the

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- 117. History of AF Training Detachment, Coral Gables, Fla., 15, in AFTRC files.
  - 118. CG, AFTRC to CG, AFTRC, 8 July 1942, in AG 353.9, Navigation and Instrument Training.
  - 119. Director of Navigation Sec., P.M. to Division Manager, Eastern District, P.M., 19 Feb. 1941, in ibid.
  - 120. 3d Ina. (TO to CG, AFTRC, 27 Aug. 1941), 20 Sep. 1941, in AG 353.90, Training, General.

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"Air Corps." To remedy this condition, Turner Field gave a supplementary course to the graduates of Coral Gables who were assigned as instructors at this school. In order to correct as many as possible of the deficiencies at Coral Gables, a navigation instructor was sent there to effect certain desired changes in the program of instruction. It was recognized, however, that the basic difficulty was not in the program of instruction itself, but was the limitation in personnel and equipment. There were only 50 hours of air training in the program at Coral Gables as compared with 100 hours given in Air Corps schools. Since there could be no substitute for adequate air training, which could not be conducted at Coral Gables because of the shortage of trainer aircraft, it was recommended that the "training of all navigators for the Army Air Forces be accomplished in schools operated by the Air Corps."<sup>121</sup>  
<sup>122</sup>

During November and December 1942, when the new 12-week program was being prepared, the Flying Training Command recommended that the air training at Coral Gables be increased to 60 hours. The new program of instruction was made applicable to the school at Coral Gables upon condition that the size of classes be increased by 50 students and that no increase in flying time be made.<sup>123</sup> As late as September 1943 the problem of bringing the training at Coral Gables up to standard

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121. Ibid.

122. 5th Ind., CG, SMCFC to C/13, 20 Sep. 1941, in Ibid.

123. CG, FFTC to CG, AFM, attn. FFI 1 thru AFM 7, 20 Nov. 1942, in AG 352.11, Navigation Schools.

124. AFM, AFM 7 to FFB, FFM 3, and FFB 0, in turn, 24 Nov. 1942, in AG 353, Navigation Training; AFM 7 to CG, FFTC, 7 Dec. 1942, in AFMCT files; C/13, Training to CG, FFTC, 27 May 1943, in AG 352.11, Navigation Schools.

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has not been solved. Air training was still limited to 50 hours, and with nearly 500 students under instruction, there were only five "flying boats" available for training purposes. All flights were over water, were flown from the one and only base available, and never exceeded 250 miles. This reduced down reckoning training to a minimum and allowed 125 no training on piloting.

By April 1944 steps had been taken to remedy one of these problems, that of the length of the air training missions. Flight training regulations of the AAF prohibited flights to destinations outside the United States. In November 1943 the commanding officer at Coral Gables requested special permission to make training flights to Cuba. 126 Permission to perform such flights was given on 30 March 1944. 127

Since the training at Coral Gables could not be due to parallel that conducted in the AAF schools, some felt that the graduates were not adequately qualified for assignment to bombardment units. In April 1942 the Directorate of Bombardment informed Individual Training: "It is desired that all the navigators for the Army Air Forces come from the output of the Army Air Forces schools in the training centers other than the Pan-American School at Miami." It was indicated that 128 all Coral Gables graduates would be available for the Ferry Command.

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- 125. CG, AFTRC to C/S, Training, 11 Dec. 1943; 2d Ind. (CO, Coral Gables to CG, AFCTIC, 29 Nov. 1943), 13 Jan. 1944, in FCT files.
  - 126. CO, Coral Gables to CG, AFCTIC, 29 Nov. 1943, in FCT files.
  - 127. 6th Ind. (to same), C/S, Training to CG, AFTRC, 30 March 1944, in FCT files.
  - 128. DR, AFTRC to AFMT, 20 April 1942, in AG 353.9B, Navigation Training.

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A year later the Flying Training Command requested "blanket authority" to assign graduates of Coral Gables only to the Air Transport Command. Navigators for the Air Transport Command and the Troop Carrier Command did not require either gunnery or bombardier training. The AC/IS, Training authorized the assignment of Coral Gables graduates to these two commands "in numbers up to the monthly quotas assigned these Commands." <sup>129</sup>

In view of all the problems encountered with the navigation training conducted by FAI, the Training Command considered plans to discontinue this training. In December 1943 the Central Flying Training Command was requested to ascertain the possibility of increasing the size of navigation classes in the AAF schools in order to discontinue, without loss of graduates, training at Coral Gables as of 30 June 1944. <sup>130</sup> In January 1944, however, navigation requirements were such that the above proposal was abandoned. <sup>131</sup> It seemed unlikely that such training would continue after the summer of 1944, and on 3 June 1944 the AC/IS, Training informed the Training Command that neither it nor FAI "desired to renew the contract." AAF navigation schools were to expand facilities to make up the loss in production occasioned by the termination <sup>132</sup> of training by the FAI company.

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- 129. CG, FFTC to AC/IS, Training, 19 April 1943; 1st Ind., 28 April 1943; CG, FFTC to AC/IS, personnel, 11 June 1943; 1st Ind., 23 June 1943, in FFTC files.
  - 130. Daily Diary, FFTC, 14 Dec. 1943.
  - 131. Daily Diary, FFTC, -3 Div., 24 Jun. 1944, in FFTC files.
  - 132. Daily Diary, Individual Training Div., AC/IS, Training, 3 June 1944, in AFHQ files.

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Chapter V

DUAL TRAINING OF BOMBARDIERS AND NAVIGATORS

From the beginning of specialized navigation and bombardier training it was deemed desirable to train these specialists in dual capacities. The need for such training was realized more clearly as a result of combat experience, the difficulties encountered in meeting the enormous demands for trained personnel, and the requirements resulting from the development of new types of combat aircraft. It became increasingly necessary to utilize the full capabilities of air-crew personnel. There was also the necessity of keeping the size of combat crews at a minimum in order to maintain the maximum pay load of bombardment aircraft. The necessity of keeping the size of crews at a minimum was especially applicable to medium bombardment planes. The need for a crew member who could function as alternate or substitute navigator or bombardier was especially applicable to heavy and very heavy bombardment airplanes, the range of which steadily increased.

There were numerous difficult problems encountered in the dual training of navigators and bombardiers. The first problem faced was the necessity for tactical units to carry on their activities with an inadequate number of school graduates while new graduates were given the second type of training. Another difficulty was in deciding which category of training should be given first. There was also the necessity of selecting personnel capable of becoming proficient in two

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specialties and maintaining the proficiency formerly acquired while undergoing the second type of training. Still another question was whether or not to convert all bombardier and navigator schools to complete dual training establishments or to retain them as established and send the graduates of one type of school to the other for the second category of training. Of lesser importance perhaps was the problem of when to commission trainees. Should they receive commissions at the conclusion of the first type of training, or after completion of both phases of dual training? The task was still further complicated when a requirement for a third phase or type of training was established--radar.

Early Plans and Development, 1941

The original instructions calling for the dual training of navigators and bombardiers were issued on 5 September 1941.<sup>1</sup> Such training was contingent, however, upon maintaining the required flow of both types of specialists to the tactical units. There was to be no return<sup>2</sup>ation of this flow until 945 navigators and 1,363 bombardiers had been trained. Navigation and bombardier schools were to be gradually integrated, and the annual training rate was to be reduced from 4,635 navigators and 5,590 bombardiers to 5,590 bombardier-navigators. Combined training was to be conducted in a 45-week course of instruction which was divided into four stages. The first 10 weeks were to be devoted

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1. A3 Diary, 8 Dec. 1941, in AFMHI files.
  2. RAE, No. 1, 3/1 to C/AC, 26 Sep. 1941, in AG 353.9, Specialized Training.

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to preflight training, the second stage of 15 weeks to navigation training, the third stage of 12 weeks to bombardier instruction, the fourth stage of 5 weeks to flexible gunnery, and 3 weeks were allowed for travel time between schools.<sup>3</sup> The first class scheduled for dual training entered the reception centers on 1 November 1941 and was scheduled to graduate on 1 August 1942.<sup>4</sup>

The shortages which existed in virtually every category of trained personnel were greatly accentuated upon the entry of the United States into the war. It was necessary to abandon the program of dual training as one of the many steps taken to expedite the flow of individually trained specialists to the tactical organizations. On 8 December 1941 the instructions of 5 September 1941 were rescinded, and a complete revision was made of "course procedure, qualification requirements,<sup>5</sup> and ratings of graduates." Navigation training reverted to its original basis until in mid-1942 Brig. Gen. J. H. Doolittle recommended that bombardier-navigators be trained for use in medium bombardment.<sup>6</sup>

#### Revival of Plans and Beginning of Training

Reasons for Beginning Dual Training. The deciding factor in reviving plans for dual training was the shortage of bombardiers and navigators. The production of these specialists was inadequate to meet the needs of tactical units until the end of 1942 in the case of bom-

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- 3. Press Release, 5 Dec. 1941.
  - 4. MR, No. 6, MO to AFM, 6 Nov. 1941, in AG 353.9, Specialized Training.
  - 5. A-3 Diary, 6 Dec. 1941, in AFM files; memo for AG by AFM, 13 Dec. 1941, in AG 353.9, Specialized Training.
  - 6. MR, AFM to AFM, 5 July 1941, in AG 353.93, Bombsight Training.

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bardiers and the end of 1943 in the case of navigators.<sup>7</sup> The equipment and employment of medium bombardment airplanes made it feasible to inaugurate certain types of dual training for personnel to be assigned to these units. Most of this type of aircraft were equipped with non-precision bombing. Therefore, celestial navigators could be given a relatively short course in bombing with the D-S bombsight and be qualified to perform the dual role in medium bombardment crews. Also, since the range of medium bombardment aircraft was not as great as that of heavy bombardment, it was possible to use bombardiers proficient only in dead reckoning navigation in the airplanes equipped with precision bombsights.<sup>8</sup>

The Directorate of Bombardment referred General Doolittle's recommendation to Individual Training which in turn requested comments and recommendations from the Flying Training Command as to the feasibility of conducting such training. The command recommended continuing the existing program on the grounds that bombardiers and navigators in medium bombardment units needed to be as proficient as those in heavy units and that dual training would cut bombardier and navigator production by half. If such training were to be conducted, it should be performed in the operational training units.<sup>9</sup> On the same day that the command registered this objection to dual training, the Directorate

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7. RMR, AFIT to FDR, 19 Feb. 1943, in MG 352.11., Courses of Instruction; CG, 2d F to CG AF, attn: AFIT, 5 March 1944, in AFIT file.
  8. 1st Ind. (basic unknown), CG, AFIT to AFIT, 16 July 1942, in MG 353.92, Bombsight Training.
  9. AFIT to CG, AFIT, 6 July 1942, in ibid.
  10. 1st Ind. (basic unknown), CG, AFIT to AFIT, 10 July 1942, in ibid.

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of Military Requirements informed the Third Air Force, which conducted virtually all medium bombardment operational training, that until the existing shortage of bombardiers and navigators was alleviated, the crew for this type of aircraft would be reduced from seven to six by combining the functions of bombardier and navigator.  
<sup>11</sup>

The decision to conduct dual training, it was explained, was not calculated to "increase operating efficiency" but was dictated by the shortage of separate specialists. Dual training had to be performed if the medium bombardment units were to continue to operate. Also, priority of precision bombsights and precision-trained personnel was given to heavy bombardment. As a result, it was impossible for medium units to conduct precision bombing, regardless of training, and it was imperative that bombardier-navigators be trained who would be proficient "in the operation of D-3 bombsights, map reading, pilotage, and dead reckoning navigation."<sup>12</sup> This type of training was considered as only temporary.<sup>13</sup> Since the shortage of either bombardiers or navigators, or both, continued, the situation was largely met by incorporating dead reckoning navigation into the regular bombardier course in the summer of 1943. Until this was done, however, three types of dual training were conducted to meet the most immediate needs. One consisted of giving D-3 bombardier training to graduate navigators, while another was to give dead reckoning navigation to graduate bombardiers. The Third

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11. AFMTR to CG, 3d AF, 16 July 1942, in ibid.

12. RMR, AFMTR to AFMTR, 10 Aug. 1942, in ibid.

13. 1st Ina. (AG, 3d AF to CG, AF, 6 Sep. 1942), AFDB to CG, 3d AF, 16 Sep. 1942, in AG 353.9, Training, General.

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procedure was to send a limited number of bombardiers and navigators through the complete course in both specialties. The purpose of this last procedure was to provide a limited number of completely dualy trained personnel for the first superbombers and to utilize the experience gained to ascertain the best plans for conducting dual training.

Navigator/D-3 Bombardier Training. As early as August 1942 the Directorate of Bombardment indicated the necessity of establishing schools for the special purpose of conducting dead reckoning navigation and non-precision bombardier training.<sup>14</sup> On 25 August 1942 the Flying Training Comma<sup>15</sup>nd was directed to select one of the bombardier schools which was scheduled to open in the following month and use it for D-3 bombardier training. The bombardier school at Carlsbad, N. M.<sup>16</sup> was selected, and training began on 3 October 1942. From October through December 1942, however, the trainees in this course, though trained to meet Third Air Force requirements, were not graduate navigators, but flexible primary graduates.

The desirability of having the navigators assigned to the Third Air Force proficient in the use of non-precision bombsights was pointed out at the time training at Carlsbad was inaugurated.<sup>17</sup> It was decided to begin such training in December, and the first class of graduate navigators to begin D-3 bombardier training at Carlsbad began instruction

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- 14. MR, AFNDB to AFTR, 10 Aug. 1942, in *ibid*.
  - 15. AFIT to CG, AFTEC, 25 Aug. 1942, in AFCT files.
  - 16. Daily Diary, AFIT, 23 Sep. 1942, in AG 319.1-3B, Daily Diaries.
  - 17. AFIT to CG, AFTEC, 2 Oct. 1942, in AFCT files.

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on 28 December 1942. The D-3 training for turnover had been terminated on 19 December 1942. This was not considered an established type of training and only two classes, graduated in January and February 1943, were given this three weeks' training.

Bombardier-Dead Reckoning Navigator Training. In January 1943 the decision was made to change from the policy of training graduate navigators as D-3 bombardiers and to train graduate bombardiers as dead reckoning navigators. This was the more profitable policy since 75 per cent of the bombardiers and navigators assigned to the Third Air Force were bombardiers. This reduced the amount of on-the-job training to be accomplished by the Third Air Force though navigators still had to be trained as D-3 bombardiers, and the bombardiers not trained at Carlsbad had to be given dead reckoning navigation by means of on-the-job training. The Third Air Force requirement for bombardiers with dead reckoning training from March through December 1943 was approximately 2,400. A total of 1,491 graduates of the six-week course at Carlsbad was produced by the end of August.

In the meantime the regular bombardier course had been converted to bombardier-dead reckoning navigation. From October through December 1943 a total of 1,475 trainees graduated from this course, rating

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18. Consolidated Flying Training Report, AFFIC, Dec. 1942.
  19. Ibia; M&I, No. 2, FMIT to FADP, 30 Nov. 1942, in AFM files.
  20. M&I, Nos. 1 to 5, FMIT to FADP, etc., 4-15 Jan. 1943; FMIT to CG, AFFIC, 11 Jan. 1943, in AFG 353.01, Training, General.
  21. FMIT to CG, AFFIC, 17 Feb. 1943, in Ibia.
  22. See chart 2 following this page.
  23. AC/3, Training to CG, AFFIC, 14 April 1943, in AFG 353.01, Training Schedule and Directives.

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PRODUCTION OF COMPUTER-aided NIGHTING NAVIGATORS

	<u>Grads this month</u>	<u>Grads to date</u>
April 1943	209	209
May	98	307
June	450	823
July	217	1,040
August	451	1,491
September	0	1,491
October	232	1,723
November	279	2,002
December	964	2,966
January 1944	565	3,531
February	1,414	4,945
March	1,007	6,012
April	2,045	8,057

Source: Consolidated Flying Training Reports (monthly), prepared by HQ., FFTC (FTTC).

CHART 2

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a total of 2,906 bombardiers trained as dead reckoning navigators.<sup>24</sup>

Another anticipated source of this category of personnel was the graduate bombardiers eliminated from the celestial navigation course.<sup>25</sup>

Experience proved, however, that most of such eliminations occurred before the dead reckoning phase of navigation was completed. Nevertheless, it was decided in March 1943 that trainees who had completed as much as nine weeks of ground school and 44 hours of flight missions before elimination would be given certificates of proficiency as dead reckoning navigators.<sup>26</sup>

#### Beginning or Complete Dual Training

The third type of dual training was that of training bombardiers as celestial navigators and navigators as precision bombardiers. The complete dual training of bombardiers and navigators was recommended in July 1942. In order to inaugurate the training it would have been necessary to deny graduates of one of the specialties to the tactical organizations while those specialists were undergoing the second category of training. At that time the tactical organizations could not forego these graduates. Requests from the combat theaters for usually trained personnel<sup>27</sup> and approaching delivery of the superbombers made

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- 24. See Chart 2 following p. 116.
  - 25. R.R., No. 2, AFMDS to AFMFT, 15 Jun. 1943, in AG 353A, Bombsight, Gunnery Training.
  - 26. CG, AFMTC to AFMFT, 11 March 1943; 1st Ind., 15 March 1943, in FACT files.
  - 27. Report, CG, 7th AF to CG, AF, 21 Oct. 1942, in AG 353.4F, Training, General; Cable, CG, South Pacific Area to G/AF, Training, Message No. S12, 18 April 1943, CH-II-10880, in AF Message Center.

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It imperative that at least a beginning of such training be made.

In order to provide personnel for the first B-29's and to acquire experience as a basis for future training, small groups of bombardiers and navigators were entered in dual training in the fall of 1942. Fifty-three bombardiers were entered in navigation training in October and 20 navigators in bombardier training in November 1942.  
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With training already initiated on a limited scale, the Flying Training Command was requested to make a study of the production of usually trained men, submit proposals for accomplishing the objective, and prepare a program of instruction for such training. The plan submitted by the command provided for sending graduate navigators to a bombardier school in groups of 150 every three weeks, the bombardier course being shortened to nine weeks. This plan would mean that tactical units would lose 450 navigators during the first nine weeks of such training. An alternate plan was to give graduate navigators a three-week course in D-3 bombardier training at Carlsbad. It was pointed out that a more accurate evaluation of the program could be made at a conference following the graduation of the experimental classes then  
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in training.  
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The Flying Training Command's plan was not concurred in by the Directorate of Bombardment because of the loss of navigators for nine weeks. As a transition program it was requested that the needs of

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28. See AF Historical Studies: i.e. 5, Individual Training of Bombardiers, 70-77.
  29. Daily Diary, AFPC, 7, 16 Oct. 1942, in AF 319.1-3, Daily Diaries.
  30. AFIT to CG, AFPC, 21 Oct. 1942, in AFACI files.
  31. 1st Ina. (AFIT to CG, AFPC, 26 Oct. 1942), 10 Nov. 1942, in AFOT files.

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medium bombardment be met by giving D-8 bombardier training to graduate  
32 navigators and dead reckoning navigation to graduate bombardiers. It  
was decided to conduct the two types of training at Carlsbad and to  
continue to send graduate bombardiers to the navigation schools in  
33 order not to disturb the flow of navigators to tactical units. From  
a training point of view it was the consensus of opinion that graduate  
navigators should be sent to bombardier schools rather than vice versa.  
It was estimated that sending navigators to bombardier schools would  
result in increasing the navigator shortage for 1943 by 2,600, making  
34 a total shortage for the year of 5,700. None of the plans for dual  
training contemplated sending all navigators through the bombardier  
course. The navigators assigned to the Air Transport and Troop Carrier  
Commands did not require bombardier training. This was an additional  
35 reason for having navigation training precede bombardier training.

Dual Program Launched

Plans were made to begin delivering bombardier-navigators to the  
tactical units in June 1943. The Directorate of Bombardment requested  
Individual Training to inaugurate training in January 1943 to meet the  
36 requirements for June and subsequent months. The requirements for  
June, July, and August, and estimated requirements for the remainder

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- 32. R&R, No. 2, AFRDB to AFRIT, 26 Dec. 1942, in AFFACT files.
  - 33. R&R, No. 3, AFRIT to AFRDB, 9 Jan. 1943; R&R, No. 4, AFRDB to  
AFRIT, 20 Jan. 1943, in AFFACT files.
  - 34. R&R, AFRIT to AFDMR, 24 Oct. 1942, in AFFACT files.
  - 35. R&R, No. 1, AFRDB to AFDMR thru AFRIT, AFPMF, AFFACT, and AFAAP,  
30 Sep. 1942, in AFFACT files.
  - 36. R&R, No. 1, AFRDB to AFRIT, 27 Nov. 1942, in AFIHI files.

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or 1943, as anticipated in November 1942, were as follows:

June . . . . .	1,332
July . . . . .	1,495
August . . . . .	1,417
September . . . . .	1,391
October . . . . .	1,440
November . . . . .	1,490
December . . . . .	1,505

In addition to these requirements for dually trained personnel, total navigator production had to be increased in order to meet the demands of the Air Transport, Troop Carrier, and Flying Training commands.

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The Directorate of Individual Training took steps in December 1942 to select the bombardier graduates who could be expected successfully to complete the course in navigation.<sup>38</sup> Difficulties were not anticipated since there was expected to be a surplus of bombardiers in the early months of 1943. By selecting those with the higher navigation aptitude scores, it was believed that such trainees could pass the navigation course. The Flying Training Command preferred to select only those students with a navigator stanine of six or better. When directed to choose those with a score of five or better, the command found that approximately 50 per cent of the bombardier graduates could

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37. Ibid. The requirements for bombardier-navigators were scaled down considerably in January 1943. See Individual Training of Bombar-  
diers, 72.
38. MR, AFMTR to AFMIS, 6 Dec. 1942, in AFCT files.
39. MR, No. 3, AFMTR to MFT C, 27 Dec. 1942, in AFCT files.

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quality for navigation training. This was more than could be accommodated in the navigation schools, and the surplus, above the requirements of the using agencies, was sent to gunnery schools.

During January and February 1943 groups of bombardiers were assigned to navigation training. In the meantime all the pros and cons on the many problems involved in such training were evaluated. The most important of these problems were: maintenance of the bombardier's proficiency while undergoing navigation training; the possibility of reducing the bombardier course to nine weeks due to lengthening the navigation course to 18 weeks and the fact that some instruction was common to both courses; whether to commission trainees upon completion of the bombardier phase or upon completion of dual training; and the feasibility of sending navigators to bombardier training rather than vice versa. While all of these problems were under discussion by all of the interested agencies and after the first group of dual trainees had graduated, the former Director of Bombardment called in question the entire program. All of the advantages and difficulties of such training were clearly delineated in the ensuing correspondence, but the decision to conduct such training remained unchanged.

By the end of March 1943 a total of 90 men had been graduated from dual training, and by the end of May this number had increased to 432.

40. R.R., Nos. 1 to 6, between AFIT and WFTC, 7 Dec. 1942 to 5 Feb. 1943; AFIT to CG, WFTC, 7 Dec. 1942, and Inds., in MG 353A, Bombardier, Gunnery Training.

41. See Individual Training of Bombardiers, 86-89, for a more detailed treatment of these issues.

42. Ibid., 89-92.

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On the basis of the experience gained in this training and the numerous proposals which had been made, several changes in the dual training program were effected during the spring and summer of 1943. In April a plan was worked out whereby bombing equipment and experienced bombardier instructors were transferred to the navigation schools. This enabled bombardiers undergoing navigation training to get a refresher course while in the navigation schools.

From the early experience in dual training it was clearly demonstrated that the navigation phase should precede the bombardier phase. In the first group of trainees none of the navigators had been eliminated from the bombardier course, whereas 14 of the 53 bombardiers taking navigation training were eliminated.<sup>43</sup> It appears, however, that not all of the difficulties encountered in training bombardiers as navigators were due to the greater difficulty of the navigation course. There were at least two other reasons. Officers who had graduated from one category of training were usually anxious to proceed with their operational training and thence to combat. These men often resented having to go through another course of dual training. Also, there is some evidence that bombardiers were sometimes subjected to ostracism at the navigation schools.<sup>44</sup> To alleviate those conditions as much as possible, the Flying Training Command directed that "in so far as possible" no bombardiers be sent to navigation schools unless

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43. Daily Diary, AFTC, A-3 Div., 13 April, 18 May 1943, in AFTRC files.  
44. Daily Diary, AFTC, 7 Jun. 1943, in AF 319.1, Daily Diaries.  
45. Conversations by the writer with various persons at AF bombardier schools; AF/AS, Training to CG, AFTRC, 16 March 1944, in AFCT files.

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they desired such training.

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The several advantages of offering the navigation course first caused the Flying Training Command to recommend, in April 1943, that graduate navigators be sent to a six-week bombardier course, with reliance on CTU and ETU training to increase the bombing proficiency of  
47 such individuals. But the continuing shortage of navigators precluded  
48 the adoption of this policy. Finally, however, in July 1943 the flow  
of dual training was reversed, and bombardiers were no longer sent to  
49 navigation schools. Such training was discontinued on 1 August 1943,  
and one of the bombardier schools, Roswell, was devoted entirely to  
training graduate navigators as bombardiers. Classes of 150 were  
entered every three weeks in a nine-week bombardier course. This type  
of training at Roswell was initiated on 11 September 1943.  
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By April 1943 it had become obvious that individual bombardier and navigator training could not be converted to dual training if production requirements were to be met. Only a portion of these specialists could be given dual training. It was consequently decided that the most efficient distribution of bombardiers, navigators, and bombardier-navigators would be as follows: for heavy bombardment, one celestial navigator and one precision bombardier proficient in dead reckoning navigation and "capable of acting as assistant navigator"; for very heavy bombard-

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46. Daily Diary, AFFTC, 27 May 1943, in AG 319.11, Daily Diaries.
  47. CG, AFFTC to AG/C, Training, 10 April 1943, in FIEI files.
  48. 1st Inu. (to same), AG/C, Training to CG, AFFTC, 15 April 1943, in FIEI files.
  49. AG/C, Training to CG, FTB, 21 July 1943, in AG 353A, Bombardier and Navigation Training.
  50. Project Book of CG, FTB, 4 Sep. 1943.

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ment, two completely qualify trained bombardier-navigators; and for medium bombardment, one completely qualify trained officer for 25 per cent of such crews and one bombardier-dead reckoning navigator for 75 per cent of the crews.<sup>51</sup> These crews require units necessitated the training of all bombardiers as dead reckoning navigators. The Flying Training Command was therefore authorized to extend the bombardier course of instruction to 16 weeks and to incorporate dead reckoning navigation in the program.<sup>52</sup> All the bombardier schools were converted to the new program between June 1943 and December 1943.<sup>53</sup>

In October 1943 the status of dual training was that all the bombardier schools, except Rockwell, trained bombardier-dead reckoning navigators for all heavy bombardment crews and 75 per cent of the medium bombardment crews. All of the navigation schools were charged in the production of navigators for heavy bombardment, Air Transport Command, and Troop Carrier Command crews, instructors for training college schools, and graduate navigators for assignment to Rockwell for completion of dual training. The latter school was charged with the mission of completing the training of one of the most critical categories of personnel in the AAF. Graduates of this school were to be used as bombardier-navigators in the D-29 program and as lead bombardiers in medium bombardment crews.<sup>54</sup>

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- 51. AC/AS, Training to CG, AFTC, 14 April 1943, in MG 353.01., Training Schedules and Directives.
  - 52. Ibid.
  - 53. Project Book of CG, AFTC, Bombardier Sec., 15 Nov. 1943; F. T. C. Memo 50-11-1, 16 June 1943.
  - 54. AC/AS, Training to CG, AFTC, 15 Nov. 1943, in MG 353, Bombardier Training.

