INDIVIDUAL TRAINING OF NAVIGATORS IN THE AAF

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INDIVIDUAL TRAINING OF NAVIGATORS IN THE AAF

Prepared by
Assistant Chief of Air Staff, Intelligence
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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 360-5.
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Individual Training of Navigators in the AAF
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
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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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. With the adoption of the 41 Group Program (7,000 pilot program) the navigator requirement was increased to approximately 1,800. 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. 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&ER, No. 2, Plans to T&O, 15 May 1940, in AAG 352.01C, Establishment of Schools.
3. WD Press Release, 14 June 1940.
production requirements. This directive required that 749 navigators should be graduated by 1 April 1941 and 1,269 by 1 November 1941.

The existing schedule of production indicated that only 1,030 navigators would graduate between 2 November 1940 and 27 December 1941.

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 54 Group Program (30,000 pilot program). The annual production rate for navigators 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 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 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

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5. RôR, 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.
requirement was initiated in December 1941. In relation to these
requirements, however, the actual estimated production for the period
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
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
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
program, however, was not initiated until the following September.

Navigation training under the 13,500 annual production program
(70,000 pilot program) was scheduled to begin in March 1943. The
required rate of production was attained in June, and the total pro-
duction 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.

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

16. Ibid.
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, Inc. A contract was entered into with PAA by which the company was

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.

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. 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.

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 material 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 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 by 21 March 1942. Although the directive of 26 September 1940 called for the production of 1,269 navigators by 1 November 1941, only 450 had 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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22. See Chart 1, following p. 23.
at Turner Field and to establish a second navigation school in that
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
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
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 4,388 per year with the first graduation sched-
uled for 11 April 1942. It appears that the expansion of facilities
as indicated above would have been approximately adequate for the 4,388
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

23. CG, SEACTC to C/AC, 27 Nov. 1941, in files of Historical Sec.,
Training Command.
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.

The training centers had been advised in December 1941 that the 9,400 rate was to be attained by 1 October 1942. Because of shortages of materiel and personnel and delay 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 until 15 August, and it was 14 September before training began at Selman Field, Monroe, La. This delay in beginning training under the 9,400 program occasioned the loss of approximately 780 navigator 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

28. Acting C/AC to CG of each TC (radiogram), 25 Dec. 1941, in AAG 353.96, Training, General.
29. Project Book of CG, AFPTC, Navigation Sec., 14 Aug. 1942. The "History of Hondo Army Air Field, Activation to 1 January 1943," p. 7 (in APhI Archives), indicates, however, that the move was made on 8 August.
be expanded to the "maximum capacity commensurate with equipment and personnel provided." In August 1942 the command was informed that 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 near future." By October navigation training was "all out" insofar 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-

32. Daily Diary, Directorate of Individual Training, 4 July 1942, in AAG 519.1-3, Daily Diaries; Daily