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With the graduates of Roswell "in every case destined for a most important position in the Air Crew," every effort was made to see that trainees and instructors in that school were the very best. In November 1943 the AG/AS, Training, requested a serial report on the first class at the school. The comprehensive proficiency, number of trainees and reasons for elimination, and an evaluation of the nine-week course were requested. It was further requested that the most careful screening of personnel for this course be made and that only those navigators who volunteered and were "extremely desirous" of becoming bombardier-navigators be assigned to this training.

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In reply, the Training Command reported that the first class, which graduated 13 November 1943, was not made up of the most desirable students. Later classes were expected to be proficient in every respect.

56

In the first class of 150 students, 50 were held over and 15 eliminated.

57

The length of the course was considered too short, and its extension to 12 weeks was requested. The additional three weeks were to be used to steep down the rapid slope of the course and to make possible the scheduling of missions "for the exclusive purpose" of maintaining navigator proficiency.

58

On 11 December 1943 the extension of the course to 12 weeks was authorized.

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- 55. Ibid.; Daily Diary, FMB, 24 Nov. 1943.
  - 56. See Report of Flying Training Students, Sep. 1943, in AFHQ files.
  - 57. The report of flying training students mentioned 56 were graduated and 15 eliminated.
  - 58. CG, AFMAG to AG/AS, Training, 3 Dec. 1943, in AFCT files.
  - 59. FMB, AG/AS, Training to CG, AFMAG, 11 Dec. 1943, in AFCT files.

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EXECUTION OF EC-B. ATLANTIC ROUTE

	<u>This month</u>	<u>To date</u>
January 1943	59	59
February	2	61
March	29	90
April	4	94
May	333	432
June	254	686
July	241	927
August	201	1,128
September	5	1,133
October	0	1,133
November	62	1,215
December	149	1,364
January 1944	152	1,516
February	252	1,798
March	151	1,949
April	139	2,088

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Source: Consolidated Flying Training Reports (monthly), prepared by  
Eq., AFFTC (AFTC).

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The B-29 Program and Dual Training

Requirement into an Early Training for the B-29 Group. One of the principal objectives of dual training is to provide bombardier-navigators for the super bombers, of which the first to go into operation was the B-29. The crew requirements for this type of aircraft called for two completely qualify trained bombardier-navigators, the primary condition being for two officers qualified as navigators. The first XB-29 was delivered on 31 December 1942, nearly a month before the first group of 59 completely qualify trained men graduated. The first YB-29 was delivered on 31 July 1943, by which time 927 such men had been trained. By the time the first production model of the B-29 was delivered, on 21 September 1943, 1,133 bombardier-navigators had been produced. Consequently, training was ahead of us and as far as the B-29 program was concerned. Priority on such personnel was given to the B-29 program up to 25 per cent of medium bombardment crews. It appears that most of the product of dual training went to the medium bombardment units during the first year of dual training.

Radar-Bombardier-Navigator Training. With the flow of graduates from Roswell beginning in November 1943, indications were that the bombardier-navigator courses of the B-29 program would be adequately met. Within four months, however, the entire program of complete dual training was indefinitely suspended. This was the result of developments

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60. R.R. No. 1, AFMB to AFIT, 10 Sep. 1942, in AFIT files.  
61. AFMB, B-1, Daily Aircraft Acceptance and Delivery Report,  
21 Sep. 1943.  
62. R.R. No. 2, AFMB to AFIT, 26 Dec. 1942, in AFIT files.

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which brought about training requirements beyond the productive capacity of the schools and possibly beyond the capacity of trainees to attain proficiency. The first factor was the addition of rear training to dual training requirements. Rear equipment applicable to navigation and bombing had been developed to the point where training on such equipment was necessary for bombardiers and navigators. It was essential that navigators be trained to proficiency in the operation of rear beacons, the Loran receiving system, GEE (the British equivalent of Loran), and "other Rear Navigation Aids."<sup>63</sup> For a number of years research and experimentation in BTU (bombing through overcast) had been conducted. By the end of 1943 it seemed that the rear bombsight had become the answer to this long search. Consequently, it was necessary for bombardiers to be trained in the use of rear blind bombing aids (H2X) or N/EP-13 and NYAF-15.<sup>64</sup> Additional training in rear was therefore scheduled for the dually trained personnel who were assigned, or were to be assigned, to the B-29 organizations.

On the same day that the first B-29 was delivered, the AC/13, Training informed the Training Command that the dually trained personnel earmarked for B-29 organizations, except those for the 58th Wing, should be sent to the AF technical school at Boca Raton, Fla. for training on rear equipment N/EP-13 (rear bombsight or H2X).<sup>65</sup> This training was scheduled to begin at Boca Raton on 13 December 1943 for

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63. Daily Diary, AFTRC, A-3 Div., 29 Nov. 1943, in AFTRC files.

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65. AC/13, training to CG, AFTRC, 21 Sep. 1943, in AC 353, Bombsight and Navigation Training.

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the graduates of Roswell.<sup>60</sup>

As this was a new type of training, it was difficult to decide exactly what personnel should be trained and what training agency should be responsible for the training. The decision in September 1943 was to train bombardier-navigator graduates as radar bombardiers, at Boca Raton.

In November the Training Command requested the Eastern Technical Training Command to retain the instructor personnel necessary for such training.<sup>61</sup>

Two days prior to the scheduled beginning of such training, it was announced that the XX Bomber Command would perform this instruction as on-the-job training in the 58th and 73rd Wings in lieu of such training by the Training Command.<sup>62</sup> The Air Communications Officer did not concur in the complete discontinuance of the training planned for at Boca Raton. The demands for such training were more extensive than the needs of the 58th and 73rd wings. There were demands for trained replacement personnel for the B-29 project, for the conversion of heavy units to very heavy units, and to meet the requirements of the Eighth and Fifteenth Air Forces. It was planned, therefore, to continue the course even though the enrollment of bombardier-navigators was temporarily stopped.<sup>63</sup>

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- 66. AC/S, Training to CG, AF, 14 Dec. 1943, in AG 353B, Bombsight and Navigation Training.
  - 67. Daily Diary, FIRC, 1-3 Div., 29 Nov. 1943, in AFTRC files.
  - 68. T.Z., AC/S, Training to CG, FIRC, 11 Dec. 1943, in AFCT files; AC/S, Training to CG, 2d AF, 14 Dec. 1943, in AG 353B, Bombsight and Navigation Training.
  - 69. Daily Diary, Technical Training Div., AC/S, Training, 23 Dec. 1943, in FINI files; AC/S, Training to CG, 2d AF, 14 Dec. 1943, in AG 353B, Bombsight and Navigation Training.

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The training of bombardier-navigators at Boca Raton did not remain in abeyance very long. In the discussions on radar training at the training conference at Training Command Headquarters, 10-13 January 1944, the opinion was expressed by Lt. Col. Edward S. Ellie of the Eastern Technical Training Command that there was "no possibility of radar on-the-job training." This opinion was based on the scarcity of men qualified to act as instructors for this type of training.  
70 Experience apparently substantiated this view since training at Boca Raton was begun in February 1944. The first personnel trained in this special course were approximately 30 instructors from the navigation schools and some navigators returned from the North African theater. This instruction was scheduled to begin on 7 February and  
71 was on A/FB-15 equipment.

The regular course of four weeks' duration began on 21 February. Ten classes of 110 students each were scheduled to complete this training by 25 November 1944. 11 classes after the first one were to consist of bombardier-in-a-reckoning navigators from the Second Air Force.  
72 The original plan contemplated the training of celestial navigator-bombardiers. The experience of the tactical units in the United Kingdom, however, indicated that better performance was obtained from bombardier-

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- 70. Report on "Training Conference-Headquarters Army Air Forces Training Command, 10-13 January 1944," "Sub-Committee Report on Bombar-dier-Navigator Training," in AFTR files.
  - 71. Daily Diary, AFTRC, Technical Training Co., 2, 4 Feb. 1944, in AFTRC files.
  - 72. CI, AFTRC to AG/3, Training, 24 Feb. 1944; 1st Inf., AG/3, Tr in-ing to CG, AFTRC, 10 March 1944, in AG 3533, Bombsight and Navi-gation Training; Daily Diary, AFTRC, 27 March 1944.

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dead reckoning navigators trained on N2K equipment.

Bomber Training Suspended, 1944. With regard to training added to the dual training requirements for B-29 personnel, an impossible condition was created. The same problems encountered in dual training were made more acute in triple category training. Raster added another month to the training period at the time when the requirements for B-29 personnel were increasing, and it added another field in which proficiency was to be maintained. It also made more real the problem of how much training a student could absorb in a given time. Faced with those problems the Commandant General of the Second Air Force recommended that complete dual training for bombardiers and navigators be discontinued. It was pointed out that the time allotted for individual and unit training after graduation from Training Command schools was inadequate to maintain proficiency in both specialties. Furthermore, bombardier-dead reckoning navigators had been found adequate as assistant navigators in the very heavy crews.  
74

The AC/S, CGN and AC/AC, Training did not favor the abandonment of dual training, though they conceded that superimposing radar training on complete dual bombardier-navigator training constituted a requirement "beyond the capacity of the schools to attain within available time." It would be acceptable to have one of the two officers trained only in dead reckoning navigation before assignment to a tactical organization.

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- 73. AC/S, Training to CG, AFTR, 15 Feb. 1944, in AG 353.1, Bombsight and Navigation Training.
  - 74. CG, 2d AF to CG, AF, attr: AC/S, Training, 10 Feb. 1944, in AG 353, Navigation Training.

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Such personnel would, however, be required to become qualified in celestial navigation by means of on-the-job training in order to have  
two radar-bombardier-navigators per crew. It was then pointed out  
by the Second Air Force that such on-the-job training would require  
nearly half of the total hours allocated to ground and flight training  
during the three months of OTU and ATU training.<sup>75</sup> In the light of  
these conditions the AC/AS, Training agreed that the Second Air Force  
should not be held responsible for this on-the-job training.<sup>76</sup>  
<sup>77</sup>

With the Training Command schools unable to produce the required number of radar-bombardier-navigators and the tactical organizations unable to assume the responsibility for the necessary individual training, or even to maintain the proficiency of multi-specialists in each category of training, it was decided to discontinue temporarily dual bombardier-navigator training. A training requirement for such personnel continued to exist, but this requirement was waived until it could be found possible to resume the dual training. In lieu of dually trained personnel, one bombardier-dual reckoning navigator and one celestial navigator would be supplied for each B-29 crew. Bombardiers were scheduled to receive radar training at Boca Raton, and navigators were to receive on-the-job radar training in the Second Air Force during  
<sup>78</sup>  
the period of their operational training.

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- 75. 1st Ind. (CG, 2d AF to CG, AF, attn: AC/AS, Training, 10 Feb. 1944), AC/AS, Training to CG, 2d AF, 19 Feb. 1944; Rpt, No. 2, AC/AS, CGAR to AC/AS, Training, 17 Feb. 1944, in ibid.
  - 76. 2d Ind., CG, 2d AF to CG, AF, attn: AC/AS, Training, 1 March 1944, in AFCT files.
  - 77. Rpt, No. 1, AC/AS, Training to AC/AS, CGAR, 17 March 1944, in AFCT files.
  - 78. AC/AS, Training to CG, 2d AF, 5 April 1944; memo for Gen. Harper by Col. L. C. Ryan, 30 March 1944, in AFCT files.

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In line with this policy the dual training at Roswell was discontinued, with the last class scheduled to graduate on 23 June 1944. <sup>79</sup> Out of the trainees at Roswell at the end of March 1944, when it was decided to close the school, 540 graduates were expected. Medium bombardment units required 240 of these during the next four months, leaving 300 available for the B-29 units. These 300 dually trained were sufficient to meet the needs of the B-29 units until June 1944 at least. The requirements of medium bombardment after July 1944 would be met by sending bombardiers to the navigation schools. This policy was reverted to when on 10 March 1944 the Training Command was directed <sup>51</sup> to begin entering graduate bombardiers into navigation training.

Radar-Bombardier and Radar-Navigator training. The dual training of bombardier-navigators having been temporarily discontinued, there remained the problem of providing radar training for the single category specialists for the B-29 organizations. The status of radar trained personnel for this program was critical. The 58th INC, the first B-29 organization to go to combat, went to its theater of operation without radar-trained personnel. Furthermore, the 22 replacement crews committed for May 1944 delivery were minus such personnel, and it was recommended that these go as 10-man crews without radar personnel. Also, the 73d INC required radar bombardiers and radar navigators for

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- 79. Project Book of CG, AFMIS, Navigation Sec., 14 April 1944.
  - 50. Memo for Col. R. L. Montgomery by Maj. H. C. McElroy, 25 March 1944, in F.C.P. files.
  - 51. AF/C, Training to 2G, AFMIS, 10 March 1944, in F.C.P. files.

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240 crews by 1 September 1944.

The existing plans for conducting the necessary radar training were entirely inadequate. There were two training agencies, the Training Command and the Second Air Force. The only school in the command equipped to conduct this training was Boca Raton, which had the job to accomplish. This school was required to train bombardiers and mechanics on N/APG-15 equipment for assignment to the First Sea Search Attack Group at Langley Field and similar personnel in N/APG-13 equipment for B-29 units. The Second Air Force was charged with continuation of training for the bombardier graduates of Boca Raton and the entire radar training for graduate navigators on N/APG-13.  
63

In order to meet the critical situation in the 53rd Wing, plans were made to send 12 well-trained radar instructors to conduct on-the-job training for this wing in the theater. These men were to be graduates of Boca Raton who had already had extensive training at Langley Field. From Boca Raton they were to be assigned to the Second Air Force for a month's training and arrive in the theater by 1 June 1944. After completion of training in the theater, they were to return to the Second Air Force as radar instructors.  
64 In order to expand the training at Boca Raton, a new radar training directive was issued in April 1944 requiring the establishment of two radar observer (bombardier)

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- 33. Memo for C/S by AC/13, Training, 1 April 1944, in AFMCT files.
  - 33. Ibid.
  - 34. AC/13, Training to CG, 2d AF, 5 April 1944; AC/13, Training to CG, AFMCT, 5 April 1944, in AFMCT files.

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courses (I/AFC-13 and I/APS-15) at the earliest possible date.<sup>85</sup>

Dual training of bombardier-navigators was an important development in crew training and represented an effort to make maximum utilization of capacities of personnel. But there was a point beyond which the ability of the trainee probably to absorb specialized instruction ceased. This was evident when the attempt was made to introduce triple training.

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85. AG/C, Training to CG, AFTC, 17 April 1944, in WAC files.

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Chapter VI

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NAVIGATION INSTRUCTIONS AND NAVIGATION PILOTS

Navigation Instructors

The provision of an adequate number of competent instructors was one of the important factors which determined the proficiency of graduates of the navigation schools. As was true in all types of training, the shortage of trained navigators and the insatiable demands of tactical organizations made it exceedingly difficult for the schools to secure the necessary instructor personnel. Due partly to this scarcity, schools for training instructors were established at a late date. The shortage of trained personnel and heavy demands by tactical units were felt more acutely in navigation than in bombardier training. The shortage of navigators continued for a year longer than that of bombardiers. Also, the Central Navigation Instructors School was not established until October 1943, 10 months after a comparable school for bombardier instructors was established. Unlike bombardier training, in another respect, the regular training program was not preceded by the special training of navigation instructors.

Supply and Instructor-Student Ratio

It is probable that no other category of aircraft training was started with as few qualified instructors as did navigation training. In October 1941 there were only two officers in the training program who had had long experience in navigation training. Maj. W. B. Har-

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bold and Maj. John W. Ryan had been connected with navigation training since its inception in 1937. There were four other officers in the training centers with limited experience. The time of these six men naturally was absorbed by administrative and supervisory duties. This resulted in all instruction being performed by recent school graduates who had no tactical experience whatever and had a maximum of only eight months' experience in the schools.<sup>1</sup>

It appears that the problem of a sufficient number of instructors was not serious prior to December 1941.<sup>2</sup> There were never more than 38 students under instruction at one time in the navigation school at Barksdale. It was the end of December 1941 before the enrollment of the navigation schools reached the 500 figure. After this date the number of students under instruction rose rapidly.<sup>3</sup>

The number of instructors required can be generally approximated since the ratio of instructors to trainees appears to have varied from 1-3.7 to 1-4.8. No little difficulty was encountered in securing even the minimum number of instructors needed. This difficulty was occasioned by several factors. From the beginning of navigation training there was a greater scarcity of navigators than of any other category of air-crew personnel. The using agencies were numerous (Second and Third Air Forces, and the Air Transport, Fleet Carrier, Antisubmarine, and Flying

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1. RIR, C/AC to C/AAF, 13 Sep. 1941, in AG 342.11H, Courses of Instruction.
  2. Since Air Corps instructors were provided irregularly for the civil contract school at Corral Gables, data used in this study are applicable only to the Air Corps navigation schools.
  3. See Chart 1 following p. 23.

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Training Commands), and no graduates could be retained for instructor purposes without the prior approval of the Director of Boarding, until 29 March 1942, and AF/AS, Training, until July 1942. After the latter date the Training Command had the right to retain "recruits needed for instructors and to report only the remainder of its production as available for assignment to other units." The problem was made more acute by the rapid increase in school population. The number of students under instruction increased approximately 150 per cent in the three-month period following 27 December 1941 and 160 per cent from October 1942 to April 1943. These rapid increases in school enrollment and the changes made in the authorized ratio of instructors to students added to the difficulty of maintaining the number of instructors required.

Prior to 7 December 1941 it appears that the ratio of instructors to students was 1 to 6. On 15 December 1941 General Arnold, with reference to the existing "crisis" in the "increased demand for trained personnel," directed the Assistant Chief of the Air Corps to "change the ratio of instructors to students in all four schools from 1 to 6 to 1 to 9" and emphasized the fact that this "will be done at all schools."<sup>4</sup> It seems that this ratio was either not put into effect or remained in effect only a short time. In April 1942 the number of instructors reported as on hand was 701, or a ratio of 1 to 1.4.<sup>5</sup> From 10 August 1942 through July 1943 the ratio of instructors to students was as

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- 4. R.R. AFDD to AFAC, 7 Feb. 1943, in AFRI files; memo for A-2 Div., AFAC by WO J. L. Snider, A-1 Div., AFAC, 3 Nov. 1943, in AFAC, A-2 Div. files.
  - 5. L.L. Gen. Arnold to Brig. Gen. Walter R. Weaver, 15 Dec. 1941, in AAG 343.9, Aviation and Instrument Training.
  - 6. AFAC Chart 6-1-1, 5 April 1942, in AAG 211D, Pilots.

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follows:

<u>Students under instruction</u>	<u>Flying instructors assigned</u>	<u>Students per instructor</u>	
15 Aug. to 23 Sep. 1943	1,987	523	3.7
Oct. 1943	2,530	576	4.0
Nov. 1943	2,630	642	4.1
Dec. 1943	2,876	612	4.7
Jan. 1943	3,214	669	4.8
Feb. 1943	3,163	1,184	2.7
March 1943	4,549	1,106	4.0
April 1943	6,039	1,147	4.2
May 1943	6,757	1,440	4.7
June 1943	7,316	1,493	4.9
July 1943	7,330	1,499	4.9

In August 1947 the established ratio was 1 to 5.22. By April 1944, when the navigator shortage was somewhat less acute, the ratio was established at 1 to 4.146.

The shortages and assignments to fill those shortages were, by the nature of conditions, somewhat erratic. At a given time the number of instructors on hand might be approximately adequate. A month later, however, any one of a number of factors might have created a marked shortage. It was also a common experience for the Military Personnel Division to make an allotment of graduates for instructor purposes, but before the time for actual assignment find that such graduates were indispensable to some other using agency, thus leaving the

7. It appears that these data on instructors, taken from the monthly Consolidated Flying Training Report of AFHQ, include supervisory personnel in addition to actual instructors. The instructor-student ratio is, therefore, slightly lower than indicated.
8. CG, AFHQ to AC/AS, Training, 23 Aug. 1947, in AFAC files.
9. CG, AFHQ to AC/AS, Training, 7 April 1944; 1st Ind., AC/AS, Training to CG, AFHQ, 11 April 1944, in AFAC files.

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navigation schools without the necessary instructors. Because of the maze of requests and the allotments made, cancelled, or delayed, it was impossible to get a clear picture of the actual status of instructors. Also, it was often difficult to distinguish between the requirements existing at the moment and those anticipated for planned expansion.

In July and August 1942 the demands of the tactical units precluded any assignment for instructor purposes. While the Flying Training Command did not "absolutely require" additional instructors in July, 249 were requested from classes 42-12 to 42-15, graduating in October 10 and November. It was pointed out also in August 1942 that if the production of navigators scheduled for the first part of 1943 were attained, the navigation schools would need to increase the number of 11 instructors by almost 300 per cent. There were approximately 500 instructors in the navigation schools at this time. As against these anticipated requirements, the number expected to be available varied 12 from 170 to 192.

Although the Flying Training Command requested 249 instructors from the October and November classes, the allotment made for October, November, and December totalled only 133. The command then requested 13 35 for December, but received none. During 1943 instructor

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10. Daily Diary, AFMTC, 29 June, 30 July 1942, in AAG 319.1-3, Daily Diaries.
  11. Daily Diary, AFMTC, 28 Aug. 1942, in ibid.; R.R., AFMTC to A.D.P., 27 Aug. 1942, in AAG 319.1-3, Basic Flight Training.
  12. R.R., AFMTC to AFMTP thru AFMDC and AFMTC, 22 Aug. 1942, in AAG 311B, Hitler and Nazis.
  13. Daily Diary, AFMTC, 7 Sep. 1942, in AAG 319.1-3, Daily Diaries; Project Book of CG, AFMTC, Navigation Sec., 11 Dec. 1942,

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requirements appear to have been met more satisfactorily. On 1 January the schools had 537 instructors on hand, and an additional 429 had been requested for the first three months of 1943.<sup>14</sup> During this three-month period 432 were received, making a total on hand on 31 March 1943 of 1,040.<sup>15</sup> The command requested 740 additional instructors for April, May, and June 1943 and received approximately this number.<sup>16</sup>

At the end of July 1943 the instructor-student ratio was approximately 1 to 5 as against an established ratio of 1 to 5.22. By April 1944 the number of students under instruction in the AAF navigation schools was 7,760, an increase of only 40 over July 1943. From July 1943 to April 1944, however, 532 graduates had been retained by the Training Command for instructor purposes.<sup>17</sup> This increase in instructor personnel against the relatively small increase in school population apparently brought the instructor-student ratio close to the authorized ratio of 1 to 4.146, of April 1944. The ratio of instructors to students was not affected by the entire 575 instructors obtained by the command. The progressive conversion of the bombardier course to bombardier-dead reckoning between June and December 1943 required the assignment of 231 navigators to the bombardier schools.<sup>18</sup>

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- 14. Daily Diary, AFMTC, A-1 Div., 23 Dec. 1943, in AFMTC files.
  - 15. Telephone conversation between Col. F. J. DuBois and Maj. G. A. Brooks of AFMTC and Lt. Col. Suarez of AFMTC, 1 Jan 1943, in AFMTC files; Project Book of CG, AFMTC, Navigation Sec., 13 Feb. 1943.
  - 16. Project Book of CG, AFMTC, Navigation Sec., 13 Feb. 1943.
  - 17. "Distribution of Bombardier and Navigator Graduates by AAF Flying Schools, by Training Command, June 1943 to May 1944," in files of Officers Branch, AFMTC.
  - 18. Daily Diary, AFMTC, A-2 Div., 1 June 1944, in AFMTC files.

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SECURITY INFORMATION

Navigation Instructors for Tactical Organizations

One of the problems encountered by the Training Command in maintaining the necessary number of navigation instructors was the loss of experienced instructors to the tactical organizations. If the command could have retained in the navigation schools all of the acquired and trained instructor personnel, there would have been no shortage of this category of personnel. It was necessary, however, that the navigator's training continue after his assignment to a tactical unit, and it was in this stage of training that the greatest difficulties in navigation training were experienced.

Because of the shortage of navigators these crew members generally joined the CRU and RRU units in one of the last two stages of training, very often in the last stage. The effects on the navigator's training are obvious. Also, it appears that prior to the end of 1943 the tactical units did not have navigator staff officers for squadrons and groups whose responsibility it was to supervise navigation training in these units. Moreover, the flight missions were heavily weighted with pilot, bombardier, and gunnery training. Most of the missions were relatively short, and the pilot performed most of the navigator's function. A great deal of the navigator's time was absorbed in giving on-the-job navigation training to the bombardier and in turn receiving training in bombing. Perhaps equally critical for the navigator was the fact that the supply and condition of navigation equipment severely affected his training. As a result of these conditions navigators in tactical units frequently not only failed to increase in pro-

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ficiency but actually lost some of their skill.

As a means of remedying this condition the Director of Training at Mather Field recommended that an advanced navigation course be instructed for the purpose of training selected school graduates and selected combat navigators who had completed their operational training.

Graduates from this type of instructors course would be staff navigation officers for squadrons, groups, target forces, and air forces. Such officers would be charged with supervising and coordinating the "continuing training" of operational flights of navigators. This contemplated course should be of six to eight weeks' duration. The Elgin, Brainerd, and C. proved this plan and submitted it to the Directorate of Military Requirements with a request for approval. The school at Mather Field also was requested to prepare a program of instruction and submit estimated requirements for personnel and equipment for conducting the course.

The Directorate of Individual Training considered the plan desirable but not feasible since it would retard the production of school graduates at a time when any curtailment was unacceptable. The directorate felt that any additional and advanced training should be con-

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19. Director of Training, Air Navigation School, Mather Field, to CG, AFHQ, 12 June 1943, in AG 750.11B, Courses of Instruction; CO, AF Navigation School, Eniwetok, ex., to CG, AAF, 27 Jun. 1943, in AG 757, Navigation Training.
  20. Director of Training, AF Navigation School, Mather Field, to CG, AFHQ, 12 June 1943, in AG 750.11B, Courses of Instruction; Daily Diary, AFHQ, 16 July 1943, in AG 319.1-8, Daily Diaries.
  21. Ed Ind., (Director of Training, AF Navigation School, Mather Field, to CG, AFHQ, 12 June 1943), CO, AFHQ to CG, USACAF, 30 July 1943, in AG 311D, Title and Order; CO, AFHQ to AFHQ, 22 July 1943, in AG 750.11B, Courses of Instruction.

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ducted in the tactical units. Though disapproving the plan, Individual Training; submitted the letter from Major Field to the Directorate of Bombardment for the information it contained on the state of navigation training in tactical organizations.

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The Directorate of Bombardment concurred in the criticisms made of navigation training in tactical units and, in fact, went beyond most other criticisms which had frequently been made. It was pointed out that "many navigators have learned little or no correct navigational procedures during the period of operational training. . . . Inspections have revealed that because of the lack of proper supervision many navigators have become laxitudinal in their training to the point of adopting improper methods and poor technique in general." The directorate felt that navigational staff officers would correct the situation and recommended that advanced navigation schools in the Flying Training Command be organized for the purpose of training such officers for "squadrons, groups, wings, bomber commands, and air force staffs." The Directorate of Bombardment believed that the need for such personnel was so acute that 27 instructors from the navigation schools should be made "immediately available" to the air forces, 9 to the Third and 13 to the Second. These instructors should be retained in the air forces and not allowed to go to theaters of operation with the units to which they were assigned. They could be returned to the navigation schools when replaced in the air forces by an equivalent number of

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22. AFMFT to CG, AFMTC, 31 July 1942, in AFM 350.11B, Courses of Instruction.  
23. RMR, No. 1, AFMFT to AFMDS, 31 July 1943, in *ibid.*

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supervisory navigators.

Because the production of navigators had fallen behind schedule, which meant that instructor requirements would not be met, the Directorate of Individual Training did not concur with either the sending of 27 instructors to the air forces or the establishment of the proposed

25 school. The Flying Training Command was willing to conduct the school but felt that navigation staff officers should be men with combat experience and also familiar with training methods employed in the navigation schools. The command also was willing to furnish the 27 instructors to the air forces if men with combat experience were unavailable and if they were to be returned to the schools when other

26 personnel were made available to the air forces.

The advanced navigation school was not put into operation, but as a "temporary alternative" it was decided to send navigation instructors to the Second and Third Air Forces. In the future, and until the proposed school could be established, the Directorate of Bombardment

27 was requested to obtain supervisory navigators from the Air Transport Command because of the shortage of instructors in the navigation schools.

Twenty-two instructors were assigned to the tactical units on detached service. Sixteen of these were expected to return after six weeks and

28 the remainder as soon as combat personnel were available.

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24. R.M., No. 3, AMENDS to AFDIR, 7 Aug. 1942, in ibid.

25. R.M., No. 7, AFRLM to AFDIR, 14 Sep. 1942, in AAC 311D, Titles and Grades.

26. 2d Ind., (OO, AFM-3 to AFDIR, 23 July 1942, in AAC 252.11B, Courses of Instruction), 3 Sep. 1942 in AAC 311D, Titles and Grades.

27. Project Book of CG, AFM-3, Navigation Sec., 3, 30 Sep. 1942.

28. Ibid., 14 Nov. 1942.

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The proposed school was never established, and in November 1943 the Directorate of Bombardment requested that a system be established whereby instructors would be furnished to the air forces with each class of graduates. These instructors released to the tactical organizations should be replaced by new school graduates. In the meantime the air forces had been directed to have a navigation staff officer in every squadron and group in both medium and heavy bombardment organizations.  
29 Individual Training believed that such a policy was feasible since there was already a turnover in this type of personnel, and  
such a policy might have a "constructive effect on morale."  
30

According to a plan approved by Individual Training, the Flying Training Command was to supply the 325 navigation instructors requested. The Directorate of Bombardment desired 300 of these by 1 May 1943. There were only 645 instructors in the schools, only 153 of whom had more than one year's experience. It was felt, therefore, that the transfer of 255 instructors by 1 May would have a serious adverse effect on the navigation schools, especially since the greatest expansion of navigation training was to be effected during the period from December 1943 to May 1943. While agreeing to furnish the 325 instructors the Flying Training Command was unable to furnish them on the  
31 schedule requested by the Directorate of Bombardment. By 1 May 1943,

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- 29. R.R., No. 1, AFMDS to AFRII, 24 Nov. 1943, in AAC 702.11A, Courses of Instruction.
  - 30. R.R., No. 2, AFRII to AFMDS, 1 Dec. 1943, in AFACI files; AFMII to CG, AFMDS, 1 Dec. 1943, in AAC 702.11A, Courses of Instruction.
  - 31. AFRII to CG, AFMDS, 1 Dec. 1943; 1st and 2d Instns., 11 Dec. 1943, 26 Jan. 1944, in AAC 702.11A, Courses of Instruction.

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42 instructors had been sent to the air forces, it appears. After this date the flow was supposed to be 10 each week. In June, however, the program for releasing this personnel was revised. According to the revised plan only 53 instructors were to be released from 1 June  
33 to 1 October 1943.

After the plan of sending navigation instructors to the tactical organizations to supervise the further training of school graduates had been in operation about four months, certain deficiencies in the plan were noted. By 1 April about thirty instructors had been assigned to the air forces. On the basis of this experience it was found that the school instructors were not immediately qualified to fill the position of navigation staff officers. This deficiency occurred because of the instructors' lack of familiarity with tactical type aircraft and lack of experience as staff officers. It was recommended that staff navigators be sent to the four-engine transition schools for a period of 4½ weeks prior to going to the tactical units. Such a procedure also would enable the four-engine aircraft to be sent on longer cross-country flights with less danger of getting lost. This policy  
34 was approved on 10 April 1943, but was abandoned after about six weeks.  
35

The practice of using school instructors as staff navigators was

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- 33. Project Book of CG, AFTRC, Navigation Sec., 13 Feb. 1943.
  - 33. Daily Diary, AFTRC, A-1 Div., 4 June 1943, in AFTRC files.
  - 34. CG, AFTRC to CP, AFM, 6 April 1943; 1st Ind., 10 April 1943, in AFM Bill, Navigation Officers.
  - 35. Daily Diary, AFTRC, A-1 Div., 28 May 1943, in AFTRC files.

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not entirely satisfactory, in the early stages at least. By April 1943 complaints were being received that such personnel were not being assigned to staff officer duties, but were looked upon as regular school graduates. The men themselves seemed to get the impression that they were "intruders" or that they had "no information to disseminate." The Third Air Force, as one of the using agencies, indicated that the above impressions were erroneous. It was pointed out, however, that these men required additional training; and that it was a mistake for the Flying Training Command to tell the men that they were to be staff officers. If they failed to get such an assignment immediately, they became discontented. In answer to a query from the command as to whether such officers were needed, the air force indicated that no additional <sup>36</sup> staff officers were needed at that time.

This reply from the Third Air Force raised some questions. It is difficult to see how the Flying Training Command could conceal from the instructors the nature of their assignment without creating a situation equally as bad as, or worse than that complained of by the Third Air Force. It is difficult also to understand the lack of demand for such officers in the air force. The shortage of navigators was more acute than that of any other category of aircrew personnel. In addition to the need for such personnel, which was common to all bombardment units,

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36. AG/AS, Training to CG, 2d AF, 27 April 1943; 1st Ind., 3 May 1943; CG, AFHQ (?) to CG, 2d AF, 7 April 1943; 1st Ind., CG, 3d AF to CG, III Bomber Command, 18 April 1943; 2d Ind., CG, III Bomber Command to CG, 2d AF, 22 April 1943; 2d Ind., CG, 2d AF to CG, AFHQ, 27 April 1943, in AAF 311, Navigation Officers.

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the Third Air Force had more on-the-job navigation and bombardier training to perform than any other training air force. It would appear that the Third Air Force needed all the staff navigators and bombardiers it could obtain.

Training of Navigation Instructors

Early Training in Navigation Schools. Before July 1943 the training of navigation instructors was one of the functions of each navigation school. Within each school there was an instructor training department which conducted a three-week course of instruction for recent graduates who had been assigned to the school for instructor purposes. This brief course consisted of a "resume of the points to be stressed" in the navigation program of instruction and of instructional techniques to be employed. This appears to have been the general arrangement in the various schools. The details of organization and the techniques and procedures employed varied widely from school to school.  
37

The values of a central instructors school in standardizing instructional procedures, in developing and evaluating the most effective devices and techniques, in serving as a clearing house and disseminator of knowledge for the navigation schools in all matters affecting instruction, and in the operation of textbooks, handbooks, and other teaching materials were lost to the navigation training program until the

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37. "History of Selman Field, Army Air Forces' Aviation School, 1 January 1943-31 December 1947," 7; "History of Selman Field, Army Air Forces' Instructors School (Navigator), 31 July 1943-22 February 1944," foreword, in AFHI Archives.

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latter part of 1943.

Training in AAF Instructors School (Navigator). The first class in the AAF Instructors School (Navigator) entered training on 6 November 1943.<sup>38</sup> The reasons for the long delay in initiating the training are not clear. As already indicated, an attempt was made between July and September 1943 to inaugurate advanced instructor training for school instructors assigned to the tactical organizations as navigation staff officers. This training was prevented, however, by the urgent need for instructors in the navigation schools in the period from September 1942 to May 1943. This was the period when the greatest expansion was being made in the navigation schools. Though this type of instructor training was not inaugurated as a regular program, one of the training groups at Mather Field conducted a limited amount of such training beginning on 1 August 1943.<sup>39</sup> This training at Mather Field was a refresher course for navigators returning from combat, who were to be assigned to tactical units as navigation instructors or as navigation staff officers. The mission of this course, as stated in September 1943, was "to bring each combat navigator up to date in new navigational devices and techniques, and to determine the type of work"<sup>40</sup> for which he was best suited.

Refresher training for returned combat men was on a very limited

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- 38. "History of Selman Field, AAF Instructors School (Navigator), 31 July 1943-29 February 1944," 14.
  - 39. "History of Selman Field, AAF Instructors School, 31 July 1943-29 February 1944," 1; Daily Diary, AFFTC, A-3 Div., 31 May 1943, in AFTRC files; CG, AFTRC to AC/AS, Training, 22 Sep. 1943, in AAG 353, Navigation Training.
  - 40. CG, AFTRC to AC/AS, Training, 22 Sep. 1943, in AAG 353, Navigation Training.

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scale. The course lasted only 30 days and was limited in size to only 10 or 12 students in order to avoid greatly overloading or curtailing the regular training program. The quotas allotted to the tactical organizations for each class were:

Second Air Force	5	navigators per month
Third Air Force	3	" " "
AEFC	1	" " "
AESUB	1	" " "

As the number of navigators returned from combat mounted and the requests from tactical organizations for refresher training increased, the training at Mather became inadequate. There was already an increasing realization of the need for a central instructors school for navigators comparable to those already established for pilots, gunners, and bombardiers. When it became desirable to process all navigators who returned from combat through the refresher course, a separate school became necessary.

The first step to establish a central instructors school was taken on 31 July 1943 when the Training Command decided to convert the refresher course into a regular central instructors school.<sup>42</sup> Pursuant to this decision the refresher school at Mather was redesignated as the "Army Air Forces Central Instructors School (Navigation)," effective 1 August 1943.<sup>43</sup> The mission of the school was stated as follows:

a. To give standardized instructor training to all navigators selected for duty in the Army Air Forces Navigation Schools.

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- 41. 1st Ind. (AC/AS, Training to CG, AFEC, 9 June 1943), 25 June 1943, in ibid.
  - 42. "History of Selma Field, AAC Instructors School (Navigator), 31 July 1943-29 February 1944," 2.
  - 43. Ibid.
  - 44. T. C. Memo 10-12-2, 6 Sep. 1943.

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- b. To conduct refresher courses for navigators returning from combat and other personnel as may be authorized by this Intrinsic Command/Headquarters.
- c. To experiment with training aids, thus preventing duplication in this effort at the schools.
- a. To collect, write, and revise instructional material in accordance with the provisions of E.C. Memorandum No. 3-2.

The program of instruction for the instructors school was to consist of a total of 300 hours allotted in the following manner:

c. Navigation technique	91 hours
(1) Instruments	28 hours
(2) Theory	10 hours
(3) Procedures	53 hours
b. Instructional technique	51 hours
c. Allied training	58 hours

Two factors militated against the success of this program as planned. In the first place, the course was to remain as only a month's program of instruction, which was too brief a time for the accomplishment of its objectives. Also, the school was to remain attached to one of the training groups at Mather Field rather than be established as a separate school. On account of these limitations, plans were made in September to establish a separate school in October. The new school was to be established at Selma Field in connection with the regular navigation school there. To make definite and detailed plans for the

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- 43. Held. For complete outline of this program of instruction see Appendix 3.
  - 43. CG, AFIRC to AC/AS, Training, 22 Sep. 1943, in AF 302, Aviation Training; Project Book of C/S, AFIRC, Navigation Sec., 9 Sep. 1943.

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proposed school, a navigation conference met at Training Command Headquarters 24-26 September 1943.

The program of instruction in the new school differed somewhat from the school at Wether which it superseded. In reality, three different programs were conducted. Combat navigators who were already with one of the training air forces or were to be assigned to such organizations were given a three-week refresher course followed by a basic instructor course of three weeks. Similar personnel for the Training Command were given these same two courses plus three weeks of advanced instructor training. New graduates of the schools who were to be retained as instructors were given six weeks of training, the three-week basic instructor course followed by the three-week advanced instructor course.<sup>47</sup> Some of the trainees were to become navigation staff officers, and others regular navigation instructors. The instruction for the latter students consisted of "advanced terrain techniques, practice in giving lectures, in instructor flying technique, and in the <sup>48</sup> reading of logs."<sup>49</sup> In addition to its principal mission of training instructors for the navigation schools and staff officers for the tactical organizations, the instructors school attempted to coordinate its functions with those of the navigation schools and also to bring about coordination between the navigation schools themselves.

One of the purposes in separating the instructors school from

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- 47. Daily Diary, AFHQ, 29 Sep. 1943, in AFHQ files.
  - 48. "Histor. of Selby Field, AFM Instructors School (navigator), 31 July 1943-29 February 1944," 6.
  - 49. Ibid., 1.

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one of the regular navigation schools was to facilitate an expansion of its student enrollment. The new school began instruction on 6 November 1943 with 7 classes of 40 students, with the enrollment scheduled to increase to 200 by 22 January 1944. The policy of assigning quotas to the training air forces was continued, and the number of students under instruction in the first few classes was divided equally between new school, recruiter and combat personnel. By the middle of December 1943, however, a new policy was adopted. The number of returned combat navigators increased greatly toward the end of 1943. The AAF Redistribution Center assigned some of these to the air forces and some to the Training Command. The number assigned to the command soon absorbed the full capacity of the instructors school, and it became necessary to cancel the quotas of the training air forces at the school. This resulted in a backlog of returned combat men in the air forces without refresher or instructor training.

In order to make the fullest possible use of combat navigators in the training program, it was decided to devote the entire capacity of the instructors school to this type of personnel. After January 1944 quotas were assigned to the navigation schools only in the event that sufficient combat men to fill the school were not made available by the Redistribution Center. Even after cancelling the quotas of the

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50. Project Book of CG, AFMRC, Navigation Sec., 17 Dec. 1943.
  51. Ibid.
  52. AC/AS, training to CG, AFMRC, 33 Dec. 1943, in AAG 211, Navigation Officers.
  53. Ibid.; 1st Ind., 18 Jan 1944; Daily Diary, AFMRC, 20 Jan., 23 Feb., 1944, in AFHQ files.

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navigation schools, it seemed that the school could not accommodate all of the returned combat personnel and that it was necessary to enlarge the capacity of the school still further. This could be done either by curtailing the production of the advanced navigation school at Selman Field or by discontinuing the preflight navigation school there. Since the demand for navigator priorities would not permit any curtailment of production, it was decided to transfer the preflight school from Selman Field back to Maxwell Field where it had been located prior to October 1942.

Training of Officers as Navigation Instructor. From the beginning of the navigation training program officers had been permitted to train in place as navigators. Apparently there were no unusual problems in such training before the latter part of 1942. In the dual training program it became desirable, if not necessary, to have instructors who were trained in both specialties. In January 1943 such training was approved subject to the understanding that officers trained in both specialties would either be used in the dual training program or be assigned to tactical units where additional training would be put to immediate use. There appeared to be some uncertainty, however, as to whether officers of the rank of captain and major were to be permitted to take the second category of training. When the entire bombardier program was converted to bombardier bombardier-navigation, there was a need for "dually" trained officers in the rank of Captain.

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- 34. Monthly Consolidated Flying Training Report.
  - 35. AFMIR to CG, AFMTC, 29 Dec. 1942; 1st Ind., 2a Ind., 16, 21 Jrm. 1943, in AFM 525, Aviation Training.

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and prior to insure its success." When AC/AS, Personnel requested information on which to base a reply to the request for such training, the AC/AS, Training, indicated that such officers should be allowed to take the second category of training regardless of rank if they were to be used as instructors. <sup>57</sup> The training of bombardier instructors in dead reckoning navigation was discontinued after the class which entered training at the navigation instructors school on 30 November <sup>58</sup> 1943.

At some unascertained date the Training Command established the policy of retaining all officer graduates of the navigation schools as instructors for a period of six months. The practice of retaining all officer graduates regardless of their teaching ability meant the loss of good instructor personnel and thus worked to the detriment of the training program. To rectify this situation the minimum period of stay <sup>59</sup> of each personnel in the Training Command was reduced to three months.

Still another phase of the problem developed as a result of sending returned combat navigators to the instructors school. Many of these men had risen to a higher rank than called for in the case of instructors. At the same time some of these men were either not experienced enough or not suited for positions commensurate with their rank. After considerable study of the problem of how best to utilize this type of

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- 56. CG, AFHQ to AC/AS, Personnel (?) July 1943, in AFHQ files.
  - 57. Rm, No. 1, AFHQ to AC/AS, Training, 20 Jul. 1943; Rm, No. 2, AC/AS, Training, to AFHQ, 8 Aug. 1943, in AFHQ files.
  - 58. Daily Diary, AFHQ, 18 Nov. 1943, in AFHQ files.
  - 59. CG, AFHQ to AC/AS, Training, 20 Sep. 1943; 1st : in SA Inst., 9, 27 Oct. 1943, in AFHQ files.

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personnel in the training; nor was it ever decided to "root them for supervisory and other key positions" by assigning them "as universities of officers holding such assignments." It was emphasized strongly that returned combat navigators assigned to the instructors school by the Redistribution Center should be men who wanted to be either instructors or supervisory officers in the Training Command.

Post-Graduate Training of Instructors. From the beginning of navigation training in Air Corps schools it was the policy to maintain as close contact as possible with the using agencies. It was the desire of those charged with the individual training of navigators that this training be as practical as possible in order to assure that the school graduate would be of the greatest utility to the tactical organizations. One of the most effective means of accomplishing this aim was to keep navigation instructors abreast of operational methods and procedures. In line with this policy instructors were sent on detached service to various stations in the training air forces in order to become acquainted

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- 60. AG/AS, training to CG, AFM&J, SJ Dec. 1943; 1st Ind., 13 Jan. 1944, in AAC files, Aviation Officers.
  - 61. Memo for Col. R. J. Montgomery by Capt. H. C. McAuliffe, 3 March 1944, in AAC files. In this connection it is interesting to note that relative to the problem of returning combat personnel adjusting themselves to non-combat functions, navigators were able to adjust more easily than any other category of personnel. Letter of Brig. Gen. W. B. McNaughton, AG/S, AGS, AFM&J, before the training conference at Fort Worth, Tex., 10-12 Jan. 1944. See "Report, Training Conference, Headquarters Army Air Forces Training Command, Fort Worth, Texas, 10, 11, 12 January 1944," in AFAC files.

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with what the air forces expected of navigators.

In February 1943, 20 bombardier-navigator instructors were sent to stations in the Third Air Force for a two-week period. Following this stay in the air force these men were sent to Carlsbad as instructors for the new course in bombardierdead reckoning navigation which began in the following month.<sup>63</sup> In June 1943 the Flying Training Command extended this practice when it requested approval of the Second and Third Air Forces and the Air Transport Command to send navigation instructors to ONU organizations for a period not to exceed 15 days for the purpose of "observation and familiarization with training."<sup>64</sup> By January 1944 this procedure seems to have become an established policy. At that time a regular allow was established of four instructors a month to the Second Air Force "to observe and participate" in operational training.<sup>65</sup>

Arrangements similar to those made with the Second and Third Air Forces also were made with the Air Transport Command throughout 1943. In May 1943 the navigation school at Kather Field made arrangements

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- 62. Another means of keeping navigation instruction abreast of the latest navigational experience was that of assigning returned combat navigators to the schools as instructors. This was done prior to the establishment of the central instructors school or the refresher training performed for the training air forces. The Flying Training Command requested AFTRC to make such assignments as early as July and August 1942. See Daily Diary, AFTRC, 29 July, 10, 23 Aug. 1942, in AG 319.1-3, Daily Diaries. This policy was followed until the instructors school was established, after which time returned combat men came primarily to constitute the principal source of new navigation instructors.
  - 63. Daily Diary, AFTRC, 3 Feb. 1943, in AG 319.1-3, Daily Diaries.
  - 64. Daily Diary, AFTRC, 1-7 Div., 1 June 1943, in AG 319.1-3 files.
  - 65. Ibid., 26 Jan. 1944.

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ments with the Air Transport Command by which supervisory and instructor personnel were assigned to one month's temporary duty with the 6th Ferrying Group of the command. It was desired to give this personnel "actual experience in navigating aircraft on transocean" flights. A like arrangement was put into effect at Selman Field in February or March 1944.

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#### Navigation Pilots

Though not classed as an instructor, one of the most important individuals connected with the instruction of navigators was the navigation pilot. The necessity for pilot-navigator coordination and cooperation is obvious. It was necessary that these pilots rate among the best in the AAF. This was necessary from both the point of view of training efficiency and student morale. As long range trainer aircraft were procured, which entailed more bad-weather flying, the responsibility of navigation pilots approximated that of combat pilots. The qualifications required for navigation pilots were increased after the inauguration of dual training. This type of training required that navigation pilots qualify as bomb-approach pilots in order to fly bombing missions. These missions were essential if bombardiers taking navigation training were to maintain their bombing proficiency while undergoing the second category of training.

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66. Father Ficela to CG, AFMTC, 23 July 1943; 4th Ind., AC/AS, Training to CG, AFMTC, 24 Aug 1943, in AFACI files.
67. CO, Selman Field to CG, AAF, thru channels, 23 Nov. 1943; 9th Ind., AC/AS, Training to CG, AFMTC, 26 Feb. 1944, in AFACI files.
68. Daily Diary, AFMTC, A-1 Div., 3 Oct. 1942, in AFMTC files.
69. CG, AFMTC to AFMTC, 9 March 1943, in AFACI files.
70. CG, AFMTC to AFMTC, 9 March 1947, in AFACI files.

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The shortage of pilots throughout the AAF until the end of 1943 naturally reflected itself in the navigation schools. In June 1941 the Chief of the Air Corps requested a loan of 60 twin-engine pilots from the Air Force Combat Command for bombardier, flexible gunnery, and navigation training.<sup>71</sup> The same shortage existed in the Combat Command, however, and the loan was considered impossible. A year later, in June 1942, the shortage of pilots in the tactical units was so acute that the Flying Training Command was notified that 400 pilots would be taken from it.<sup>72</sup>

The ratio of navigation students per pilot during the first two years of school training has not been ascertained. In September 1942 the authorized ratio was 9 to 1.<sup>73</sup> This remained the established ratio until March 1943. With the number of students under instruction increasing over 100 per cent during this period, it was difficult to maintain the ratio. In January 1943 pilots in the navigation schools were flying more hours per month than any other pilots in the Flying Training Command. In order to maintain the flying schedule in seasons of bad weather it was often necessary that they fly eight hours a day. Because of these conditions the command requested authority to reduce student-pilot ratio from 9 to 1 to 3 to 1. Pilots already had been allocated for the year 1943 and authority to change the ratio was given contingent upon the command's effecting the change by reassigning pilots

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- 71. CAC to CG, AFHQ, 26 June 1941; 1st Ind., 23 June 1941, in AG 211G, Pilots.
  - 72. Daily Diary, AFHQ, 5 June 1941, in AG 219.1-3, Daily Diaries.
  - 73. Project Book of CG, AFHQ, Navigation Sec., 9 Sep. 1942.

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already under its jurisdiction. If the student-pilot ratio at Selman Field was representative of some other navigation schools, the ratio rarely reached 9 to 1. The ratio at this school in 1943 was between 7 and 8 to 1, was 8 to 1 in 1943, and in February 1944 was 7.3  
75 to 1.

Because of longer and probably superior training and experience, navigation pilots, like pilots in the bombardier and gunnery schools, were especially desirable to the tactical units. Until mid-1943, in fact, these types of pilots were the sole source of four-engine transition school trainees. From these schools they moved to the Second Air Force as heavy bombardment pilots. By December 1943 it had become the established policy to release 50 experienced pilots from the navigation schools each 4<sup>1</sup>/2 weeks. Forty-two days prior to the release of these experienced pilots to the 4-engine transition schools, the navigation schools received an equal number of twin-engine graduates.  
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Shortages of navigation instructors and pilots were severe handicaps to the advanced navigation schools. In addition to these personnel problems, the lack of materiel necessary for individual training of navigators was even more restrictive in its influence.

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- 74. CG, AFMTC to AFMTR, 9 March 1945; 1st Ind., 20 March 1943, in AFMTC files.
  - 75. "History of Selman Field AAF Navigation School, 5 June 1943 to 29 Feb. 1944."
  - 76. Daily Diary, AFMTC, A-1 Div., 25 Dec. 1943, in AFMTC files.

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Chapter VII

MATERIEL FACTORS IN NAVIGATION TRAINING

Materiel Factors and Production

There were many factors which operated to curtail production of navigators, the basic factor being the shortage of many materiel items necessary for the conduct of training. Compasses, driftmeters, sextants, and other items were important scarce equipment, but trainer aircraft was the most critical item. Numerous types of synthetic navigation trainers were produced, and at one time it was recommended that <sup>1</sup> these be utilized instead of flight equipment. Synthetic trainers were used extensively in conducting ground missions, but trainer aircraft remained indispensable to navigation training.

Since there was a shortage of navigators at all times from the beginning of navigation training, ceaseless efforts were made to increase production of this category of personnel. Virtually every effort made to expedite production met the obstacle of shortage of equipment, principally airplanes. The opening of new schools was contingent <sup>2</sup> upon the delivery of airplanes and other equipment. The length and

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1. Memo to Maj. Carl J. Crane, Earksdale Field, 26 Sep. 1941, in AAG 352.9, Navigation and Instrument Training.
  2. Project Book of CG, AFTRC, Navigation Sec., 15 May, 1 Aug. 1943.

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content of programs of instruction were affected by the same factors.

The efforts to expand school capacity in connection with each new  
phase of the expansion program encountered the same problems.  
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Trainer Airplanes

The basic type of aircraft used in navigation training was the AT-7. This was the first trainer aircraft used by the AAF exclusively for navigation training. The AT-7 is a transport type aircraft with arrangements for three students and with a rotatable celestial dome for taking sextant readings. The selection of this airplane as the basic navigation trainer seems to have been made in January 1941.  
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Owing to the shortage of AT-7's, several other types of aircraft also were used, for example, AT-11's, AT-13A's, A-23A's, B-18's, B-34's, and C-60's. It was necessary, of course, to modify these airplanes in order to use them in navigation training.

The nature of navigation training required a plane possessing a particular type of internal accommodations and flight capabilities. Aircraft used for this purpose had to have three sets of navigation installations on account of the three-student method of instruction. Since navigation training missions of 4, 8, and 12 hours' duration were desired, it was necessary for navigation trainers to have a longer range than any other advanced trainer type airplane. As late as April

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3. Brig. Gen. Walter R. Weaver to C/AC, 2 Jan. 1941, in AAG 363.9, Navigation Training.
  4. Daily Diary, AFMTC, A-3 Div., 5 Dec. 1942, in AFMTC files; RAR, No. 2, AFMTC to AC/AS, Program Planning, 4 March 1943, in AFMTC files.
  5. RAR, No. 1, T&O to Materiel Div., 6 Jan. 1941, in MG 452.1N, Training Airplanes.

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1944, however, there were no airplanes at the navigation schools capable of flying 12-hour unbroken missions. The AT-7's were used for the four-hour missions and the C-60's for the eight-hour missions.

Student-Airplane Ratios. The desired ratio of students to airplanes changed from time to time. In December 1940 the desired ratio for B-18's was 4 to 1 and for AT-7's it was 5 to 1.<sup>6</sup> By September 1942 the ratio had risen to 11.4 to 1,<sup>7</sup> and there was very little change in the ratio after that time. In May 1943 the ratio was established at 12.5 to 1.<sup>8</sup> From September 1942 through April 1943 the actual ratio of students to trainer airplanes was very close to the desired ratio. The large increase in the number of students under instruction after that date caused a temporary increase in the ratio.<sup>9</sup> By April 1944,<sup>10</sup> however, the actual ratio was down to approximately 11 to 1.<sup>11</sup>

Requirements and Procurement. The delivery of AT-7's appears to have been adequate by September 1941 since the number of trainees at that date was not large; there were only 120 navigation trainees in Air Corps schools and about 45 AT-7's had been delivered by June 1941.<sup>12</sup> In October 1941 this type of airplane was being produced at the rate of 10 a month, and by July 1942 production was at the rate of one<sup>13</sup> a day. All of this increased production, however, did not re-

- 6. R&R, No. 1, T&O to Materiel Div., 25 July 1941, in ibid.
- 7. Brig. Gen. Walter R. Weaver to C/AC, 2 Jan. 1941, in AAG 353.9, Navigation Training.
- 8. Project Book of CG, AFTRC, Navigation Sec., 8 Sep. 1942.
- 9. Col. K. P. McNaughton to CG, AFFTC, 19 May 1943, in AFACT files.
- 10. Monthly Consolidated Flying Training Report, Sep. 1942 to July 1943.
- 11. Ibid., April 1944; R&R, No. 1, AC/AS, Training to AC/AS, OC&R, 29 April 1944, in AFACT files.
- 12. R&R, No. 1, C/AC to C/AAF, 25 July 1941, in AAG 452.1P, Training Airplanes.
- 13. Chief, Engineering Sec. to Chief, Materiel Div., 3 Oct. 1941, in ibid; R&R, AFROM to AFTRT, 3 July 1942, in AAG 452.1A, Training Airplanes.

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flect itself in trainers available to the navigation schools. Many of the A-7's were lacking in the necessary navigation installations such as compasses, driftmeters, and other items.<sup>14</sup> Furthermore, some of these airlanes were assigned to agencies other than the Flying Training Command and to activities within the command other than navigation training.<sup>15</sup> These diversions of A-7's seriously threatened the expansion in the schools which was scheduled for September 1942.<sup>16</sup>

The failure to procure sufficient A-7's made it necessary to utilize any other type aircraft which could be used immediately or modified for use. Throughout the last half of 1941 attempts were made to secure AT-12's for the navigation schools.<sup>17</sup> A considerable number of these airlanes appears to have been obtained during 1942.<sup>18</sup> In 1942 and 1943 three other types of aircraft were secured and modified for navigation training. These were the A-23A's, B-34's, and C-60's. The B-34's were received first, followed in order by the A-23A's and the C-60's.<sup>19</sup>

Inordinate delays in delivery of airlanes were occasioned by modification. In August 1942 the Flying Training Command was scheduled

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14. R.R's between AFRCM and AFRT, 2, 3, 26 July, 26 Aug., 18 Sep. 1942; AFRT to CG, AFFTC, 5 Aug. 1942, in AAC 452.1A, Training Airlanes.
  15. R.R. AFRT to AFRCM, 3 June 1942, in *ibid.*; CG, AFRCM to AFRT, 10 July 1942, in AAC 452.1B, Training Airlanes; AFRT to CG, AFFTC, 24 Sep. 1942, in AAC 452.1B, Training Airlanes.
  16. CG, AFFTC to AFRT, 10 July 1942, in AAC 452.1R, Training Airlanes.
  17. R.R. No. 1, C/AC to C/AAF, 25 July 1941; R.R. No. 3, Air Staff to CGAC, 11 Aug. 1941; No. 5, CGO to Materiel Div., 16 Aug. 1941, in AAC 452.1, Training Airlanes; R.R. No. 1, CGAC to Chief, Materiel Div., 21 Dec. 1942; R.R. No. 2, Materiel Div. to CGAC, 26 Dec. 1942, in AAC 452.1Q, Training Airlanes.
  18. Daily Diary, AFFTC, A-3 Div., 6 Oct. 1942, in AFRC files; Project Book of CG, AFFTC, Navigation Sec., 12 Oct. 1942.
  19. Daily Diary, AFFTC, 20 Aug., 29 Dec. 1942 in AFRC files.

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to receive 39 A-23's, 80 B-24's, 113 C-60's, and 100 C-45's. At that time none of the A-23's were available. The B-31's were to be converted at the rate of four a day, 56 of the C-60's by February 1943,  
<sup>20</sup> and the first C-45's in November 1942. The B-31's were not available until the end of December. The C-60's were diverted to the glider program and then back to navigation again, and by February 1943, 52 of them were still undelivered. As a result of this experience the opinion was expressed that "the decision to use modified airplanes as a solution to the shortage of navigator trainers is the most important factor  
<sup>21</sup> in the delay in delivery that subsequently occurred." While all of this difficulty was being encountered in securing modified trainer aircraft, the delivery of AT-7's was behind schedule, and the number of AT-10's which had been allocated to navigation training was reduced  
<sup>22</sup> from 300 to 83. In December 1942 an additional allocation of 20 AT-  
<sup>23</sup> 7's, 26 AT-10's, and 50 C-60's was made. As late as March 1943, however, there was still a shortage of airplanes, deliveries being so far behind schedule that 52 of the C-60's allocated in July 1942 were still  
<sup>24</sup> undelivered.

The demand for trainer planes increased at the same rate as did the enrollment of the navigation schools. In December 1942 there were 3,265 students under instruction in the navigation schools. By March

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- 20. Project Book of CG, AFTRG, Navigation Sec., 1 Aug. 1942.
  - 21. Memo for Col. T. J. DuBose by Maj. E. H. Herrod, 10 Feb. 1943, in AFHOT files.
  - 22. Project Book of CG, AFTRG, Navigation Sec., 12 Oct. 1942.
  - 23. Ibid., 11 Dec. 1942.
  - 24. LCR, No. 3, AFTRG to AC/AS, A-1 thru A-7, 9 Mar. 1943, in AG 352, Navigation Training.

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1943 this number had increased to 4999 and by June 1943 to 7,797. By  
25 June 1943 the ratio of students to airplanes had risen to 14.3 to 1.  
At the same time this increased demand for trainer airplanes was being  
felt, the dead reckoning navigation course for bombardiers was initiated  
at Carlisle. Soon thereafter the entire bombardier program was expanded  
to include dead reckoning navigation. This necessitated the modifica-  
tion of all bombardier trainer aircraft (AT-11's) to provide for instal-  
26 lation of navigation equipment.

Demands for Tactical Type Trainers. The AT-7, though it was the  
basic type of navigation trainer airplane, was never entirely satis-  
factory because of limited range and altitude performance characteristics  
and because it accommodated only three students. As early as June 1943  
consideration had been given to discontinuing production of the bombar-  
27 dier trainer airplane, the AT-11. When it became necessary to modify  
all AT-11's, as a result of the decision to train all bombardiers as  
dead reckoning navigators, the question of stopping production of both  
the AT-7 and the AT-11 was raised. Since neither airplane was entirely  
satisfactory, it was desired to produce a new type of trainer which  
28 would meet the demands of both bombardier and navigation training.

One of the most important reasons for desiring a new type bombar-  
dier-navigator trainer plane was the vast difference in the performance

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- 25. Monthly Consolidated Flying Training Report.
  - 26. Daily Diary, AFETC, 24 April 1943, in AMG 310.1-3, Daily Diaries.
  - 27. RER, No. 1, AC/AS, AFMD to AFMSC thru AC/AS, Training, 3 June  
1943, in AFACT files.
  - 28. Daily Diary, AFETC, A-4 Div., 4 March 1944, in AFETC files.

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characteristics of the AT-7 and the AT-11 and the tactical aircraft in which operational training was conducted. There was an increasing demand to simulate combat conditions as nearly as possible in all stages of training. If this were to be accomplished, it was necessary greatly to increase the performance characteristics of trainer type aircraft in range, speed, and altitude. General specifications submitted in March 29 1944 for the proposed new trainer called for the following performance:

1. Speed at 25,000 feet	325 MPH (true)
2. Range and cruising power	1,300 miles
3. Service ceiling	23,000 feet
4. Level flight, one engine normal load	8,000 feet
5. Endurance	
for bombardier	about 6 hours
for navigation	about 3 hours

A few days before the above recommendations for a new type trainer were made, AC/AS, Training had indicated to the Training Command the 30 possibility of acquiring some C-47's for use as navigation trainers.

It was expected also that combat type airplanes, released by never type combat aircraft, would soon be available to the schools. In view of these possibilities and the fact that any newly designed airplane could not reach the production-delivery stage before 1946, the proposal 31 for a new type plane was not concurred in.

As late as April 1944, therefore, the answer to the immediate problem of navigation trainer aircraft seemed to lie in the procurement of additional C-45's and in acquiring C-47's. The superiority of these

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- 29. CG, AFIRC to AC/AS, Training, 17 March 1944, in AFAC files.
  - 30. Daily Diary, AFIRC, A-E Div., 18 March 1944, in AFIRC files.
  - 31. RMR, No. 3, AC/AS, OCAR to AC/AS, Training, 11 April 1944; 1st Ind. (CG, AFIRC to AC/AS, Training, 17 March 1944), 13 April 1944, in AFACT files.

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aircraft over the AT-7's is indicated by the following comparative  
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data:

	<u>AT-7</u>	<u>O-60</u>	<u>O-47</u>
Fuel capacity (gallons)	200	644	830
Range (miles)	730	1,300	1,500
Endurance (hours)	4	7.7	10
Number students	3	5	8

The status of trainer aircraft in the navigation schools at the end of April 1944 was: AT-7's, 550; AT-13's, 43; A-23A's, 17; and  
33  
O-60's, 100.

#### Other Material Items

Since all navigation training missions were made on the ground prior to being performed in the air, the demand for navigational equipment went far beyond the requirement for trainer airplanes. Compasses, astro-compasses, driftmeters, air position indicators, and navigation kits were as indispensable to navigation training as the trainer plane itself. The number of these items required was greatly in excess of the number of airplanes needed. It was necessary to have all of these items in the planes and an additional supply for use in executing ground missions. This duplicate requirement did not exist for navigation kits, however, since the student used the same kit for both ground and air training.

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32. R.R., No. 1, AG/AS, Training to AG/AS, COMR, 28 Apr. 1944, in AFAC files.  
33. These were given as approximate figures. Ibid.

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As in the case of trainer aircraft, there was an almost continuous shortage of all these items. The quantity shortage militated against navigator production in the same manner as did the aircraft shortage.  
34 Of equal importance with the quantity shortage of these items was the fact that the newest types and models of equipment were allocated on a first priority to the tactical organizations. As a result the navigation schools frequently found themselves training students in the use of outmoded navigational instruments. The obvious result of this was the assignment of graduates to tactical aircraft with the equipment of which they were unfamiliar and which, therefore, they were reluctant or incompetent to use. The ultimate effect of this was the failure to realize in combat the full benefits of the newest and most improved navigational equipment. On several occasions the Training Command requested a small allotment of new equipment in order at least to familiarize instructors and students with its characteristics and operation.  
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Two examples of the difficulties encountered in securing new type navigational instruments for training purposes are those of the B-5 driftmeter and the gyro-stabilized flux gate compass. In the case of the B-5 driftmeter it appears that it was installed in tactical aircraft and used in combat for a period of time without the knowledge

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- 34. Project Book of CG, AFMRC, Navigation Sec., 25 June, 12 Oct., 14 Nov., 11 Dec. 1942.
  - 35. P.R. No. 1, AFMRS thru AFRII, 9 Sep. 1943, in AG 353.9B, Navigation and Instrument Training; CG, AFMRC to AG/AS, Training, 20 Oct. 1943, in AFMCT files; memo for Col. R. H. Montgomery by Maj. H. C. McAuliff, 6 March 1944, in AFAC files.

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of the navigation schools which continued to use the B-3 driftmeter. Often when the schools began training on the B-5, they received information that this driftmeter was being replaced in combat by the B-3. Though this information appeared to be erroneous, the larger part of navigation training in the schools at the end of 1943 was being conducted on the B-3.

The gyro-stabilized flux gate compass was ready for delivery by the middle of March 1943. The navigation schools were scheduled to receive some of the first ones delivered. In the following May the Flying Training Command requested the compasses on the basis of one for each navigation syllabus and one for each 140 students for classroom instruction. This request was approved subject to the provision that requirements of /the/ tactical aircraft be met first. As late as January 1944 the commanding officer at San Marcos reported that there were only two installations of this equipment at that school. In the following month the Training Command requested that action be taken to install these compasses in all AT-7's. In the ensuing correspondence it was indicated that production was insufficient for tactical aircraft and that it might be January 1945 before all AT-7's could be equipped with this compass.

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- 36. Director of Training, AF Navigation School, Hondo, Tex., to CG, AFTRIC thru CG, AFCTC, 5 Nov. 1943, in AFACT files.
  - 37. AFTRIC to CG, AFTRIC, 5 March 1947, in AFACT files.
  - 38. 2d Ind. (to same), 10 May 1943, in AFACI files.
  - 39. 1st Ind. (CG, AFTRIC to AC/AS, Training, 16 June 1943), 3 July 1943, in AFACI files.
  - 40. CO, AF Navigation School, San Marcos, Tex., to CG, AFTRIC, 26 Jan 1944, in AFACT files.
  - 41. 2d Ind. (to same), 14 Feb. 1944; RAR, No. 7, AC/AS, MED to AC/AS, Training, 8 April 1944, in AFACI files.

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The item of equipment for which there was the largest quantity demand in the navigation schools was navigation kits. The kits contained approximately forty items of equipment, including sextant, American watches, computers, plotters, log forms, calibration cards, Air Almanac, flashlight, Hydrographic Office publications, Technical Manuals, and other items.<sup>42</sup> The nature of this equipment was such as to make it essential that a kit be issued to every navigation student upon entrance into training. The shortage of kits was so severe, however, that it was February 1943 before it was possible to issue kits upon graduation.<sup>43</sup> Attempts were made continuously from April to October 1943 to secure kits in sufficient quantity to issue them to students entering training.<sup>44</sup> At the end of October 1943 the status of navigation kits (celestial navigation, bombardier-dead reckoning navigation, and bombardier-celestial navigation) was indicated as 3,560 on hand as against a requirement of 15,236. In other words, there was a shortage of 9,600. Furthermore, in addition to this shortage the navigation schools needed 61,461 kits in order to supply them to entering students to the end of 1944.<sup>45</sup> In January 1944 the Air Service Command expected to be able to supply at least the celestial navigation kits in sufficient number by June 1944.<sup>46</sup>

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- 42. "Report of the Army Air Forces Board," Project No. (H-4) 537, 5 Nov 1944, "Review of AN Navigation Kits," in AAC files.
  - 43. Daily Diary, AFHQ, A-3 Div., 15 Jan. 1943, in AFHQ files; AFMS to CG, 2d AF, 22 Feb. 1943, in AAG CII, Navigation Officers.
  - 44. Project Book of CG, AFMNC, Navigation Sec., 20 Oct. 1943.
  - 45. Ibid.
  - 46. R.R. No. 1, AC/AS, AFAD to AC/AS, Training, 7 Jan. 1944, in AFAD files.

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The problem of driftmeters, compasses, and navigation kits is merely an example of conditions which prevailed in regard to virtually all items of navigation equipment. Differences in shortages of various items and at different times were only matters of degree. The situation was naturally more acute at those times when school population was increased rapidly, as in the early months of 1943. Another factor at that time was the adding of dead reckoning navigation to the regular bombardier course. These two conditions created an unusual shortage which was met partially by cannibalizing B-25's and B-26's used in pilot transition training. The Flying Training Command was authorized to remove navigational equipment from these airplanes,  
<sup>47</sup>  
except that needed for pilot navigation training.

By April 1944 there were still problems of materiel confronting navigation schools. The prospect of continued introduction of new equipment and tactical aircraft of even higher performance characteristics, while older equipment and plane types still remained in use, made the possibility for any final solution to the materiel problem unlikely.

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<sup>47</sup>. CG, AFHQ to AFRII, 26 Feb. 1943; 1st Ind., 10 April 1943, in AFHQ files; Daily Diary, AFHQ, A-7 Div., 5 Feb., 19 April 1943, A-7 Div., 23 Feb. 1947, in AFHQ files.

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Chapter VIII

SUMMARY

Before 1933 all navigation training in the Army air arm was a part of pilot training, the chief emphasis in the Air Corps schools. From 1933 to 1939, however, some specialized navigation training was given in tactical units. When the expansion program began in 1939 a program requirement of 509 officer navigators was established. There were then only 166 qualified navigators on duty with the GHQ Air Force.

Program requirements for navigators and other aircrrew categories pyramidized after 1939, and for many months production fell far short of the goals. No sooner were plans formulated to meet one requirement than was a far higher objective directed. For example, in December 1941 the Air Corps training centers, about to start training to meet an annual goal of 4,888 navigators, were told to submit plans to produce 9,400 navigators a year. Still before training to meet the 4,888 goal was started, the training centers were informed of yet another directive, calling for production of 13,500 navigators a year; the training centers were to reach this rate of production between 1 March and 1 August 1943. Although training under the 9,400 program was not begun until September 1942, the directed rate of production under the 13,500 program was met in June 1943. The program was still mounting, reaching 20,000 by September 1943, but by the end of the year it appeared that it would be stabilized or possibly reduced.

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Although original plans for the expansion program contemplated that all individual training of navigators would take place in specialized Air Corps flying schools, a year later no such specialized schools were yet in operation, and a contract was made whereby Pan-American Airways, Inc. agreed to train 850 navigators for the Air Corps. In addition to this civil contract school, on 1 November 1940 training began at Barksdale Field, but bad flying weather and insufficient facilities there and the reduction of Air Corps classes at the PAA school as a result of the beginning of training of United Kingdom students made it necessary to open navigator training at other stations.<sup>1</sup> Single-purpose schools--devoted entirely to navigator training--were needed, but materiel shortages forced training in conjunction with advanced pilot schools. In July 1941 navigator training was abandoned at Barksdale and begun at Turner, Kelly, and Mather Fields. Training had trailed so far behind goals up to this time that only 461 navigators were graduated from Air Corps and civil contract schools by 1 November 1941 although the production schedule called for 1,269.

Late in 1941 and continuing thereafter plans were made to increase the size of classes and to expand facilities at the schools. Mather Field was converted to a single-purpose school. In August 1942 a school at Hondo, Tex., replaced that at Kelly Field and in September one at Selman Field replaced Turner Field. Delays in be-

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1. The termination of British training by PAA in 1942, however, made it possible for the AAF to increase the size of its classes from 50 to 200.

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ginning training, however, caused "extremely acute" shortages in 1942, and the Flying Training Command was instructed that "drastic corrective action" should be undertaken immediately and that training should be expanded to the "maximum capacity commensurate with equipment and personnel provided."

A severe strain was put on the training agencies by the heavy demands for navigators in 1943. Additional complicating factors were the beginning of dual bombardier-navigator training and the lengthening of the navigator program of instruction from 15 to 18 weeks in January 1943. Better flow of equipment to the schools, entrance of double classes, and the opening of another school at San Marcos, Tex., helped to solve the problem.

The demands of the Air Transport, Troop Carrier, and Antisubmarine Commands in 1943 overtaxed the capacities of the training agencies. In September 1943 there was an apparent shortage of about 5,000 navigators. The Training Command opposed return to a 15-week program of instruction and called attention to "continued reports" of "non-utilization of navigators" in overseas Troop Carrier and Air Transport units. Questioning of the requirements of these two commands resulted, by January 1944, in a drastic lowering of their quotes. Meanwhile, an actual rather than a "paper" shortage had arisen in the Second and Third Air Forces. In many cases crews were in the last phase of operational training before they received navigators. This situation was gradually alleviated during 1943, but the late arrival of navigators probably accounts for some of the complaints from combat areas on the lack of navigator proficiency.

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Despite continued difficulties in meeting production requirements, the Training Command and AC/AS, Training used every alternative to prevent reversion to a 15-week program of instruction. By January 1944 it appeared that the chief production problems had been solved. But the fluctuating crew requirements of medium and very heavy bombardment and the attempt to introduce a third type of training—radar—for bombardier-navigators threatened to throw the whole program out of balance again. As a result the dual training of bombardier-navigators by the Training Command was stopped until it would be possible to resume it on a satisfactory basis.

The heavy production requirements necessitated an adequate flow of trainees from preflight to advanced navigation schools. More navigation trainees were produced from eliminees from other categories of aircr<sup>e</sup>w training than from any other source, although by October 1943 about half of the students were new cadets. The standards which new cadets were required to meet for navigation training were higher than those for any other type of aircr<sup>e</sup>w training. Although the pressure of the expansion program forced abandonment of earlier high academic prerequisites, the altitude requirements for navigator training remained higher than those for bombardiers and pilots.

By the fall of 1941 the equivalent of the later preflight bombardier-navigator schools had been established. The official preflight programs for the two types of training, however, were identical, and early in 1943 the pilot preflight program was adopted as standard for bombardiers and navigators as well.

Before 1943 practically all of the training of navigation stu-

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cologists was carried on in the tactical units of the CGO Air Force and its successor, the Air Force Combat Command. Individual training of navigators in tactical units was subject to several handicaps. Special projects, regular tactical operations, and bad weather at many bases interfered with the conduct of such training. In April 1936 the Commanding General of the CGO Air Force recommended the "establishment of a centralized school" to train navigation specialists, a recommendation similar to one made to the Chief of the Air Corps several months before. But shortage of equipment and lack of funds to procure it caused the project to be deferred.

In 1939 tactical units were given an additional responsibility, the transition stage of advanced pilot training. This caused a corresponding reduction in opportunity to give specialized navigation training. Even so, as late as March 1940 it appears that the establishment of single-purpose navigation schools under the Chief of the Air Corps was not contemplated. Navigation training in Air Corps schools was to be carried on at schools already engaged in one or more types of other specialized training.

The delay in establishing specialized schools for individual training and the rapid increase in the number of combat units under the expansion program caused the delegation of a large part of advanced pilot training and even more specialized non-pilot training to tactical organizations. It was planned, however, gradually to eliminate individual training in the tactical units as equipment became available to conduct it in Air Corps schools.

Although the established AAC policy was that individual train-

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ing in the tactical units should merely supplement rather than duplicate or replace that of the training centers, in August 1942 it was decided to send preflight navigator graduates for whom facilities of the Flying Training Command were inadequate to various air forces for advanced training. The training was accompanied by abnormal difficulties. For nearly three months the attempt was made to get 50 preflight graduates and the necessary equipment ready for shipment to the Caribbean Department. They were finally sent, but the Sixth Air Force informed AG/AS, Training that it would be unable to train any other navigation cadets after these graduated. Somewhat more success occurred in the Hawaiian Department, but apparently only three groups of cadets had been sent there by March 1943 and training was discontinued in April. After this time, individual training and qualification of navigators in tactical units seems to have been confined to giving navigation training to men who had already qualified in another specialty. Even this type of training was disapproved in November 1943, and in January 1944 all individual training of navigators in tactical units was definitely terminated.

The programs of instruction used in individual training of navigators in tactical units differed radically from those used in the Air Corps schools. They were less detailed, less academic, consisted mostly of air training, and were designed to effect the earliest possible attainment of combat proficiency. For example, in July 1941 more than 500 hours were allotted to ground training in Air Corps navigation schools, whereas only 182 hours were allotted to all ground training in the tactical units.

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The essential differences in both mission and method of the two training agencies--Air Corps schools and tactical units--account for most of the difficulties encountered in conducting individual navigation training in the tactical organizations and in the attempts to standardize courses of instruction in both. It was desired that training in the two agencies be closely parallel since individuals trained as navigation specialists in the tactical units were to be rated and/or commissioned.

In August 1941 the Chief of the Air Corps learned that the 16th Reconnaissance Squadron required only 30 hours of training in order to qualify as a dead reckoning and celestial navigator. He pointed out to the Chief of the AAF that approximately 500 hours were required in Air Corps schools. He recommended a standard curriculum for the air forces closely patterned on that used in Air Corps schools. The difficulties involved in trying to make the training comparable were obvious. They were certainly not solved by the decision of the Chief of the Air Staff that military personnel should be rated as navigators only if the training received was "substantially as comprehensive" as that given in Air Corps schools with the concession that such training would have to be within the capabilities of the tactical unit conducting it. The Commanding General of the Air Force Combat Command stated that the policy of his organization was to prescribe proficiency standards, not to specify a curriculum. He suggested the single requirement that the commanding officer specify that an individual was qualified "to carry out the function of navigator in the combat crew of bombardment and reconnaissance aircraft at the time of application" for rating. To this

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the Chief of the Air Staff added the requirement that he qualify "as expert gunner or aerial sharpshooter," and these became the standard requirements for rating navigators in tactical organizations.

In July 1942 when plans were being made to set up group schools in various air forces to give advanced navigation training to graduates of preflight navigation schools, a somewhat different problem was faced. The Directorate of Individual Training insisted that "high standards must be maintained" if such training took place. Some cadets were trained in the air forces from October 1942 to September 1943 despite the objections of the Flying Training Command to the policy. Apparently the requirements established by the Flying Training Command were followed. In September 1943 training of cadets in the air forces ended, and on-the-job training was restricted. In January 1944 it was directed that only AAF navigation schools were authorized to train and qualify navigators.

Apparently not many navigator cadets were trained in tactical units after July 1943. Because of the difficulties encountered, the relatively poor quality of the training performed, and the small number of navigators produced, there are grounds for questioning whether it was a profitable venture. Among the problems were the delays in travelling from preflight to the air forces, the lack of navigation training equipment, the shortage of instructor and supervisory personnel in the tactical units in the summer and fall of 1943, and the hardship on the air forces involved in giving individual training in addition to their regular OTU and RTU missions. There was a rather general belief that the product of the Flying Training Command schools was far superior to

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the man trained on the job. Individual Training in February 1943 stated: "Due to the present shortage of navigators, a serious situation of uncoordinated, half-baked training in the air forces is arising."

Because of the pressing demands on the individual training agencies and the critical shortages of the means necessary to accomplish their mission, training was nearly always based on what was expedient rather than on what was possible or theoretically possible. Those factors conditioning instruction in the navigation schools are reflected in the various programs of instruction for advanced navigator training.

From July 1940 to April 1944 there were five different programs of instruction in effect in the navigation schools: (1) a 10-week tentative program of 8 July 1940; (2) a revised program (apparently 12 weeks) of 20 September 1940; (3) a revision of 3 February 1941 specifying a 15-week program; (4) a further revised program of 15 July 1941, still 15 weeks in length; (5) an 18-week program approved on 27 January 1942 and changed slightly in July and November 1943.

The tentative program of 8 July 1940 was never actually used since it had been revised before training began at Barksdale Field in November 1940. The navigation program of instruction became reasonably well stabilized with the adoption of the 15 July 1941 course which remained in effect for 18 months. By the end of 1942, however, it was badly in need of revision, as new equipment had come into use,

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2. At the conclusion of the period covered by this study, a 20-week program was about to be adopted.

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new instructional methods and devices had been perfected, and combat experience had revealed the need of certain changes. Already the addition of instruction, often unofficial, on new equipment had resulted in a heavy overload on the students. They were finding it impossible to absorb the vast amount of instruction; the elimination rate was rising; there was an increase in the number of holdovers; and there was a decrease in the quality of the graduates. The Commanding General of the Flying Training Command recommended an extension of the course from 15 to 18 weeks, and this was approved by the Directorate of Individual Training in January 1943 on condition that there should be no reduction in the flow of graduates, that the additional time be used to relieve pressure on the trainees rather than for adding new material to the course, that there be no increase in flying time, and that there be no additional buildings constructed besides those already authorized.

It was found impossible to avoid adding some new materials to the program, because of the introduction into use of new equipment at the same time that old equipment remained in use in some combat theaters. Thus, there was a considerable increase in the number of hours of instruction. The 18-week program of January 1943 underwent only two minor revisions in 1943, but early in 1944 plans were under way to extend it to 20 weeks in order to put all aircrav training "in phase."

The overwhelming proportion of the individual training of navigators was ground training. The percentage of time allotted to this phase, including allied training, was approximately 82 to 87 per cent of the total hours in the curriculum. The academic ground training

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made up about 75 per cent of navigation instruction, since a large part of the navigator's proficiency could be attained on the ground.

Theoretical instruction was not extensive. Indoctrination in procedure, the primary need of the student, was provided by ground problems, followed by ground missions. The 18-week program provided for 26 ground problems and about the same number of ground missions, which were simulated flight missions. The ground problem was essentially instructional, the ground mission mainly a testing procedure, and the flight mission the laboratory phase of training. Examinations were weighted 25 per cent in measurement of proficiency in ground training, and performance of ground missions 75 per cent. The minimum over-all passing grade was 70.

Air training was carried on concurrently with ground instruction. Here all prior training was put to the final test. All types of navigation were progressively combined on single missions and applied on simulated day and night combat missions. Under the 18-week program 21 flights were scheduled, to which about 100 hours were allotted. Proficiency was measured purely by accomplishment, not on a percentage basis. There was a fairly close correlation between ground and air performance of navigation trainees, although some students were unable to adapt to air conditions. Trainees failing to meet any one basic requirement in air training were eliminated.

From the beginning of navigation training in Air Corps schools the content of instruction and training procedures was closely co-ordinated with the experience and demands of tactical organizations. Reports from tactical units began to come in after the summer of 1941.

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then the Chief of the Air Corps requested comments on navigator proficiency. There were many more reports and recommendations from theaters of operations after combat operations began.

Although combat units made relatively few complaints about dead reckoning and celestial navigation abilities of navigators, several deficiencies were noted in some aspects of navigation training. Beginning early in 1942 there were occasional adverse comments, particularly from the European theater, on proficiency in piloting and map reading. Apparently there was no appreciable increase in time allotted to these points in the navigation course as a result of these complaints, although particular schools took some action to increase emphasis on piloting and map reading.

Before the closing months of 1942 training in the use of radio as a means of navigation apparently did not receive sufficient emphasis, mainly because of lack of equipment. Throughout 1941 and 1942 tactical units pointed out the need for more stress on radio training, with the result that the January 1943 program of instruction increased the number of hours on radio navigation from 10 to 23. Complaints came in from combat theaters early in 1943 that navigators often entirely ignored or were ignorant of radio navigation methods. The Flying Training Command asked for information which would facilitate bringing radio training up to the desired standards.

Early in 1943 long-range navigation (Loran) methods were perfected, and all navigators graduating after 1 January 1944 were to be proficient on Loran equipment. The need of combat units for navi-

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Navigators familiar with long-range navigation caused the amendment of the January 1943 program of instruction to include 10 hours on Loran equipment.

Proficiency in navigation required ability to navigate by any and all methods. Many navigators reached theaters without the capacity to utilize combined methods. Overseas units reported and inspection of Second Air Force stations confirmed in the summer of 1943 that recent graduates of navigation schools tended to think in terms of "separate and distinct systems of navigation" rather than realizing that "they were required to get the airplane from one point to another using a combination of all possible information which might assist them." One authority attributed this weakness to the schools' system of using flying time to "supplement the progress of ground instruction." He recommended that all ground instruction be given prior to any air training so that the student would have an opportunity to "combine anything he likes." This recommendation was not adopted, but navigation schools did give increased emphasis to combined methods. The revised program of instruction of November 1943 indicates that 8 of the 23 ground missions and 14 of the 21 flight missions specifically required a combination of various methods of navigation.

In April 1944, after navigation training in specialized schools had been in operation nearly four years, instruction in the various schools had still not been standardized, nor was there a textbook on aerial navigation. This was the case despite continuing efforts of Headquarters, AF and the Training Command to try to effect standardization.

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In December 1943 a conference was held at Headquarters of the Flying Training Command to "standardize the navigation curriculum and to tie in the navigation program with preflight and bombardier training." But the new program of instruction of the following month did little to effect standardization, and in May 1943 AC/AS, Training directed the Flying Training Command to take immediate steps to standardize the course. Following this directive the Flying Training Command attempted to prepare a standard textbook and navigator's handbook, but it seems that nothing was accomplished before the establishment of the Central Instructors School (Navigator) at Selman Field in October. In November the school was assigned the task of preparing a navigation handbook, but higher priority projects diverted attention from this job. In December the instructors school was asked to prepare a standard set of publications to replace those issued by individual schools. After considerable work on the standardization problem, a conference was held at Selman Field in February 1944, but the program submitted was not acceptable to all the schools and a second conference was scheduled for 1 March 1944. The fact that standardization still had not been achieved by April 1944 indicates that there were two prerequisites to standardization: a central instructors school (finally established in October 1943) and uniform textbooks, syllabi, and other instructional material.

Original plans for navigation training contemplated flexible gunnery as well as bombardier training for all navigators. But both bombardier and gunnery training had to be abandoned after 7 December 1941. In the spring of 1943, however, navigator graduates were "scheduled"

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for five weeks of training at flexible gunnery schools, but the only feasible procedure was to send navigation trainees to the gunnery schools either prior to or immediately after preflight training. In July it was decided that they would be sent before entrance into preflight, but actually they went whenever it was expedient, and assignment was contingent upon vacancies in the flexible gunnery schools. At times bombardier and navigator quotas at gunnery schools had to be suspended entirely because of the shortage of career gunners.

By early 1943 gunnery school capacity had been greatly expanded and the flow of navigation trainee to gunnery schools became stabilized, although there were still instances in which large groups of navigators graduated without having received gunnery training. On 29 January 1944 the Training Command directed the three flying training commands to see that all navigation trainees entering advanced navigation schools after 10 June 1944 had gunnery.

Navigator training also took place in the PAA school at Coral Gables, Fla., and efforts were made to bring its program of instruction and proficiency standards in line with those of the Air Corps schools. When the 15-week program was adopted in Air Corps schools in February 1941, the course at Coral Gables was lengthened also from 12 to 15 weeks. But it included only 356 hours as compared to 449 in Air Corps schools. It was not long before the quality of PAA training was questioned. Attempts were made to correct the deficiencies by altering the program of instruction, but the basic difficulty was the limitation in personnel and equipment. As late as September 1943 the problem of bringing training at Coral Gables up to standard

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still had not been solved. Since the PAA program could not be made to parallel that conducted in AAF schools, the graduates came to be used by the Air Transport Command and Troop Carrier Command, whose navigators did not require gunnery or bombardier training. On 3 June 1944 AC/AS, Training informed the Training Command that neither it nor PAA "desired to renew the contract" and <sup>AAF</sup> navigator training at Coral Gables was to end.

From the beginning of specialized navigation and bombardier training it was considered desirable to train these specialists in dual capacities. But there were several difficult problems involved; for example, the necessity for tactical units to carry on their activities with an inadequate number of school graduates while new graduates were given the second type of training, the decision as to which category of training should be given first, the necessity of maintaining the first acquired proficiency while learning the second, and whether trainees should be commissioned at the end of the first type of training or after the completion of both phases of dual training.

The original instructions calling for dual training of bombardiers and navigators were issued on 5 September 1941, but the program had to be abandoned after the United States entered the war in order to expedite the flow of individually trained specialists to the tactical units. Navigation training, therefore, reverted to its original basis until after mid-1942 when Brig. Gen. J. H. Doolittle recommended that bombardier-navigators be trained for use in medium bombardment. The Flying Training Command contended that dual training would cut production of these specialists by one half; if dual training were conducted, it should be in tactical units. But because of the shortage of separate

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specialists, it was decided to combine the functions of bombardiers and navigators for medium bombardment units. Bombardier-navigators would be trained "in the operation of D-8 bombsights, map reading, pilotage, and dead reckoning navigation." The dual program was considered as temporary. Since the shortage of either bombardiers or navigators, or both, continued, the situation was met largely by incorporating dead reckoning navigation into the regular bombardier course in the summer of 1943. Until this was done, however, three types of dual training were conducted to meet the most immediate needs: (1) giving D-8 bombardier training to graduate navigators, (2) giving dead reckoning navigation to graduate bombardiers, and (3) sending a limited number of bombardiers and navigators through the complete course in both specialties (complete dual training).

Late in December 1942 the first class of graduate navigators to be given D-8 bombardier training entered the bombardier school at Carlsbad, N. M. Only two classes were given this three weeks' training. Meanwhile it had been decided to abandon this policy and to train graduate bombardiers as dead reckoning navigators, a more desirable policy to meet the needs of the medium bombardment units of the Third Air Force.

The third type of dual training--complete dual training--began before the regular bombardier course had been converted to bombardier-dead reckoning navigation, was recommended in July 1942. Requests from combat theaters for dually trained personnel and approaching delivery of the B-29 superbomber made it imperative that at least a be-

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beginning of such training be made. In October and November 1943 complete dual training was started on a small scale.

There were several strong objections raised to a complete dual training program, but the decision to conduct it remained unchanged. On the basis of the experience gained in the first part of the training, several changes were made in the spring and summer of 1943. For example, a refresher bombardier course was put into the navigation schools to enable bombardiers undergoing navigation training to maintain their proficiency. The early experience also demonstrated that the navigation phase should precede the bombardier phase. After July 1943 bombardiers were no longer sent to navigation schools, and the bombardier school at Roswell, N. M., was devoted entirely to training graduate navigators as bombardiers, beginning 11 September 1943.

By April 1943 it was obvious that production requirements could not be met if all bombardiers and navigators were given complete dual training. It was decided to train all bombardiers as dead reckoning navigators, and the bombardier course was extended to 13 weeks to incorporate dead reckoning navigation. All the bombardier schools were converted between June and December 1943. The school at Roswell, however, continued to train graduate navigators as bombardiers, and particular attention was given to the training taking place there. The results of early training were not entirely satisfactory, and in December 1943 the course was extended from 9 to 12 weeks to step down the tempo and to give trainees a chance to retain their navigator proficiency.

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Crew requirements for the B-29 called for two completely dually trained bombardier-navigators. When the flow of graduates from Roswell started in November 1943, indications were that the bombardier-navigator demands of the B-29 program would be adequately met. But within four months the entire program of complete dual training was suspended indefinitely. One development causing this suspension was the addition of radar training to dual training requirements for men to be assigned to B-29 units.

In September 1943 it was contemplated that bombardier-navigators would receive radar training at Boca Raton, Fla., but two days before it was to start there it was announced that the IX Bomber Command would perform the radar instruction as an on-the-job training course instead of having it take place in the Training Command. But the needs were broader than those of the IX Bomber Command, and the plan to utilize Boca Raton was revived. Because of the scarcity of men qualified to serve as instructors for radar training, on-the-job training apparently could not meet all the needs. Training at Boca Raton began in February 1944. Original plans called for the training of celestial navigator-bombardiers, but experience of tactical units in the United Kingdom indicated that better performance was obtained from bombardier-dead reckoning navigators trained on H2X equipment.

Radar training added to complete dual training created an impossible situation. It lengthened the training period at a time when requirements for B-29 personnel were increasing, and it added another field in which proficiency had to be maintained. Consequently, the Commanding General of the Second Air Force recommended that complete dual

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training be discontinued, and although AC/AS, Training and AC/AS, Operations, Commitments, and Requirements opposed its abandonment, they conceded that the addition of radar training made the situation extremely difficult. The Training Command schools were unable to produce enough radar-bombardier-navigators, and the tactical units were unable to assume the responsibility for the necessary individual training. Therefore, it was decided temporarily to discontinue complete dual training. In lieu of dually trained personnel, one bombardier-dean reckoning navigator and one celestial navigator would be supplied for each B-29 crew. Bombardiers were scheduled to receive radar training at Boca Raton, and navigators were to receive on-the-job radar training in the Second Air Force during their operational training. In line with this policy dual training at Roswell was discontinued with the last class to graduate on 23 June 1944. To meet the requirements of medium bombardment, however, the former policy of sending graduate bombardiers to the navigation schools was directed again in March 1944.

After discontinuance of complete dual training, there still remained the problem of providing radar training for single category specialists. The B-29 requirements for radar personnel were critical, and the first superbomber organization to go to a combat theater left without radar-trained men. Training facilities at Boca Raton and in the Second Air Force were inadequate. To expand training at Boca Raton, a directive was issued in April 1944 requiring the establishment of two radar observer (bombardier) courses at the earliest possible date.

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Shortages of trained navigators and the insatiable demands of the tactical units made it exceedingly difficult for navigation schools to obtain and hold enough qualified instructors. It seems that the problem of a sufficient number of instructors was not serious prior to December 1941, but after that time enrollment in the navigation schools rose rapidly. Before 7 December 1941 the ratio of instructors to students was about 1 to 6. On 15 December it was directed that this be changed to 1 to 8, but apparently it was not done. In April 1943 the ratio was 1 to 5.64. In August 1943 the established ratio was 1 to 5.23, and by April 1944 it had been established at 1 to 4.146. Apparently the instructor-student ratio was close to the authorized figure by April 1944, but there had been frequent acute shortages before.

One problem faced by the Training Command was the loss of experienced instructors to the tactical organizations. The tactical units lacked both navigation instructors and navigation staff officers. Partly as a result of these conditions navigators in operational training frequently lost some of their proficiency. To help to remedy this situation, the recommendation was made in June 1943 that an advanced navigation course be started to train selected school graduates and selected combat crew navigators who had completed their operational training. Such men could serve as staff navigation officers. The Directorate of Individual Training considered the plan desirable but not feasible since it would retard the production of school graduates at a time when any curtailment was unacceptable. But the poor quality of navigator training in the air forces required attention. The advanced navigation course was not established, but as a "temporary

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alternative," it was decided to send navigation instructors from the Flying Training Command on detached service to the Second and Third Air Forces. The command also agreed to furnish 225 navigation instructors to meet the needs of the air forces for staff officers. It was unable, however, to furnish them on schedule. By 1 May 1943 it seems that only 42 instructors had been sent to the air forces.

Before July 1943 each navigation school trained its own instructors, giving a three-week course to recent graduates who had been assigned for instructor purposes. A central instructors school was clearly needed, but it was not created until later in the year. Some instructor training on a small scale, in the form of a refresher course for returned combat navigators, took place at Mather Field after 1 August 1943. As the number of navigators returned from combat mounted and requests from tactical organizations for refresher training increased, the training at Mather became inadequate. The Training Command decided to convert the refresher course into a regular central instructors school, still to be located at Mather. The program of instruction consisted of 200 hours--91 on navigation technique (25 on instruments, 10 on theory, 56 on procedures), 51 on instructional techniques, and 58 on allied training. But the course was too short, lasting only a month, and it was attached to a training group at Mather rather than established as a separate school. Consequently, a new central instructors school was established at Selman Field in September.

At Selman three different programs of instruction were conducted: (1) combat navigators with training air forces were given a three-week refresher course followed by a three-week basic instructor course; (2) combat navigators with the Training Command were given the same course

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plus three weeks of advanced instructor training; (3) new graduates of the schools, who were to be retained as instructors were given the basic and advanced instructors courses.

Training at Selman began on 6 November 1943. The first few classes were equally divided between new school graduates and combat personnel, but soon combat navigators in the Training Command alone absorbed the full capacity of the school and a backlog of combat navigators without refresher or instructor training accumulated in the air forces. To make full use of combat navigators in the training program, it was determined that the entire capacity of the instructors' school would be used for this type of personnel. To enlarge capacity at Selman, the preflight school there was moved to Maxwell Field.

In the policy of maintaining close contact with the using agencies, attempts were made to keep school navigation instructors abreast of operational methods and procedures in tactical organizations. To effect this, instructors were sent on detached service to training air forces to find out what was expected of navigators and to observe and participate in operational training. By January 1944 this procedure seems to have become an established policy.

The shortage of pilots in the AAF until the end of 1943 was reflected in the navigation training program. The ratio of navigation trainees per pilot for the first two years of school training has not been ascertained, but in September 1942 the authorized ratio was 9 to 1. With the rapid increase of trainees, it was hard to maintain this ratio. It was often necessary that navigation pilots fly as many as eight hours a day. The high quality of these pilots made them especially desirable

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to the tactical units, and by December 1943 it had become established policy to release 30 experienced pilots from the navigation schools every 4½ weeks.

Of all the many factors curtailing the production of navigators, the basic retarding influence was the shortage of materiel items necessary for the conduct of training. Shortages adversely affected the opening and expansion of schools and the length and content of programs of instruction. In fact, virtually every effort made to expedite production met the obstacle of shortage of equipment, especially airplanes.

The basic type of aircraft used in navigation training was the AT-7, although AT-11's, AE-13A's, A-39's, B-18's, B-54's, and C-60's also were used. These had to be modified before use. The desired ratio of students to airplanes rose from 3 to 1 (for AT-7's) in December 1940 to 11.4 to 1 by September 1942. There was little change in the ratio after that time. From September 1942 through April 1947 the actual ratio of students to planes was close to the desired ratio. There was a temporary increase thereafter, but by April 1944 the actual ratio was about 11 to 1.

Although the delivery of AT-7's seems to have been adequate by September 1941, many of the planes were lacking necessary navigation installations. Also, some of the planes were diverted to agencies other than the Flying Training Command, a fact which threatened the expansion of schools scheduled for September 1942. It was necessary, therefore, to modify other types of planes, and inordinate delays were occasioned by modification. A serious shortage of planes resulted

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from slowness in deliveries and modification.

The AT-7 was never entirely satisfactory because of its limited performance characteristics. Consideration was given to stopping production of it and the AT-11, the bombardier trainer plane. Their performance was far inferior to that of the tactical aircraft in which operational training occurred. But the possibility of obtaining some C-47's for navigation trainers, expected release of combat type airplanes, and the slowness with which a newly designed trainer plane would reach the production-delivery stage caused the abandonment of the proposal for a new type of plane. As late as April 1944 the answer to the immediate problem seemed to lie in the procurement of more C-46's and in acquiring C-47's.

The demands for equipment also extended to such items as compasses, astro-compasses, driftmeters, air position indicators, and navigation kits. The newest types and models of equipment were allocated on a first priority to the tactical organizations. As a result navigation schools often trained students in the use of outmoded navigational instruments. The item for which there was the greatest quantity demand was the navigation kit. This should have been issued to every student upon his entrance into training, but it was February 1943 before it was even possible to issue kits upon graduation. At the end of October 1943 there was a shortage of 9,696 kits. In January 1944 it was expected that the supply of celestial navigation kits would be adequate by June.

In view of the intricate and almost overwhelming problems, the record of the AAF in individual training of navigators from the beginning of the expansion program in 1939 to April 1944 seems to be a

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creditable example of getting a tough job done. Difficulties were tremendous and continuous. Headquarters planners and those who executed policies on lower levels constantly had to be alert to changing conditions and requirements which necessitated expansion of facilities, elevation of production goals, modification of programs of instruction, and adoption of new training techniques. Many of the solutions to problems were not considered desirable or permanent, but were dictated by expediency and the necessity for compromise. Based on fluctuating requirements of general programs, the individual training agencies had to effect adjustments to meet the demands made on them. Quality often had to be sacrificed in the interest of meeting these demands, particularly in the days when the entire Army air arm was operating on an economy of scarcity, but in general the Headquarters training office, the Flying Training Command, and its successor, the Training Command, tried to maintain high standards in keeping with the important role of the navigator as an aircrew member in the combat theaters. Mistakes were made and there were many deficiencies in the training. The training agencies sought to find out what the principal weaknesses were--especially from the all-important point of view of combat needs--and, within the severe limitations under which they were operating, attempted to correct them.

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G L O S S A R Y

AAF	Army Air Forces
AAG	Air Adjutant General (formerly custodian of AAF Central Files)
AC	Air Corps
AC/AS	Assistant Chief of Air Staff
A/C Br.	Aviation Cadet Branch
AC/S	Assistant Chief of Staff
AF	Air Force
AFAAP	AC/AS, A-1 (Personnel)
AFACT	AC/AS, Training
AFAMC	Materiel Command
AFASC	Air Service Command
AFATC	Air Transport Command
AFBFO	Budget and Fiscal Office
AFCC	Air Force Combat Command
AFCETC	Central Flying Training Command
AFDIR	Directorate of Military Requirements
AFDOP	Directorate of Personnel
AFFTC	Flying Training Command
AFHDI	Historical Division
AFIHL-AH	Administrative History Branch
AEFDP	Military Personnel Division
AERAS	Directorate of Air Support
AERBS	Directorate of Base Services
AFRDB	Directorate of Bombardment
AERIT	Directorate of Individual Training
AFROM	Directorate of War Organization and Movement
AFSUB	Antisubmarine Command
AFTAS	Air Surgeon
AFTRC	Training Command
AFWFC	Western Flying Training Command
AG	Adjutant General
Asst.	Assistant
AFO	Army Post Office
Br.	Branch
BFO	Bombing through overcast
C/AAF	Chief, Army Air Forces
C/AC	Chief of the Air Corps
C/AS	Chief of the Air Staff
CG	Commanding General
CO	Commanding Officer
C/S	Chief of Staff

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Div.	Division
ETA	Estimated time of arrival
Exec.	Executive
F. T. C.	Flying Training Command
GCACFC GHQ AF	Gulf Coast Air Corps Training Center General Headquarters Air Force
Ind.	Indorsement
JAG	Judge Advocate General
M&D	Materiel, Maintenance, and Distribution
OCAC	Office, Chief of the Air Corps
OC&R	Operations, Commitments, and Requirements
OTU	Operational Training Unit
PAA PWA	Pan-American Airways, Inc. Public Works Administration
R&R RTU Reg.	Routing and Record Sheet Replacement Training Unit Regulation
Sec.	Section
SEACFC	Southeast Air Corps Training Center
TC	Training Center
T. C.	Training Command
TCC	Troop Carrier Command
T/O	Table of Organization
T&O	Training and Operations Division
TMX	Teletypewriter exchange (message)
WOACFC WD	West Coast Air Corps Training Center War Department

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211B	Titles and Grades
211C	Titles and Grades
211D	Pilots
211D	Titles and Grades
211E	Cadets
319.1-3	Daily Diaries

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319.11 Daily Diaries  
352.01C Establishment of Air Service Schools and Staff Colleges  
352.01D Establishment of Schools  
352.11 Navigation Schools  
352.11A Courses of Instruction  
352.11B Courses of Instruction  
352.11C Courses of Instruction  
352.11D Courses of Instruction  
352.11E Courses of Instruction  
353 Bombardier Training  
353 Navigation Training  
353A Bombsight and Navigation Training  
353B Bombsight and Navigation Training  
353.01A Training Schedules and Directives  
353.9 Advanced Aviation Training  
353.9 Navigation (Advanced Aviation) and Instrument Training  
353.9 Specialized Training  
353.9A Navigation (Advanced Aviation) and Instrument Training  
353.9A Training, General  
353.9B Gunners, Bombardiers  
353.9B Navigation and Instrument Training  
353.9B Training, General  
353.9B1 Training, General  
353.9B2 Training, General  
353.9C AC Training Directives and Programs  
353.9C Training, General  
353.9C Training Programs and Directives  
353.9C1 Training, General  
353.9C2 Training, General  
353.9D1 Training, General  
353.9D2 Training, General  
353.9E Training, General  
353.9F Training, General  
353.9F Training in Aviation, Pilot  
353.9G Training, General  
353.9I Aviation Pilot Training  
353.9-13 Bombsight Training  
452.1 Training Airplanes  
452.1A Training Airplanes  
452.1B Training Airplanes  
452.1N Training Airplanes  
452.1P Training Airplanes  
452.1Q Training Airplanes  
452.1R Training Airplanes

The materials in these classified and unclassified file books were invaluable in the preparation of this study. Much of the material is duplicated in the more compact files in the Office of the Assistant

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ant Chief of Air Staff, Training. Many documents, however, particularly for the earlier years, were found only in Central Files.

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Air Adjutant General

Miscellaneous materials

Assistant Chief of Air Staff, Intelligence, Historical Division

Miscellaneous materials

During the preparation of this and other studies the Training Section, Administrative History Branch, has collected many materials on all phases of aircrew training. Daily diaries of training agencies, the Project Book of the Commanding General, Flying Training Command [later Training Command], social and periodic reports, and various official publications are in these files. (For other materials in this office, see Special Studies.)

Assistant Chief of Air Staff, Personnel

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Assistant Chief of Air Staff, Training

Miscellaneous materials

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Training Command, A-2 Division, Historical Section

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Personnel of the Historical Section of the Training Command combed files in the Headquarters of the Training Command for data on navi-

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gation training and lent notes on the subject to the author. Notable items were excerpts from daily diaries of the staff divisions of the Training Command.

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"History of Selman Field, Monroe, Louisiana, 15 June 1942-31 December 1942."

Eventually unit histories will be filed in the Archives of the Historical Division, Assistant Chief of Air Staff, Intelligence. At the time of the preparation of this study, however, some of the above were in the Historical Section of the Training Command.

~~REFURBISHED~~

~~RECORDED~~

Appendix 1

PROGRAM OF INSTRUCTION  
TRAINING OF AERIAL NAVIGATORS  
for military students to be given in  
AIR CORPS FLYING SCHOOLS  
[15 July 1941]

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## I. OBJECTIVE:

To qualify students as navigator members of combat crew.

## II. SCOPE:

1. Qualification as precision dead reckoning and celestial navigators.
2. Qualification as junior officer members of the combat crew.

## III. DURATION:

Fifteen weeks.

## IV. PROGRAM:

### 1. Flying Training.

	<u>Hours</u>
a. Familiarization	3:00
b. Calibration	4:00
c. Navigation Flights (Day)	61:00
d. Navigation Flights (Night)	<u>32:00</u>

Total Hours - 100:30

Note: Two or three students per airplane, as equipment permits.

### 2. Ground School.

#### a. Dead Reckoning Navigation.

(1) Instruments	20:00
(2) Maps and Charts	27:00
(3) Dead Reckoning Procedure	29:00
(4) Dead Reckoning Problems	30:00
(5) Preparation and Critique	34:00
(6) Radio Navigation	16:00
(7) Review and Examination	<u>50:00</u>

Total Hours - 200:00

#### b. Celestial Navigation.

(1) General Theory	8:00
(2) Time and Hour Angle	20:00
(3) Instruments	11:00
(4) Star Identification	14:00
(5) Astronomical Triangle	22:00

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	<u>Hours</u>
(6) Precomputed Data	14:00
(7) Celestial Navigation Procedure	30:00
(8) Preparation and Critique	35:00
(9) Review and Examination	40:00
Total Hours	200:00
c. Meteorology.	
(1) Theory and Principles; Weather Analysis; Weather Reports	10:00
(2) Interpretation of Weather Maps; Discussion of Forecasts	17:00
(3) Special Weather Influences; North and South America	10:00
(4) Ocean Meteorology - Facilities and Influences	5:00
(5) Thunderstorms; Tornadoes; Icing Conditions	14:00
(6) Practical Exercises	9:00
Total Hours	65:00
3. Athletics and Military Training.	
a. Athletics.	Exercise of at least one (1) hour per day.
b. Military Training.	Reviews, Inspections, Duties of Jr. Officers.
	50:00

V. TEXTS:

Phase of Instruction	Texts Now Available	Proposed Texts	Supply Agency
(1) Dead-reckoning Navigation	TM 1-205; Spec. Pub. #107	:	AG
(2) Celestial Navigation	TM 1-206 TO 03-15-1 TO 03-15-2	:	OSAC
(3) Meteorology	TM 1-230 TM 3-740 Cir. "P"	:	AG
(4) Athletics	FM 21-20	:	AG
(5) Military Training	FM 22-5	:	AG

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AIR NAVIGATION TRAINING SCHOOLDetails of Curriculum

<u>Index</u>	<u>Details of Curriculum</u>	<u>Time in Class</u>
No.	Introduction to the Navigation School & Orientation.	1:00
Lect.	Answer questionnaire on mathematical education and military experience	1:30
No. No.	Assignment to flights and elements and instructors.	:30
Cur. Subj.	Read Pilots Information File. (This will be accomplished by each student in the evenings or in some spare time during the first week of school, and must be completed before flying commences.)	
1-1-1	General Definitions of Navigation.	1:00
2-2-1	Earth's Surface. Use of the sphere showing system of coordinates, meridians and parallels, latitude and longitude, great circles and small circles, course, including difference between great circle course and Mercator course; distance, statute mile and nautical mile.	1:00
3-3-1	Lambert-conformal Conic Projection and the Mercator Projection; explanation of construction of these projections. Method of measuring course and distance on each. Practical exercises.	2:00
23-3-2	Gnomonic, Stereographic, and other Projections; Plotting Sheets. Continued study of map projections and their development on a plane surface; the gnomonic projection and the stereographic projection. Mention of the less common projections, polyconic, and modifications of the polyconic and the mercator projections. Use of plotting sheets in navigation.	2:00
27-3-3	Use of Plotting Sheets. In order to illustrate the use of the plotting sheet the student will prepare a blank plotting sheet for the flights he will later fly by plotting in the location of airports, lighthouses, or other objectives in the operating area. The use of a planning sheet on both the Lambert-conformal and the Mercator projections to determine the sectional maps or plotting sheets necessary for the flight will be illustrated by an explanation and practical exercise.	2:00

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<u>Index</u>	<u>Time in Class</u>
63-3-4 Chart Navigation. Review of maps and charts; continued study in the use of the planning chart. This will be illustrated by practical exercises in which the planning chart on both the Lambert-conformal projection and the Mercator projection will be given. In working from the planning chart to the plotting chart both types of projections for the plotting chart will be illustrated. The great circle distance, and the Mercator course and distance will be determined and compared; factors influencing the decision on which route to fly, the great circle route or the full Mercator course; method of determining the Mercator legs of the great circle route. Practical exercises illustrating all the uses of these two types of charts on both projections will be given.	4:00
6-4-1 Map Reading and Elementary Dead-reckoning. Map symbols; how to do pilotage. To illustrate this the instructor will select some landmark which can be readily described, such as peculiar shaped mountain or a town with railroads or highways entering and leaving from certain directions. The student from this description will locate the object or place by latitude and longitude. The use of elementary dead-reckoning to assist the navigator in pilotage will be illustrated by calculation of G.T.A. for landmarks or check points along fictitious route, ground speed having been determined by pilotage.	3:00
17-4-2 Pilotage and Elementary Dead-reckoning. Continued study of this method of navigation; emphasize the importance of determining safe altitude at which to fly; map reading and elementary dead-reckoning; keeping the complete record in navigator's log.	1:00
4-5-1 Magnetism and the Compass. Theory of magnetism; explanation of variation and deviation; Isogonic and Agonic Lines; Lines of annual change; General construction of the compass, how to set and read the compass; practical exercises in working from true course to compass heading and "Follow the pilot" procedure.	2:00
5-5-2 Drift Meter - Its Purpose and Use. Alignment of the Drift Meter by the plumb bob and chalk line; mention of the transit or pelorus method; explanation of operation of the Drift Sight.	1:00

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7-5-3 Altimeter, Air Speed Meter, and other Instruments. Description, purpose and use of the Altimeter, Air Speed Meter, Air Temperature Thermometer, the Airplane Clock and the flight instruments, the Directional Gyro, the Artificial Horizon, the Bank and Turn Indicator, the Rate of Climb Indicator, and the Automatic Pilot, use of the Remote Control of both the Automatic Pilot and the Directional Gyro. Definition of indicated, calibrated, and true values of airspeed and altitude; how to correct indicated readings for pressure and temperature; methods of setting the altimeter.	3:00
8-5-4 Compensation and Ground Swinging of the Compass. Method of eliminating lubber line error; method, purpose, and importance of compensation, use of the transit and the compass swinging base.	1:00
9-5-5 Air Swinging of the Compass by Terrestrial Bearing. Air Swinging of the compass by the B-2 or B-3 drift meter; Practical exercises in determination of compass deviation by the use of this instrument, allowing the student to handle the instrument in simulated problem.	2:00
10-5-6 Computer Slide Rule Face. Brief explanation of slide rule principle of construction of the E6-B computer. Problems in multiplication, division, proportion, interconversion of statute, nautical miles and kilometers, method of finding calibrated and true altitude, and true air speed.	1:00
11-5-7 Calibration of the Air Speed Meter. Procedure on Calibration flight; practical exercises in calibration.	4:00
12-5-8 Practical Exercises in Air Swinging of the Compass by Terrestrial Bearing. Sample problem illustrating use of B-2 or B-3 drift meter in air swinging will be given. Data will be given to student who will make necessary computations to determine deviation correction.	3:00
14-5-9 Preparation of Air Speed Calibration Cards. Making the air speed calibration cards from the data collected on Flight Mission #2.	1:00
18-5-10 Preparation of the Compass Deviation Cards. Making graph and compass deviation correction cards from the data obtained on Flight Mission #3.	1:00

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44-5-11	Octants. Instructions in the Care and Use of Aircraft Octants. This lecture is primarily designed to permit the student to become familiar with operation of the Octant. An explanation of the direct and indirect sighting features of Octants will be given.	1:00
86-5-12	Octant Check. Discussion of Octant errors. Checking Octant to determine instrumental error by use of collimator or other method, or check by stationary curve to determine instrumental and personal error.	1:00
15-6-1	Vector Diagrams and Graphic Solutions. Vector diagrams illustrating the wind and drift triangle; graphic solutions; practical exercises in this; determination of wind and ground speed by drift on two headings and the double drift problem.	4:00
16-6-2	Various Problems Solved by Computer. Use of the computer; solving problems in wind and ground speed, double drift, off-course corrections. Practical exercises in solving all of the above problems.	2:00
20-6-3	Practical Exercises in Use of the Dead-reckoning Tables in Solution of the Drift Triangle. Practical exercises and use of the dead-reckoning tables.	3:00
19-7-1	Duties of the Navigator; Keeping the Log. Chronological order of procedure; Correction of air speed and altitude by the computer; Determination of course and compass heading, speed, time, and distance; Allowance in elapsed time for double drift; Allowance for time of turn, Method of averaging drift to find track made good when flying in clouds; Follow the pilot instruction. Procedure during climb and descent. All of the above will be illustrated in class by sample problems on which the log sheet will be kept.	4:00
22-7-2	Practical Problems in Standard Navigation Procedure; Dead-reckoning. Additional work in keeping log sheet, using E6-B computer; Determining course, variation, deviation, compass heading; problems in ground speed by double drift, by both timing methods, and by wind streaks in low over-water flying. Calculating distance run, distance to go, and D.T... .	4:00

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| 24-9-1  | Chronometers and Time Signals.<br>Determining the rate on the watch by time signals; Zone time and the time zones of the world; Greenwich time. Use of the hack watch. Students will be assigned in turn to rate master watch placed in the classroom.  | 1:00 |
| 25-9-1  | Radius of Action.<br>Explanation of the Radius of Action problem and discussion of the ideal solution. A brief resume of vector diagram as involved in the Radius of Action problem will be given. No time will be spent on the solution as practiced on tactical missions. The lecture period will be divided into two parts, the greater portion being devoted to Radius of Action when returning to second base. | 4:00 |
| 26-9-2  | Patrol.<br>The stereotyped pattern for patrol missions will be illustrated. Method of obtaining ground speed from drift on two headings and averaging ground speed on the long legs of the pattern will be explained. Method of determining E.T.A. and closing entries in log book at end of each leg will be explained.  | 1:00 |
| 29-9-3  | Interception.<br>The application of the interception problem to surface vessels will be explained; the ideal solution of an interception problem will be illustrated by diagram. Practical exercises will be given.   | 4:00 |
| 30-9-4  | Search.<br>Typical search patterns will be illustrated; terminology used in reconnaissance work will be explained.  | 1:00 |
| 31-9-5  | Review of Radius of Action and Interception.<br>Review of the ideal solution and practical problems.  | 2:00 |
| 36-10-1 | Interpretation of Bearings, Lines of Position and Fixes.<br>Definition of a bearing and a line of position; explanation of the necessity for the running fix; practical exercises in the use of one bearing or one line of position; the various combinations of bearings to obtain a fix.  | 4:00 |
| 37-10-2 | Practical Problems on Bearings and Fixes and Review of Theory of Bearings and Fixes.<br>Detailed explanation of the interpretation of bearings, lines of position, and fixes. Practical problems to illustrate lecture.   | 3:00 |

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<u>Index</u>	<u>Time in Class</u>
48-11-1 Federal Aids to Navigation. Use of light beacons, radio range beacons; reference should be made to Technical Orders 03-15-1 and 03-15-2.	2:00
49-12-1 Operation of the Radio Compass Receiving Set. Detailed instructions in the procedure necessary for operating the set as a homing device and as a compass.	1:00
50-12-2 Theory of Radio Navigation. Advantages and limitations of radio navigation, its use as an auxiliary method. Radio procedure when the compass is located on the plane contrasted with procedure when the ground radio direction finder station is used.	4:00
52-12-3 Conversion of Bearings. The necessity for the conversion of bearings will be fully explained. Explanation will cover the method of converting a radio bearing to a Mercator bearing before plotting on a Mercator plotting sheet; the method of converting a radio bearing taken by an aircraft to a direct bearing before plotting on the Lambert-conformal chart. Practical exercises in converting bearings and plotting them on the different map projections.	2:00
53-12-4 Practical Problems in Bearings and Fixes. Theoretical flight will be given illustrating the use of radio bearings in obtaining fixes, finding the average track and ground speed. Work will be done on a Mercator plotting sheet and log book will be kept.	3:00
45-13-1 Observations - Parallax and Refraction. The limitations of the bubble octant to indicate the horizontal under flight conditions will be discussed. The procedure of taking observations by recording the time and altitude of each of ten shots will be outlined to the student. Theory of parallax and refraction will be explained and necessity for correction to octant observations illustrated by diagrams, the use of the correction tables in the Air Almanac and in the solution books will be given. The remainder of the period will be devoted to octant practice.	2:00
38-14-1 Introduction to the Celestial Sphere. A brief introduction to the celestial sphere illustrating by diagram the method of locating bodies by declination and hour angle. Practice in identifying the stars, estimating their declination and hour angle will occupy the major portion of this period.	2:30

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| 41-14-2 | Names of Constellations and the Navigational Stars.<br>The primary method of star identification will be to fix in memory the pattern of each constellation as shown on the navigational star chart in the Air Almanac. The names of the principal navigational stars in each constellation will be memorized. The pointer system as an aid to locating stars will be explained. This method of star identification will be followed in all the night star classes. | 2:30 |
| 43-14-3 | Location of Stars on the Horizon Projection.<br>Necessary instructions to enable the student to locate the stars on a horizon projection will be given with no discussion of theory involved. This will be a mechanical process for the purpose of having him plot in the stars by their right ascension and declination and identify them in the sky. One such projection with the stars then visible will be made and used in identification.                     | 2:30 |
| 47-14-4 | Making the Observation; Use of the Octant.<br>Students will use octants in observing stars previously identified. Proper method of making observations and recording the correct time will be explained. The use of the graphic average form will be illustrated.   | 2:30 |
| 55-14-5 | Observation of the Stars and Solution for a Line of Position.<br>First part of this period the instructor will explain the use of the Ageton solution together with the observation to determine intercept and demonstrate method of plotting a line of position. Students will then take observations, compute a solution, and plot the resulting line of position.  | 2:30 |
| 58-14-6 | Plotting the Line of Position.<br>Additional practice in making observations and plotting the lines of position.  | 2:30 |
| 61-14-7 | Completion of Horizon Projection for Use as a Star Finder.<br>The student will continue making the identification chart on the horizon projection in order that he will eventually have his own star finder for each hour of local sidereal time. Observation with the octant will be performed and the lines of position plotted.  | 2:30 |
| 64-14-8 | Observation of Stars and Plotting Fixes.<br>Students will make observations on pairs of bodies whose relative positions are favorable for a fix, lines of position will be plotted and a fix obtained.  | 2:30 |

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70-14-9 Observation of the Planets. Practice in observing planets, working solutions by Ageton, and plotting lines of position. Fix will be made if practicable. Identification of new stars will be maintained.	2:30
75-14-10 Observation of the Moon. Observations will be taken on the Moon; Ageton solutions will be worked, and corrections for parallax and refraction applied. Lines of position will be plotted; identification of new stars will be maintained.	2:30
81-14-11 Observation and Solution by H. O. 214. The theory of observation which outlines the number of shots and times to be recorded, based on the stability of the platform (from which observation is made) and the rate of change in altitude of the body will be explained. A celestial body or bodies will be observed. Solutions of the Astronomical triangle will be worked by H.O. 214. Lines of position will be laid down from the assumed position and fixes will be obtained with favorable lines of position.	2:30
88-14-12 Precomputed Solutions & Adjustments of Observation. Observations will be made on celestial bodies for which solutions have been precomputed by H.O. 214 and adjustment of the altitude for time difference of observation will be made. Lines of position will be plotted and fixes obtained.	2:30
98-14-13 Midnight Star Identification; Observation of Bodies on the Meridian and of Polaris. In the preparation for this class the horizon projection for the time of the class will have been prepared. This will be used in identifying the changed position of the stars and new stars with which the student is unfamiliar. Observations will be taken on Polaris and latitude determined. Bodies on the meridian will be observed to determine latitude. Resulting lines of position will be plotted and if favorable, fixes will be obtained.	2:00
101-14-14 Early Morning Star Identification. Star identification class will be scheduled for early morning to enable students to become acquainted with stars as they appear at that time. Horizon projections should be employed by students as an aid to identification.	2:00

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		<u>Time in Class</u>
56-15-1	Plain, Traverse, Parallel, and Mid-latitude Flying. Plain Flying will be used as an introduction to the calculated methods and for the purpose of refreshing the student's memory on trigonometry and logarithms. The subject of mid-latitude and traverse flying will be mentioned very briefly as a matter of general information. Parallel flying will be dwelt on to show the calculation of distances on the sphere as the first practical method of calculating flying.	4:00
57-15-2	Mercator Flying. This method of solution will be emphasized as the calculated method of most practical use, its application to the Mercator chart will be brought out. Practical problems in this form of solution will be given, including particularly problems crossing the Equator and the Greenwich Meridian and the International Date Line.	4:00
60-15-3	Great Circle Flying. The calculated method of determining the Great Circle course and distance by the Ageton solution will be used. Emphasis will be made upon the decision the navigator must make by comparing the great circle distance with the full Mercator distance to determine the route he will fly. The method of calculating the Mercator legs of the great circle route by the Ageton solution will be explained. One practical problem will be given. Method of solution by H.O. 214 will be mentioned.	4:00
62-15-4	Problems in Mercator Flying. Additional practical exercises solving Mercator solutions for course and distance.	4:00
32-16-1	Procedure on Tactical Interception Missions. Interception problems will now be discussed from the viewpoint of the procedure involved in solving them on tactical missions. Factors influencing the navigational technique required will be discussed. Practical exercises will consist of theoretical flights outlining in detail the step by step procedure in the solution of these problems. Reference should be made to mimeographed pamphlet "Precision Dead-Reckoning Applied to Tactical Missions."	4:00
33-16-2	Procedure on Tactical Radius of Action Missions. Discussion and illustration of the method of dividing the tactical mission into phases for the purpose of determining radius of action. Factors influencing this problem will	

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- be fully discussed. Reference should be made to mimeographed pamphlet "Precision Dead-reckoning Applied to Tactical Missions." Practical exercises will consist of theoretical flights outlining in detail the step by step procedure in the solution of these problems. 2:00
- 34-16-3 Procedure on Tactical Search Missions. The factors influencing this tactical mission will be discussed with emphasis upon the use of correct terminology. Practical problems illustrating the more common search patterns will be given. Reference should be made to mimeographed pamphlet "Precision Dead-reckoning Applied to Tactical Missions." 1:00
- 46-16-4 Review of Tactical Radius of Action and Interception Missions. Before the review is taken up a detailed explanation will be given illustrating the usual procedure on bombing missions from the departure over initial point to the objective itself. The dead-reckoning procedure required to solve the navigational problem involved in calculating the indicated air speed required to fly several short courses while changing altitude in order to arrive at the objective at a pre-determined time, will be fully explained. A theoretical flight illustrating the procedure on a combined interception and radius of action mission will be given. The plotting sheet and the log book work will be completed. Reference should be made to mimeographed pamphlet "Precision Dead-reckoning Applied to Tactical Missions." 4:00
- 54-16-5 Review of Tactical Missions. A brief review of procedure on tactical missions; theoretical flight involving the combined radius of action interception and search mission will be given. Reference should be made to mimeographed pamphlet "Precision Dead-reckoning Applied to Tactical Missions." 4:00
- 65-17-1 Celestial Definitions. Explanation of the celestial sphere. These definitions will be explained with the black slated sphere, showing the circles, arcs and angles by chalk lines. These definitions must be memorized, and the student must be able to visualize these circles not only on the slated sphere but in the heavens. 2:00

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| 68-17-2 | Review of Celestial Definitions.<br>A review of celestial definitions with particular emphasis on correct terminology. Use of diagrams on the sphere to illustrate the values defined.   | 2:00 |
| 66-18-1 | Motions of the Heavenly Bodies.<br>Short discussion of the planetary system, depicting the motion of the earth as similar to the motions of the other planets; explain the position of the planetary system with reference to the fixed stars; show how the motion of the earth in revolution about the sun generates the seasons for the earth.   | 2:00 |
| 69-18-2 | Time.<br>Explanation of the apparent motion of heavenly bodies and the generation of time; mean, civil, and standard time, apparent time, time zones, Greenwich time, the equation of time, sidereal time.   | 2:00 |
| 71-19-1 | Relation of Time, Hour Angle and Longitude.<br>The preliminary part of this lecture will be the transition from the study of motions and time to hour angle and longitude. The relation between time and longitude will be made clear. Practical exercises in the problems dealing with time, hour angle, and longitude will be given.   | 3:00 |
| 73-19-2 | Practical Problems in Time, Hour Angle, and Longitude.<br>A short review of time and its relation to hour angle and longitude. Introduce at this time the purpose of such time in navigation; how to locate a body by its hour angle. This statement will be made as an introduction to the astronomical triangle in order to show that having obtained the necessary elements of this triangle from the almanac, it can then be solved. The major portion of this period will be devoted to practical exercises in time, hour angle, and longitude. | 3:00 |
| 72-20-1 | Time Diagram.<br>The time diagram will be explained and its use as a means of depicting the angles concerned in those problems will be practiced by several exercises.   | 1:00 |
| 74-21-1 | Solution by H.O. 214.<br>A brief explanation will be given of the method of solving the Astronomical triangle by H.O. 214. Practical problems to illustrate this lecture will be given by the instructor.  | 1:00 |

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76-21-2	Elements of the Astronomical Triangle. Elements of the astronomical triangle will be shown on the slanted sphere; discussion and explanation as to how each element is obtained will be made; explanation of a position circle, what it is, how the line of position is developed from the position circle. The definition and explanation of intercept will be made; how the assumed position can be selected and the altitude and azimuth for the assumed position computed; comparing the observed altitude with the computed altitude to secure intercept; importance of having correct sign affixed to intercept. Illustrate procedure for laying down azimuth and plotting LOP.	2:00
79-21-3	Practical Problems in Determining Values of the Astronomical Triangle. A brief review of the elements of the astronomical triangle. Practical problems in solving it by H.O. 214. Laying down the lines of position.	2:00
39-5-5	Use of Pelorus and Calibration of Turret. Description, explanation and use of pelorus. Method of calibrating turret. Practical problems in calibration.	2:00
40-21-1	Solution by H.O. 211. The students will be taught how to use the almanac and H.O. 211 by purely mechanical methods. The purpose of this lecture is to enable the students to find the azimuth of celestial bodies for use in compass swinging.	1:00
40X-22-3	Air Swinging of the Compass by Celestial Azimuth. The procedure in operating the pelorus to observe the heavenly bodies, and the operation of the B-2 or B-3 drift meter to observe the shadow of the airplane by which the relative bearing from the reciprocal of the azimuth can be obtained will be fully explained. Practical problems illustrating the determination of compass deviation corrections by these methods will be given.	4:00
77-23-1	Determining G.H.A. and Declination. Use of the American Air Almanac for obtaining hour angle and declination of the sun and stars. Practical exercises in determining hour angle and declination.	2:00

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- 100-23-2 Additional Tables of the Almanac and the Rude Star Finder; the Coriolis Theory.  
Explanation of all the additional tables in the almanac and practical exercises in their use. The use of the Rude Star Finder with special emphasis on the selection of bodies for observation during flight. Explanation of the Coriolis Theory and its effect on air observations. Practical problems in applying the necessary corrections. 3:00
- 104-23-3 Use of the Almanac and the Rude Star Finder in the Navigational Plan.  
Practical exercises using all the tables of the air almanac and the Rude Star Finder will be given. Emphasis will be placed on the value of the star finder in preparation for celestial missions. 3:00
- 80-24-1 Interpretation of the Single Line of Position; the Running Fix. This lecture will contain an explanation of how to use position lines after they have been laid down on the plotting sheet. Interpretation of the line of position, the running fix, and the fix will be a continuation or review of previous explanations of this subject taken up under bearings and fixes. Practical exercises in the interpretation of lines of position and in the making of a running fix will be given. 2:00
- 85-24-2 Interpretation of Fixes.  
Interpretation of fixes and determination of average track and average ground speed from the fixes. Practical exercises in plotting and interpretation of fixes. 2:00
- 89-25-1 Latitude by Polaris.  
The theory and method of determining latitude by observations of Polaris will be explained and practical exercises will be given. 1:00
- 90-25-2 Meridian Altitude  
The advantages and limitations of observing a body on the observer's meridian will be explained. The four possible cases of the astronomical triangle will be illustrated and the solution for each case shown by diagram. 1:00
- 82-26-1 General Precomputation; Adjustment.  
Importance of precomputation to the military navigator, who conceivably would have additional duties during the tactical flight, will be explained. The different methods of pre-computation, precomputed solutions and their adjustment for the time difference between the time of solution and the time of observation. Practical exercises in adjustment. 2:00

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83-26-2	The Stationary Curve. The use of the precomputed stationary curve for checking octants and chronometers will be explained. Mention of its use in the landfall will be made. Practical exercises in making the stationary curve using Ageton solution.	2:00
84-26-3	Practical Problems in Making Stationary Curves. Additional practical exercises in making a precomputed curve by Ageton solution.	2:00
87-26-4	Practical Problems in Precomputing Solutions. Practice in precomputing solutions will be accomplished by preparing solutions for stars to be observed in the night class.	1:00
93-26-5	The Running Curve. Explanation of the course curve, its correction and value. Full discussion as to the selection of assumed positions, and method of indexing by time and latitude or longitude. In explaining the use of the curve in flight it should be stressed that early or late take-off does not impair its value.	1:00
110-27-1	Theory of Star Altitude Curves. Explanation of the theory of the star altitude curves will be given fully. Their importance as a form of precomputation for use under the same conditions when precomputation is advisable will be stressed. Their limitations in regard to the restricted selection of stars will be mentioned. The explanation to the theory of these curves should include a review of finding the GST from GCT, application of D.R. longitude to obtain approximate LST for the selection of the stars. Method of observing the stars, finding their altitude circles, performing the adjustment and the running fix before the LST for the position of the fix can be picked off from the curves. Rules for the instance when the GST is greater or is lesser than LST and the direction in which the difference in longitude is to be measured. Illustrate also the method of precomputing solutions for the star altitude curves. Remainder of the period to be devoted to practical exercises in solving observations by means of the star altitude curves. Observations which have been taken during night classes can be used handily in this work.	4:00
112-27-2	Practical Problems Using Star Altitude Curves. Continuation of the use of star altitude curves and a brief review of the theory. The major portion of the period will be devoted to practical exercises and the use of the curves.	2:00

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91-28-1

The Navigation Plan.  
The navigation plan is a study of the mission to be accomplished; the route (the great circle route, the Mercator course, or some arbitrary route) or alternate routes selected; the weather forecast for the entire area of the flight; the selection of alternate destinations; emergency landing places along the route; the type of navigation which will solve the problem most satisfactorily; alternate or auxiliary methods; aids to navigation such as location of radio stations, light beacons, prominent landmarks, etc; complete data on the celestial bodies to be observed; the amount of precomputation to be accomplished. The navigation plan should consider all circumstances that might arise in order to insure the success of the mission.

2:00

94-28-2

Dead-reckoning Preparation for the Running Curve Flight.  
Initial preparation for any flight on which a running course curve will be used must consist of these essential steps; selection of destination, time of take-off, estimated ground speed, with the ground speed, the assumed position for every twenty minutes of flight after the time of take-off, can be determined. Latitude and longitude of the assumed position and the estimated time of arrival at those positions will be noted. To illustrate these problems samples will be prepared which can be used on flight mission #16.

1:00

95-28-3

The Landfall Flight.  
The landfall problem will be introduced by showing its application under certain conditions. Point out the fact that the destination is chosen for the assumed position; the limitation is that the plane's position, although uncertain to some extent, must be definitely on one side of the original course to destination; discuss the selection of the course which the plane will fly during the landfall problem. Explain the advantages of selecting the azimuth or its reciprocal for the course; the mean azimuth as a course; or some course within  $30^{\circ}$  of the azimuth or its reciprocal; show how the distance to run to the line of position is calculated on these different courses. Show by diagram how the lines of position rotate with assumed position as center and how the plane arrives eventually on one of these lines. Mention briefly the other possibilities of the landfall problem. Point out that a single solution can be used to perform a landfall, although it is advantageous to have a precomputed curve for a period of a few hours.

3:00

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- 96-23-4 Celestial Preparation for Running Curve Flight. Navigation plan for flight will be made. Select celestial bodies or bodies to be used in flight. Use assumed positions previously determined and work azimuth solution making precomputed curve. Index the curve by latitude or longitude; discuss method of taking observations, determining intercept, plotting lines of position. Show effect of early or late take-off and effect of an actual ground speed faster or slower than the estimated ground speed, discuss the interpretation of the lines of position and explain the use of the running curve using different bodies. Discuss the advisability of having a precomputed stationary curve for a period earlier than take-off for the point of departure and for a period later than the estimated time of arrival for the destination. Explain the use of the stationary curve when the take-off is advanced or delayed. To illustrate these problems, samples will be prepared which can be used on flight mission #16. 4:00
- 97-23-5 Landfall by Intercept Method (Course Equal to Mean Azimuth  $\pm 30^\circ$ ). Detailed explanation of the step by step procedure for performing the intercept method will be given. Again point out that the landfall can be performed with one or two solutions as well as by precomputed curve for a longer period. The selection of the mean azimuth as a course, the determination of intercepts from a series of observations, determination of the mean ETA for these intercepts and determination of the azimuth, plus or minus  $90^\circ$  for the mean time of the observations, will be fully explained. The necessity of plotting the lines of position on the chart to determine distance to run to the line of position will be illustrated and fully explained. The method of determining the error in the landfall problem and reporting it on the navigator's report will be explained. A practical problem illustrating this method will be given. 3:00
- 99-23-6 Landfall, course within  $30^\circ$  of Azimuth or Reciprocal. In the same manner as the previous lecture on landfall procedure, this method will be taken up and discussed in full. The necessity for plotting the lines of position will be explained. Method of measuring the distance to run to the line of position of each observation, and the ETA at each of these LOP's will be calculated. The determination of the mean ETA will be made as well as the mean time of the observations, at the expiration of this mean time the azimuth  $\pm 90^\circ$  will be selected as the course to the destination. Practical problem illustrating this method will be given. 3:00

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- 103-28-7 Practical Problems in Making Plan for Night Celestial Flight.

During this period the charts will be prepared, courses and distances computed, log books made up, navigation plan will be made and the data entered therein for a theoretical flight. Several solutions will be precomputed, and all preparation that can be possibly accomplished on the ground will be made.

2:00

- 105-28-8 Practical Problem on Day Landfall Flight.

Data for flight mission #17 will be given. Students will plot curves, using points of departure and destination as assumed positions. Data for observations will be given and students will determine intercept and azimuth from pre-computed curves. Lines of position will be plotted and distance to dead-reckon and ETA for each line of position will be determined. Average ETA for the mean line of position will be found and new course determined from the mean time of the observations. All pertinent dead-reckoning data will be entered in log book.

4:00

- 106-28-9 Practical Problem on the Night Landfall Flight; Double Curve Method.

The Double Curve Method--this variation of the landfall must be performed with two precomputed curves on each of two different bodies. The advantage of this method is that it permits the navigator to head directly for his objective. Illustrate and explain how the lines of position fall through the destination and how the observations fall against the precomputed curve. Discuss the possibility of drawing a curve through the observations on each body to intersect the precomputed curve for the respective body. Show how the usual method of calculating mean ETA and mean time of observation on each body can be applied to this method. Explain how to determine time to turn and course (Azi.  $\pm 90^\circ$ ) to destination. Explain how, when working with stars, precomputed solutions or curves can be used by changing the time 3m56s of mean time earlier for each day that has elapsed since the date of the solution. This problem will be a theoretical flight using the points of departure and destination and the date for mission #18. Students will determine two bodies to use and precompute curves on each for the points of departure and destination. From data given, students will plot observations against curves and determine time to turn on new course to destination. All necessary dead-reckoning will be carried on concurrently and entered in the log.

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- 107-28-10 This Lecture is a continuation of the Problem begun in Lecture 103-28-7. Data simulating observations will be given the student. He will solve for fixes by adjustment or other method as indicated by the instructor. The fixes will be interpreted and the average track and ground speed determined. The log book and method of keeping this information will be explained and practiced. The procedure of computing a dead-reckoning position ahead of the actual position will be followed, and a course from the average tract to the destination and the ETA at the destination will be determined. Method of reporting errors on this flight in the navigator's report will be explained. 2:00
- 108-28-11 Theoretical Flight on Night Celestial Mission. Data for a theoretical flight will be given students. Students will solve data to obtain fixes by H.O. 214 & 211. Fixes will be obtained and plotted, and the average track and ground speed determined. New course to the destination will be found and the ETA computed. All work will be done on mercator chart and all necessary data entered in log. 3:00
- 111-28-12 Practical Problem on a Night Celestial Flight. Theoretical Flight using the data required in flight mission #19-A will be given. 3:00
- 113-28-13 Practical Problem on Night Celestial Mission Using Star Altitude Curves. This will be a theoretical flight; data will be given students simulating flight conditions. Solutions will be precomputed. Assumed altitudes will be given and necessary adjustments will be made. Fixes will be plotted on a mercator chart, average track and ground speed determined, new course to the destination will be calculated; ETA at final destination determined; dead-reckoning will be kept concurrently in the log book. 3:00
- 114-28-14 Practical Problem on Night Celestial Flight Using Star Altitude Curves (cont'd.). Additional practical problems in the use of star altitude curves by means of theoretical flights. Emphasis will be placed on the interpretation of the fixes. 4:00
- 117-28-15 Review of Procedure on Celestial Flights. A brief review of all the methods of celestial navigation and a theoretical flight illustrating all these methods will be performed by the students. 2:00

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- 118-28-16 Practical Problem on Night Celestial Flight Using Star Altitude Curves.  
A theoretical flight illustrating the use of star altitude curves will be performed by the students. This theoretical flight will be in preparation for mission #19-B. 3:00
- 119-28-17 Review of Procedure on Celestial Flights (cont'd.).  
This period will be devoted to ironing out any misconceptions in procedure that the students have acquired. A review of methods and procedure with regard to long flights will be made. 2:00
- 121-28-18 Making the Navigation Plans for a Long Flight.  
Reference will be made to lecture 91-28-1 for data to be incorporated in navigation plan. The instructor will supervise this work and point out any deficiencies in detail or method. A point of departure and destination will be given the student who will make out a plan covering all contingencies. 2:00
- 122-28-19 Practical Problem on Long Flight by Various Navigation Methods.  
The preparation for this flight was outlined in detail in Lecture 121-28-18. A theoretical flight involving all methods of solution will be given, dead-reckoning will be carried on concurrently at all times, radio bearings will be used wherever practicable. The student will solve given data, determining fixes by Ageton, H.O. 214, and star altitude curves. The fixes will be plotted and the average track and ground speed, ETA at turning point, new course to the destination, and ETA at final destination determined. All work will be done on mercator chart, and the necessary entries concerning dead-reckoning made in the log book. 3:00
- 124-28-20 Preparation for Long Flight.  
During this period the preparation for the graduation flight will be continued, dead-reckoning data and details completed. The details of the navigation plan and the necessary precomputation will be performed. 4:00
- 125-28-21 Preparation for Long Flight (cont'd.).  
The graduation flight will simulate as closely as possible a tactical mission and should be of duration equal to the range of the aircraft less reserve. During this flight as many methods of procedure as can be performed under the conditions of the flight will be accomplished. The destination having been selected the navigational plan will be evolved and the preparation for the flight will commence in this period. 3:00

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120-29-1	Operation of Mechanical Computers. A brief description of the various mechanical computers and their operation for typical problems will be illustrated. Winkles in the procedure for using these computers in flight will be explained. Remainder of the period will be devoted to checking the students off on the computers.	4:00
126-29-2	Practical Problem in use of Special Computers and Instruments. The procedure with mechanical computers, a continuation of the use of mechanical computers and the performance of typical problems by the students will be accomplished.	2:00

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AIR NAVIGATION TRAINING SCHOOL

Details of Missions

General

Due to the limited number of planes available, it is necessary for purposes of training to fly three navigators in a plane. It must be emphasized, however, that each navigator will perform all missions without assistance from other navigators in the plane. The exception will be those missions outlined in Details of Missions where the cooperation of all three navigators is required in order to successfully complete the flight. Examples of this type of mission are #3 and #9.

Position reports will be kept on the Radio Log by all the navigators. The No. 1 navigator will submit his Radio Log to the pilot who will transmit the report.

Each navigator upon completion of a flight mission will immediately fill out a navigator's report in the operations office. If the element instructor flew with the student the navigator's report, together with the navigator's log sheets, will be turned in to him and the Critique given then if practicable.

If the instructor does not fly with the student, the navigator's report and navigator's log sheets will be securely fastened together and placed in a box provided for that purpose in the Operations Office immediately after conclusion of flight. These forms will be collected by the Assistant Flight Commander and given to the element instructors for use in the scheduled Critique periods.

In the Critique the element instructors will rehash the flight mission with the students assigned to them, pointing out the errors committed by the student and offering suggestions for correcting them. The flight mission grade will then be determined by the element instructor in the presence of the student, the grade to be based upon the neatness, procedure, and accuracy of the student as demonstrated by his technique in flight.

On missions 7A, 7B, 7C, and 12A, 12B, 12C, and 13A, 13B, 13C, the three navigators in the element will each fly a complete mission in each of these three series from the 1st navigator's position. That is, each navigator will have control of the direction of the plane for one complete mission. On missions that are only scheduled once, navigators within an element should alternate on successive missions so that each navigator will occupy the 1st navigator's position once in every three missions.

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Mission #1 (Weight 1)HoursAlignment of the Drift Sight

1:00

Student will align the B-2 or B-3 drift sight on the ground using plumb bobs and chalk line. The drift wires will be aligned parallel to the center line of the aircraft. The ground speed transverse wire will be aligned so that when the line of sight thru the center cross wires is vertical to the horizontal axis of the plane, the trail angle is zero. Instructors will be present to supervise students.

Mission #2 (Weight 4)Calibration of the Airspeed Meter

2:00

Calibration flight will be flown over the speed course. Time of runs will be clocked by the Type A-8 stop watch. Minimum of eight runs, two in each direction will be flown. The graph and calibration card will then be made from the data collected on the flight.

Duties: 1st navigator will use pilot's instruments. 2nd navigator will use the navigator's instruments for  $2\frac{1}{2}$  complete runs and then exchange seats with 3rd navigator. 3rd navigator will time the first  $2\frac{1}{2}$  runs and then exchange places with 2nd navigator and use navigation instruments to get data for the remainder of the runs. All three navigators will get the time interval for each run. Four calibration cards will be prepared, one for pilot's indicator and three for the navigator's indicator, one of the latter will be placed in each navigator's position. The 2nd and 3rd navigators will work separately in making up their calibration cards after exchanging data as read in flight.

Mission #3 (Weight 4)Air Swinging of the Compass by Terrestrial Bearings

3:00

The navigator's compass will be swung in the air, using the B-2 or B-3 drift meter, to determine the relative bearing between the heading of the plane and a terrestrial line of bearing such as a rail-road, highway, etc. The gyro turn indicator will not be used to turn off headings. Headings differing by approximately fifteen degrees will be flown until deviations have been secured. In case airplane is not equipped with B-2 drift meter, ground swinging will be performed.

All three navigator's compasses and the pilot's compass will be swung at the same time. Before taking off the compasses should be corrected for lubber line error and compensated on master nose.

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Hours

Duties: 1st navigator will read drift meter and 1st compass and call figures to 2nd navigator. 2nd Navigator will read 2nd compass copying down his own compass readings and the compass readings and pointer readings of 1st navigator.

3rd navigator will read 3rd compass and copy down own compass readings. Data will be worked out on ground and graphs and compass deviation correction cards for all compasses worked up.

The pilot will record the headings of his compass on the standard form.

Mission #4 (Weight 4)Pilotage

3:00

Pilotage Mission will consist of location of the plane's position by pilotage or elementary dead-reckoning, and estimation of ground speed by elapsed time and distance between known points.

To be performed in conjunction with dead-reckoning by 2nd and 3rd navigators on missions #5, 6 and 7.

Duties: 2nd and 3rd navigators will keep up dead-reckoning and will also get ground speed from pilotage fixes and apply this ground speed to determine ETA at next check point. All work will be entered on navigator's log. The 2nd and 3rd navigators should be able to accurately fix the plane's position at any time by pilotage. In order to become proficient in pilotage and map reading it will be necessary for all navigators to practice pilotage concurrently on all missions when their duties permit. The continuity of the dead-reckoning will not be discarded because of pilotage. The 2nd and 3rd navigators will determine the Dead-reckoning ETA and the Pilotage ETA at destination.

Mission #5 (Weight 1)Familiarization Flight

3:00

The flight will be over a triangular course with all legs approximately equal. Each navigator will occupy 1st navigator's position on one leg and have control of the plane for that period.

The purpose of the flight is to accustom the student to the operation of the navigator's instruments in the air. The student will practice recording drift, determining compass heading and true course. Various features of the drift sight will be used and practice will also be obtained in setting the compass and directing the pilot to the "on course heading."

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Hours

Duties: 1st navigator will direct pilot and dead-reckon from 1st navigator's position, taking double drifts every 1/2 hour and keeping position reports by latitude and longitude.

2nd and 3rd navigators will perform Follow the Pilot Mission and reckon their error by Piloteage at destination by the difference between where their dead reckoning placed them, and where they actually were.

They will also perform concurrently, Mission #4 as outlined in Details of Missions.

Mission #6 (Weight 4)

Mission #6A, 6B, 6C - Dead-reckoning Between Visible Landmarks  
(with concurrent Mission #3)

3:00

Straight course between visible landmarks such as water, tower, lighthouse, crossroad or other similar objective, will be chosen. Student will keep the log sheet and record frequent drift readings, determine ground speed by either double drift and/or the ground speed meter and determine ETA.

Duties: 1st navigator will direct pilot to area chosen for Mission #3 and perform mission as directed in Details of Missions using approximate headings to be flown on Mission #6 to secure data for determining deviation corrections to be used in flight.

2nd and 3rd navigators will perform Mission #3 as outlined in Details of Mission, for deviation corrections to be used in flying mission #6.

After completing mission #3, 1st navigator will direct pilot to point of departure and dead-reckon to destination.

2nd and 3rd navigators will perform Follow the Pilot Mission and dead-reckon to destination. #4 Mission will be performed concurrently by the 2nd and 3rd navigators. Dead-reckoning procedure as outlined for all dead-reckoning missions will be followed by all three navigators.

Perform return mission in same manner.

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HoursMission #7 (Weight 6)

Mission #7A, 7B, 7C - Dead-reckoning Between Indistinguishable Points      3:00  
(with concurrent Mission #3)

Student will fly a course of approximately one hour's flight, attempting to arrive at a latitude and longitude enroute to another point which will be a visible landmark. The turn will be made at the time indicated by the estimated time of arrival at the indistinguishable point. The second leg will be approximately one hour.

Duties: Perform mission #3 as outlined in Details of Missions for the approximate headings to be flown on mission #7. Deviation corrections as determined from the above data will be used in flight.

1st navigator will direct pilot to point of departure and then dead-reckon to turning point. The turn will be made at expiration of 1st navigator's ETA without reference to landmarks. He will then dead-reckon the second leg to destination. 2nd and 3rd navigators will perform Follow the Pilot mission and dead-reckon to turning point. They will then determine dead-reckoning position at time of turn as directed by 1st navigator and draw course line from that point.

2nd and 3rd navigators will determine error at expiration of ETA by pilotage. The error will be determined by the difference between the actual position of plane and their dead-reckoning position.

Mission #8 (Weight 4)Alignment of the Pelorus

3:00

The pelorus will be aligned on the ground using the transit method or by mounting another pelorus on a tripod.

The procedure on this mission will be outlined in lecture #39, covering Calibration and alignment of Pelorus in AT-7 turret. Instructors will be present to supervise the work of the students.

Mission #9 (Weight 6)

Air Swinging of the Compass by Celestial Azimuths      3:00  
(Performed concurrently on Missions Nos. 12A, 12B, 12C)

Compass will be swung at  $15^{\circ}$  intervals around nose through  $360^{\circ}$ .

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Hours

Duties: Pilot will read and record the readings of his compass for each change of heading.

1st navigator will operate Pelorus for 16 different headings, taking relative bearings on sun and noting correct GCT.

2nd navigator will operate 1st compass, copying down own compass readings and the bearings and time as called off by 1st navigator.

3rd navigator will operate 2nd compass, copying down own compass readings.

After completing 16 headings, 1st and 2nd navigators will exchange positions and complete the remaining headings around the 360° rose.

Since only 3 men are available to operate the Pelorus and the 3 compasses, it will be necessary to re-swing ship a second time to obtain deviation corrections for 3rd compass.

2nd navigator will operate Pelorus and proceed as outlined above for the 1st 8 headings.

3rd navigator will take position in the 1st navigator's seat and will read 1st compass, copying down figures as above. 1st navigator will operate 3rd compass and copy down own compass readings.

At completion of 8 headings, 3rd navigator will take over with the Pelorus and operate it for the remaining 16 headings. 2nd navigator will exchange positions with 3rd navigator and operate 1st compass.

1st navigator will continue to operate 3rd compass. On the ground the data collected in flight will be used to make a graph and compass deviation correction cards will be made up for each compass.

Mission #10 ("Eight Q")Follow the Pilot

Follow the Pilot procedure should not be considered as i.- practical exercise. It is a type of flying often used in tactical operations. In the training program, no separate mission is set aside for Follow the Pilot, since 2nd and 3rd navigators can learn the necessary procedure while solving other navigation problems.

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Hours:

Duties: 2nd and 3rd navigators will follow the pilot, determining his track and ground speed, plotting on their chart his position at frequent intervals. Ground speed will be determined by drift on two headings or by double drift.

This mission will be performed on all dead-reckoning flights by the 2nd and 3rd navigators. Dead-reckoning procedure as outlined for all dead-reckoning missions will be followed, but the course of the plane will be controlled from the 1st navigator's position.

2nd and 3rd navigators will maintain continuity of dead-reckoning at all times by working from compass heading to true course and plotting track being made good on their plotting sheet. Double drifts will be taken concurrently with 1st navigator at times as determined by him. Mission #4 will be performed concurrently with this mission.

Off-course error will be determined by pilotage. The error is determined by the difference between the actual position of the plane and the dead-reckoning position as determined by the 2nd and 3rd navigators.

### Mission #11 (Night 1)

#### Octant Practice (Performed on Missions Nos. 12A, 12B, 12C)

Duties: This mission will be performed by each navigator on the Radius of Action missions. On the first leg of the Radius of Action Mission the 2nd navigator will take his Octant shots as soon as possible after passing over point of departure. As soon as he has completed at least two observations, the 3rd navigator will take at least two observations.

The 1st navigator will take at least two sets of observations after turning and while dead-reckoning the last leg to the destination.

Each navigator will be equipped with a back watch or master watch and will accurately time each shot.

The observations made will be retained for use as a practical problem illustrating the method of plotting lines of position in night star class.

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	<u>Hours</u>
<u>Mission #12 (Weight 8)</u>	4:00
<u>Mission #12A, 12B, 12C - Radius of Action</u> (With secondary Mission No. 11)	

Radius of Action returning to a second base will be performed on a flight of about two hours' duration. Course will be laid so that the radius on the first course will be not less than one hour. Remaining course will be directed to a landmark simulating the second base.

Duties: On the first leg the Radius of Action problem will be worked twice by the 1st navigator.

The 2nd navigator will work Radius of Action problem once after the second double drift has been taken on first leg. The 3rd navigator will work Radius of Action problem once on last leg by simulating a Radius of Action problem and working it from some dead-reckoning position on first leg.

All three navigators will perform Mission #11 concurrently as outlined in Details of Missions.

<u>Mission #13 (Weight 9)</u>	
<u>Combination Patrol, Interception and Search</u> (With concurrent Mission No. 9)	4:00

An initial course will be chosen which will take the plane to a large body of water and patrol pattern will be flown over the water for at least one hour. During the patrol mission, the position, course and speed of a surface vessel will be reported. At the conclusion of the patrol problem, an interception will be performed upon the target selected. The interception problem should be at least one hour. (In order to secure valuable over-water training of the navigator, the duration of these missions should be as long as the range of the aircraft will permit.)

Duties: Mission #13A - As soon as the ship is on course, 1st navigator will operate Polaris and take relative bearings on sun and note the correct GCT. The 2nd navigator will record heading of 1st compass, relative bearing which the 1st navigator obtained from Polaris, and correct time. The 3rd navigator will read and record compass readings of the 2nd navigator's compass. Data will then be completed, Agaton solutions will be worked by 1st and 2nd navigators to determine sun's azimuth, and compass deviation corrections determined for 1st and 2nd compass. 3rd navigator will use deviation correction card in plane.

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This procedure will be followed for each long leg of the flight. The 1st navigator will be responsible for direction of ship and will dead-reckon to point selected for patrol. He will then direct pilot on patrol and try to spot a ship for interception problem.

The 2nd and 3rd navigators will dead-reckon by following the pilot determining the off-course error as explained for Mission #10 in Details of Missions.

At end of patrol all three navigators will work interception problem. The 1st navigator will control the direction of the ship.

At end of the interception problem all navigators will dead-reckon to the destination. 1st navigator using standard prescribed dead-reckoning procedure and the 2nd and 3rd navigators dead-reckoning by Follow the Pilot and performing Mission #4 and Mission #9 concurrently.

Mission 13B--The same procedure as above will be followed except the 1st and 3rd compasses will be swung. The 2nd navigator in this instance will use the compass deviation card already in the plane.

Mission 13C--The same procedure will be followed as on Mission 13A.

Mission #14 (.eight 6)Radio Bearings and Fixes

4:00

The course will be flown in three legs, each leg being of at least 1:15 duration. Each navigator will take his turn at the first position, and will remain there for the duration of one of the legs. It is recommended that this course be in the shape of an equilateral triangle, the last leg tying into the home base.

Definite landmarks will be chosen for the corners of this triangle, and it will be the first navigator's responsibility to guide the plane to this intermediate destination before turning over his position to the next man.

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Hours

On this mission radio bearings and fixes will be taken and plotted on the mercator chart. Interpretation of the fixes will be made in regard to the pilotage and D.R. account of the flight.

Duties: Three students will operate the radio compass and take at least three fixes during the period that the plane is on one leg. The 1st navigator will submit his bearings to the other navigators who will work these out on their charts in the air. The navigators in the second and third position will be responsible for an accurate D. R. account of the mission using Follow-the-Pilot procedure. The 1st navigator will keep an accurate D. R. log of the flight, and call for one double drift on his leg of the flight. Additional checks on wind conditions can be made at the turning points.

If the plane is off course, and this fact is indicated by the fixes, then the 1st navigator will determine the average track of the airplane, plot a turning point ahead on the average track by using D. R. procedure, and average G. S. as indicated by the fixes. He will then instruct the pilot to turn to the particular destination, and he will navigate the ship to this point.

Each navigator will maintain his work.

Mission #15 (.eight 5)

Lines of Position and the Running Fix      4:00

This flight will be a long flight on one course of not less than two hours duration, during which the navigator performs accurate dead-reckoning in order to locate a small objective. The return flight will be similar, with a duration of two hours on one heading.

The use of lines of position on a single body will be made on this flight in the same manner as radio bearings were used on Mission #14. In cases where the change in azimuth of the body has been sufficient to afford a good intersection of the lines of position, a running fix will be made.

Duties: Three navigators will fly on this mission. One of these will be designated as 1st navigator for the flight, another the 1st navigator on the flight back. One navigator will necessarily miss a turn at first position, but the men in each element will cooperate so as to equalize the time spent in the first position during the succeeding flights.

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All navigators will accomplish an accurate account of D.R. throughout the flight, the 1st navigator directing the pilot on the double drifts, and course corrections. As a result, he will figure that he is making good the course planned, and the navigators in the secondary positions will determine by their D.R. and celestial the actual track of the plane.

Regarding the celestial phase of the mission, each student will be responsible for obtaining a minimum of five lines of position during the flight. The data from the observations on the body will be computed in the air by N.O. 214, or adjusted N.O. 211 or 214 solutions that have been precomputed. At least two of the solutions for the lines of position will be precomputed.

Mission #16 (Weight 7)

4:00

Precomputed Course Curves

This mission is similar to mission #15 in the selection of the course, and in the manner in which the navigators perform D.R. and change positions at end of flight out.

The precomputed course curve will be used on this mission. As many observations as possible will be taken and plotted on the chart. Interpretation of these lines of position, computation of ground speed, and determination of celestial ETA will be accomplished in the air.

Duties: Each student will obtain as many observations as possible during the entire flight. A running curve will be made for both directions, and as this mission is normally scheduled as a day mission, the curve will be made for the sun.

Each student will maintain a complete D.R. log of the flight, the first navigator directing the pilot and assuming that he is making the course good, the secondary navigators tracking the ship by D.R. During the D.R. work, each student will obtain observations, plot them on the curve, and subsequently, on the chart. From the plotted lines of position, ground speed and/or course will be determined. The average ETA at the destination will be computed. This information will be kept in the log book along with the D.R. in the prescribed manner.

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Hours

Mission #17 (Night 6)Mission #17A, 17B - The Day Landfall

4:00

This flight consists of a course approximately equal to the azimuth of the sun or its reciprocal and will be at least one hour and a half in duration, with the destination selected some 50 or 60 miles perpendicular to the course. Upon the return a similar pattern is flown. It is imperative that the courses and destinations be carefully planned with great consideration for the azimuth of the body, the course and its length, and the distance down the LOP to the destination. The Squadron Commander will be of assistance to the Operations Officer in selecting routes and destinations for this mission.

There are two general types of landfalls, and usually it is more convenient to work one of each type on the same flight. The duties of students in each type are as follows:

Duties: All navigators will accomplish the same work in the air. The 1st navigator will direct the pilot, and the turn onto the line of position thru the destination will be made by his ETA. The 2nd and 3rd navigators will determine their own data on the flight and compute the time to turn, before arriving at the LOP. They will note actual time of turn and follow the pilot to the destination, noting the actual position of arrival. Their error on the landfall will be calculated by standard procedure.

Mission #18 (Night 6)The Night Landfall

4:00

The primary purpose of this mission is to familiarize the student with night flying and night observations while accomplishing a mission that he is already familiar with.

Duties: Same as for Mission #17.

Mission #19 (Night 9)Mission #19A - Night Celestial Using Ageton or G.O. 214  
to Obtain Fixes

8:00

This mission should be performed on a flight of at least four hours' duration. It will require several hours' preparation. In making the navigation plan the three navigators will select their stars so that when simultaneous observations are necessary, only one

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Hours

navigator will be using the turret, the other navigators will be observing out the windows. As usual, the 1st navigator directs the pilot. After turning to the destination, the 2nd and 3rd navigators will follow the pilot to the destination. Off-course error will be determined by standard procedure. On return flight, the 1st navigator will change places with one of the other members of the element.

Mission #19D - Night Celestial Using Star Altitude Curves

8:00

Procedure same as on #19A; Star Altitude Curves will be used for all fixes.

Mission #20 (Weight 9)

Long Celestial Flight

12:00

This mission will be the graduation flight and consists of three flights of at least four hours' duration. This mission should simulate a tactical mission, to complete the transition necessary for the student to apply all the technique he has learned to the tactical navigational requirements. It should be in daylight and darkness - the daylight portion to be over water. All methods of navigation will be practiced.

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AIR NAVIGATION TRAINING SCHOOL  
INDEX TO SUBJECTS & LECTURES

CURR. LECT.	SUPJ. NO:	Lect.	SUBJECT: -1- <u>General Definitions:</u> (Weight - 1)	Hours
1	1	General Definitions		1
2	1	Earth's Surface	SUBJECT: -2- <u>Earth's Surface:</u> (Weight - 1)	1
23	2	Use of Plotting Sheets	SUBJECT: -3- <u>Maps and Charts:</u> (Weight - 5)	2
3	1	Lambert-conformal Conic and Mercator Projection		2
27	3	Gnomonic and Stereographic and other Projections; Plotting Sheets		2
63	4	Use of Plotting Sheets		2
		Chart Navigation		4
		Total Hours	-----	10
			SUBJECT: -4- <u>Pilotage &amp; Elementary Dead-reckoning:</u> (Weight - 3)	
6	1	Map Reading and Elementary Dead-reckoning		3
17	2	Pilotage and Elementary Dead-reckoning		1
		Total Hours	-----	4
			SUBJECT: -5- <u>Instruments and Equipment:</u> (Weight - 6)	
4	1	Magnetism and the Compass		2
5	2	Drift Meter; Its Purpose and Use		1½

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CURR. LECT. NO:	SUBJ. LECT. NO:	SUBJECT: -5- (Cont'd.)	Hours
7	3	Altimeter, Airspeed Meter and other Instruments	3
8	4	Compensation and Ground Swinging of the Compass	1
10	5	Computer Slide Rule Face	1
11	6	Calibration of the Airspeed Meter	4
14	7	Preparation of Airspeed Calibration Cards	1
18	8	Preparation of Compass Deviation Cards	1
39	9	Pelorus; Use and Calibration of Turret	2
44	10	Octants	1
86	11	Octant Check	<u>1</u>
Total Hours - - - - -			10

SUBJECT: -6-  
Wind and Ground Speed:  
(Weight - 4)

15	1	Vector Diagrams and Graphic Solutions	4
16	2	Various Problems Solved by the Computer	2
20	3	Practical Exercises and Using Dead-reckoning Tables	<u>3</u>
Total Hours - - - - -			9

SUBJECT: -7-  
Standard Navigation Procedure: Dead-reckoning:  
(Weight - 5)

19	1	Duties of the Navigator; Keeping the Log	4
22	2	Practical Problems on Standard Navigation Procedure; Dead-reckoning	<u>4</u>
Total Hours - - - - -			8

SUBJECT: -8-  
Chronometers and Time Signals:  
(Weight - 1)

24	1	Chronometers and Time Signals	1
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CURR. NO:	SURJ. LECT. NO:	SUBJECT: -9- <u>Dead-reckoning Problems:</u> (Weight - 5)	Hours
25	1	Radius of Action	4
26	2	Patrol	1
29	3	Interception	4
30	4	Search	1
31	5	Review of Radius of Action and Interception	2
		Total Hours - - - - -	12
		SUBJECT: -10- <u>Bearings and Fixes:</u> (Weight - 4)	
36	1	Interpretation of Bearings, Lines of Position, and Fixes	4
37	2	Practical Problems on Bearings and Fixes, and Review	3
		Total Hours - - - - -	7
		SUBJECT: -11- <u>Federal Aids to Navigation:</u> (Weight - 1)	
48	1	Federal Aids to Navigation	2
		SUBJECT: -12- <u>Radio Navigation:</u> (Weight - 5)	
49	1	Operation of the Radio Compass Receiving Set	1
50	2	Theory of Radio Navigation	4
52	3	Conversion of Bearings	2
53	4	Practical Problems in Bearings and Fixes	2
		Total Hours	10

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CURR. LECT. NO:	SUBJ. LECT. NO:	SUBJECT: -13- <u>Observations, Parallax &amp; Refraction:</u> (Weight - 1)	Hours
45	1	Observations, Parallax & Refraction	2
		SUBJECT: -14- <u>Star Identification:</u> (Weight - 4)	
38	1	Introduction to the Celestial Sphere	2 <sup>1</sup> <sub>2</sub>
41	2	Names of Constellations and the Navigational Stars	2 <sup>1</sup> <sub>2</sub>
43	3	Location of the Stars on the Horizon Projection	2 <sup>1</sup> <sub>2</sub>
47	4	Making the Observation; Use of the Octant	2 <sup>1</sup> <sub>2</sub>
55	5	Observation of the Stars and Solution for the Line of Position	2 <sup>1</sup> <sub>2</sub>
58	6	Plotting the Line of Position	2 <sup>1</sup> <sub>2</sub>
61	7	Completion of the Horizon Projections for Use as a Star Finder	2 <sup>1</sup> <sub>2</sub>
64	8	Observation of the Stars and Plotting Fixes	2 <sup>1</sup> <sub>2</sub>
70	9	Observation of the Planets	2 <sup>1</sup> <sub>2</sub>
75	10	Observation of the Moon	2 <sup>1</sup> <sub>2</sub>
81	11	Observation and Solution by H.O. 214; Theory of Observations	2 <sup>1</sup> <sub>2</sub>
88	12	Precomputed Solutions and Adjustment of Observations	2 <sup>1</sup> <sub>2</sub>
98	13	Midnight Star Identification; Observations of Bodies on the Meridian and of Polaris	2
101	14	Early Morning Star Identification	2
		Total Hours	34

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CURR. LECT. NO:	SUBJ. LECT. NO:	SUBJECT: -15- <u>Calculated Flying:</u> (Eight - 4)	Hours
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56	1	Plain, Traverse, Parallel and Mid-latitude Flying	4
57	2	Mercator Flying	4
60	3	Great Circle Flying	4
62	4	Problems in Mercator Flying	4
Total Hours - - - - - 16			

SUBJECT: -16-  
Standard Navigation Procedure; Tactical Missions:  
(Eight - 7)

32	1	Procedure on Tactical Interception Missions	4
33	2	Procedure on Tactical Radius of Action Missions	2
34	3	Procedure on Tactical Search Missions	1
46	4	Review of Tactical Radius of Action and Interception Missions	4
54	5	Review of Tactical Missions	4
Total Hours - - - - - 15			

SUBJECT: -17-  
Celestial Navigation, General; Celestial Definitions:  
(Eight - 3)

65	1	Celestial Definitions	2
68	2	Review of Celestial Definitions	2
Total Hours - - - - - 4			

SUBJECT: -18-  
Motions of Celestial Bodies:  
(Eight - 2)

66	1	Motions of Heavenly Bodies	2
69	2	Time	2
Total Hours - - - - - 4			

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CURR. LECT. NO:	SUBJ. LECT. NO:	SUBJECT: -19- <u>Time, Hour Angle, Longitude:</u> (Weight - 4)	Hours
71	1	Relation of Time, Hour Angle and Longitude	3
73	2	Practical Problems in Time, Hour Angle, Longitude	<u>2</u>
		Total Hours - - - - -	6
		SUBJECT: -20- <u>Time Diagram:</u> (Weight - 1)	
72	1	Time Diagram	1
		SUBJECT: -21- <u>Astronomical Triangle, Its Solutions, and Position Circles:</u> (Weight - 4)	
40	1	Solution by H.O. 211	1
74	2	Solution by H.O. 214	1
76	3	Elements of the Astronomical Triangle	2
79	4	Practical Problems in Determining Values of the Astronomical Triangle	<u>2</u>
		Total Hours - - - - -	6
		SUBJECT: -22- <u>Air Swinging of the Compass by Terrestrial Bearings and Celestial Azimuths:</u> (Weight - 5)	
9	1	Air Swinging of the Compass by Terrestrial Bearings	2
12	2	Practical Examples in Air Swinging by Terrestrial Bearings	<u>3</u>
40	3	Air Swinging by Celestial Azimuths; Practical Problems	<u>4</u>
		Total Hours - - - - -	9

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CURR. LECT. NO:	SUBJ. LECT. NO:	SUBJECT: -23- <u>Use of Almanacs &amp; Rude Star Finder:</u> (Weight - 2)	Hours
77	1	Determining G.H.A. and Declination	2
100	2	Additional Tables of the Almanac and the Rude Star Finder; Coreolis Theory and Corrections	3
104	3	Use of Almanac and Rude Star Finder in the Navigation Plan	3
Total Hours - - - - -			6
SUBJECT: -24- <u>Position Lines and Use:</u> (Weight - 4)			
80	1	Interpretation of the Single Line of Position; the Running Fix	2
85	2	Interpretation of the Fixes	2
Total Hours - - - - -			4
SUBJECT: -25- <u>Observations for Latitude:</u> (Weight - 1)			
89	1	Latitude by Polaris	1
93	2	Meridian Altitudes	1
Total Hours - - - - -			2
SUBJECT: -26- <u>Precomputation:</u> (Weight - 4)			
82	1	General Precomputation; Adjustment	2
83	2	The Stationary Curve	2
84	3	Practical Problems in Making Stationary Curves	2
87	4	Practical Problems in Precomputed Solutions	1
93	5	Running Curve	1
Total Hours - - - - -			8
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CURR. LECT. NO:	SUBJ. LECT. NO:	SUBJECT: -27- <u>Star Altitude Curves:</u> (Weight - 4)	Hours
110	1	Theory of Star Altitude Curves	4
112	2	Practical Problems Using Star Altitude Curves	2
Total Hours -----			6
SUBJECT: -28- <u>Standard Navigation Procedure, Celestial:</u> (Weight - 3)			
91	1	The Navigation Plan	2
94	2	Dead-reckoning Preparation for the Running Curve Flight	1
95	3	The Landfall Flight	3
96	4	Celestial Preparation for the Running Curve Flight	4
97	5	Landfall, Intercept Method; Course Equal to Mean Azimuth $\pm 180^\circ$	3
99	6	Landfall; Course within $30^\circ$ of Azimuth or Reciprocal	3
103	7	Practical Problem in Making Plan for Night Celestial Mission	2
105	8	Practical Problem on the Day Landfall Flight	4
106	9	Practical Problem on the Night Landfall Flight; Double Curve Method	3
107	10	Practical Problem on Night Celestial Mission (cont'd.)	2
108	11	A theoretical Problem on a Night Celestial Mission (cont'd.)	2
111	12	Practical Problem on the Night Celestial Flight (cont'd.)	3
113	13	Practical Problem on Night Celestial Mission Using Star Altitude Curves	3
114	14	Practical Problem on Night Celestial Mission Using Star Altitude Curves (cont'd.)	4

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CURR. LECT. NO:	SUBJ. LECT. NO:	SUBJECT: -23- (Cont'd.)	Hours
117	15	Review of Procedure on Celestial Missions	2
118	16	Practical Problem on Night Celestial Mission Using Star Altitude Curves	3
119	17	Review of Procedure on Celestial Missions (cont'd.)	2
121	18	Making the Navigation Plan for a Long Flight	2
122	19	Practical Problem on a Long Flight by Various Navigation Methods	2
124	20	Preparation for a Long Flight	4
125	21	Preparation for a Long Flight (cont'd.)	2
		Total Hours - - - - -	59

SUBJECT: -29-

Use of Special Computers and Instruments:  
(Weight - 1)

120	1	Operations of Mechanical Computers	3
126	2	Practical Problem in Use of Special Computer and Instruments	2
		Total Hours - - - - -	5

SUBJECT: -30-

Standard Navigation Procedure on School Missions:  
(Weight - 0)

13	1	Instructions on: Mission 1, Alignment of the Drift Sight; Mission 2, Airspeed Calibration; Mission 3, Compensation and Air Swinging of the Compass	1
21	2	Instructions on: Mission 5, Familiarization Flight; Mission 6-A, Simple Dead-reckoning Flights	1
28	3	Instructions on: Mission 6-B and 6-C, Simple Dead-reckoning Flights	1
35	4	Instructions on: Mission 7-A, 7-B and 7-C, Dead-reckoning on Dog Leg Course	1

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CURR. LECT. NO:	SUBJ. LECT. NO:	SUBJECT: -30- (Cont'd.)	<u>Hours</u>
42	5	Instructions on: Mission 9, Air Swinging of the Compass by Celestial Azimuths	1
51	6	Instructions on: Mission 12-A, 12-B and 12-C, Radius of Action Flights; Mission 11, Octant Practice	1
59	7	Instructions on: Mission 13-A, Patrol and Interception Flights	1
67	8	Instructions on: Missions 13-B and 13-C, Patrol and Interception Flights	1
78	9	Instructions on: Mission 14, Radio Navigation Flight; Mission 15, The Running Fix Flight	2
92	10	Instructions on: Mission 16, Running Curve Flight	1
102	11	Instructions on: Mission 17, Day Landfall Flight; Mission 18, The Night Landfall Flight	1
109	12	Instructions on: Mission 19-A, Night Celestial Flight	1
115	13	Instructions on: Mission 19-B, Night Celestial Flight	1
116	14	Instructions on: Mission 19-C, Night Celestial Flight (cont'd.)	1
123	15	Instructions on: Mission 20, Long Flight	<u>1</u>
Total Hours - - - - - 16			

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T.C. MEMORANDUM )  
NUMBER 50-12-1 )

HEADQUARTERS  
ARMY AIR FORCES TRAINING COMMAND  
FORT WORTH, TEXAS 22 July 1943

TRAINING

Navigation Training, General Training Program

(This Memorandum supersedes T.T.C. Memorandum No. 50-12-1, dated 15 April 1943, and T.T.C. Memorandum No. 50-12-1A, dated 9 June 1943.)

1. Mission: The mission of the AAFTC Navigation Schools is to train students in the theory and practice of aerial navigation as employed by the Army Air Forces in the various theaters of operation.

2. Objective: The aerial navigation training conducted in the schools will have as its objective the following:

- a. The qualification of students as precision dead reckoning navigators with basic proficiency in pilotage, radio and celestial navigation.
- b. The qualification of students as officers of the Army Air Forces.
- c. The attainment and maintenance of the high degree of physical fitness requisite to a combat crew member.

3. Duration: The training period of the AAFTC Navigation Schools is eighteen (18) weeks.

4. Passing Grade: A grade of 70% is prescribed as the minimum passing grade for all phases of training.

5. Location of Navigation Schools: The AAFTC Navigation Schools are as follows:

Army Air Forces Navigation School, Monroe, Louisiana  
Army Air Forces Navigation School, Hondo, Texas  
Army Air Forces Navigation School, San Marcos, Texas  
Army Air Forces Navigation School, Mather Field, California  
Army Air Forces Contract Navigation School, Coral Gables, Florida

6. Standards of Proficiency: Standards of proficiency required of all graduates of Army Air Forces Navigation Schools:

- a. Navigation.
  - (1) Able to navigate during daylight hours by dead reckoning means with a maximum course error of  $1\frac{1}{2}^{\circ}$  and a maximum E.T.A. error of  $1\frac{1}{2}$  minutes per hour of flight from the last known position.

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- (2) Proficient in day celestial navigation to include landfalls.
  - (3) Able to navigate during darkness by celestial means to within fifteen miles of objective over distances up to full range of training type aircraft.
  - (4) Proficient in "Follow-the-pilot" method of navigation.
  - (5) Able to solve and successfully navigate radius of action, interception, and search problems.
  - (6) Proficient in determining position by radio fixes.
  - (7) Proficient in planning and navigating a rendezvous problem, to include: calculating time of take-off, time required for climb to altitude, and speed along desired track.
  - (8) Proficient in pilotage and map reading.
- b. Operation and Adjustment of Equipment.
- (1) Proficient in use of current type bombing and navigational computers such as the E-6B, Aerial Dead Reckoning Computer, to include proficiency in the following uses of the E-6B or similar type computer.
    - (a) All uses described in TO 05-35-9.
    - (b) As a circular slide rule, in solving multiplication and division problems as confront the bombardier and navigator.
  - (2) Instructed in the proper care and handling of navigation equipment.
  - (3) Instructed in performing preflight inspection of navigation equipment.
  - (4) Instructed in the operation of Loran equipment.
  - (5) Proficient in the calibration of aircraft instruments, to include:
    - (a) Air and ground swinging of compass.
    - (b) Aligning of drift meter and astrocompass.
    - (c) Calibrating airspeed meter, free air temperature gauge, radio compass and astrocompass.
- c. Other.
- (1) Proficient in sending and receiving radio telegraph code signals at the rate of 10 or more words per minute.
  - (2) Proficient in sending and receiving blinker signals at the rate of 5 or more words per minute.
  - (3) Thorough knowledge of basic weather analysis as contained in TM 1-232 with emphasis placed on interpretation of weather symbols in weather reports; effect of weather on military operations; weather conditions producing aircraft icing, thunderstorms and atmospheric turbulence.
  - (4) Must have demonstrated ability in pressure chamber to operate at altitudes above 25,000 feet.
  - (5) Qualified as aerial gunner as prescribed in TM 1-270.  
(NOTE: To be accomplished up to the limits of the quotas available to navigators at the flexible gunnery schools.)

7. Program of Instruction.

- a. Aerial navigation ground training will consist of the following:

		Subject	Phase
		Hours	Hours
(1)	Pilotage		33
(a)	Basic Principles	17	
1.	General Definitions		
2.	Earth's Surface		
3.	Map Projections		
4.	Map Reading and Pilotage		
5.	Time, Speed, and Distance		
6.	DR Computer (Slide Rule Face)		
7.	Pilotage Log Book Procedure		
8.	Magnetism and the Compass		
(b)	Instruments	12	
1.	Driftmeter		
2.	Altimeter and AS Meter		
3.	Other Airplane Instruments		
4.	Plotting Equipment		
(c)	Airmanship	4	
(2)	Calibration		19
(a)	Basic Principles	17	
1.	Compensation, Ground Swinging and the Sighting Compass		
2.	Deviation Analysis		
3.	Compass Swinging by Terrestrial Bearing		
4.	Compass Swinging by Celest. Az.		
5.	A. S. Meter Calibration		
6.	Alignment of the Driftmeter and Astrocompass		
(b)	Instruments	2	
1.	Astrocompass		
2.	Free Air Temperature Gauge		
(3)	Dead Reckoning		41
(a)	Basic Principles	38	
1.	Dead Reckoning Tables		
2.	Ground Speed by Timing		
3.	DP Log Book Procedure		
4.	Controlled Ground Speed		
5.	Vector Diagrams and Graphic Solutions		
6.	Mercator Plotting Sheet		
7.	Plane Flying		
8.	Mercator Flying		
9.	Follow the Pilot Procedure		
10.	Search and Patrol		
11.	Interception		
12.	Radius of Action to Same Base		
13.	Radius of Action to Alternate Base		

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		Subject	Phase
		Hours	Hours
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	6. Use of Almanac		
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	9. Interpretation of L.O.P. and Fixes		
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b. Aerial Navigation air training will consist of the following:

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Subject	Phase	
Hours	Hours	
(1) Familiarization	4	
(2) Instrument Calibration	8	
(3) D.R. and Pilotage	40	
(a) Straight	8	
(b) Dog leg	8	
(c) Combined Radius of Action Interception and Search	24	
(4) Day-Celestial and Radio	20	
(5) Night-Celestial - Radio - Night	28	
Pilotage		
c. Allied training will consist of the following:		
(1) Military	50	
(2) Physical Training	108	
(3) Identification	9	
(4) Code	9	
(5) Weather	42	
(a) Weather Observation, Se- quence and Wind Aloft Re- ports	12	
(b) Temperature, Pressure and Moisture	5	
(c) Cloud Discussion	3	
(d) Air Mass and Frontal Weather	6	
(e) Thunderstorms, Turbulence Icing and Terrain Effects	4	
(f) Special Weather Influences North and South America	4	
(g) World Weather	2	
(h) Ocean Weather	3	
(i) Maps	3	
(6) First aid (Not given to graduates of bombardier schools)	7	
d. Administrative	20	

It is necessary to schedule 20 hours during the course for the accomplishment of administrative detail such as commissioning boards, purchase of uniforms, physical examinations, etc.

The Memorandum will be followed explicitly in the manner best suited to the local conditions and the equipment and other training facilities available at the individual stations.

e. The size of classes and size of students will be as prescribed by the Headquarter.

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9. Recommendations and comments on the training prescribed above will be submitted through normal channels.

By command of Major General YOUNT:

DAVID M. SCHLATTER,  
Colonel, A.S.C.,  
Actg. Chief of Staff.

OFFICIAL:

J. H. HILLS,  
Colonel, A.G.B.,  
Adjutant General.

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T. C. MEMORANDUM )  
NUMBER 50-12-2 )

HEADQUARTERS  
ARMY AIR FORCES TRAINING COMMAND  
FORT WORTH, TEXAS 8 Sept 1943

TRAINING

Navigation Training - Central Navigation Instructors School.

1. The mission of the Army Air Forces Central Navigation Instructors School is to accomplish the following objectives:

- a. To give standardized instructor training to all navigators selected for duty in the Army Air Forces Navigation Schools.
- b. To conduct refresher courses for navigators returning from combat and other personnel as may be authorized by this Headquarters.
- c. To experiment with training aids, thus preventing duplication in this effort at the schools.
- d. To collect, write, and revise instructional material in accordance with the provisions of T. C. Memorandum No. 5-2.

2. Proficiency Standards: Proficient in the technique of precision navigation as standardized by the Air Forces.

a. Navigation Technique.

- (1) Instruments: Proficient in the installation, calibration, operation, use and first echelon maintenance of all navigation instruments and equipment. Well grounded in latest developments of instruments and equipment.
- (2) Theory: Schooled in theory and background necessary for the accomplishment of the directive for navigation training of the student.
- (3) Procedures: Thoroughly facile in use of standard navigation procedures employed by the Air Forces.

b. Instructional Technique.

- (1) Well versed in the latest teaching principles and methods.
- (2) Accomplished in the utilization of synthetic devices and training aids.
- (3) Cognizant of the duties of the navigation instructor.
- (4) Proficient in the application of these techniques to accomplish the directive for navigation training of students.

c. Military Training Proficiency.

- (1) General Military Training: Review of basic requirements of Military Training necessary to acquire accepted standards for Air Corps officers.

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(2) Tactical Officer Requirements: Well grounded in advanced military training program for cadets.

- d. Allied Training. As rated navigators, proficiency in the following allied subjects must be maintained.
- (1) Combat Intelligence for Air Crews.
  - (2) Meteorology.
  - (3) Reconnaissance.
    - (a) Code
    - (b) Identification
    - (c) Observation
  - (4) Bombing and Gunnery.
  - (5) Chemical Warfare.
  - (6) Physical Training.

The Central Navigation Instructors School will be under the direct administration of the Army Air Forces Central Flying Training Command, and will be located at Army Air Base, Monroe, Louisiana.

Supervisory personnel of the school will not be transferred without prior approval of this Headquarters.

The size of classes and flow of students will be as prescribed by Headquarters, Army Air Forces.

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

The duration of the course of instruction at the Army Air Forces Central Navigation Instructors School will be one month.

The period of instruction at the Central Navigation Instructors School will be continuous.

	Subj. Hours	Phase Hours
(1)		91:00
(2)	25:00	10:00
(3)		56:00
(4)	2:00	
(5)	2:00	
(6)	4:00	

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4.	G.M.#4 Day Ferry	2:00
5.	G.M.#5 Day Combat	2:00
6.	G.M.#6 Night Combat	2:00
7.	G.M.#7) Combination Day	8:00
	8. G.M.#8) Nite crossing	
(b)	C.N.T. Mission	4:00
(c)	Flight Missions	12:00
(d)	Preparation & critique	18:00
		51:00
b.	Instructional Technique.	
(1)	Four-step methods of instruction	6:00
(2)	Application of four-step method to the navigation class	2:00
(3)	Duties of the element instructor	3:00
(4)	Classroom technique	1:00
(5)	Tryout Performances	24:00
(6)	Discipline and Military Training of cadets	10:00
(7)	Use and operation of training aids	5:00
		58:00
c.	Allied Training	
(1)	Combat Intelligence for Air Crews	8:00
(2)	Meteorology	16:00
(3)	Reconnaissance	4:00
(4)	Bombing-Gunnery	12:00
(5)	Chemical Warfare	6:00
(6)	Physical Training	24:00
		200:00
TOTAL		

By command of Major General YOUNT:

WALTER F. KPAUS,  
Brig. Gen., G.S.C.,  
Chief of Staff.

OFFICIAL:

J. H. HILLS,  
Colonel, A.G.C.,  
Adjutant General.

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MEMORANDUM FOR THE COMMANDING GENERAL, ARMY AIR FORCES: (Attention Assistant Chief of Air Staff, Intelligence, Historical Division)

Subject: Critique of Army Air Forces Historical Studies: No. 27, Individual Training of Navigators in the AAF.

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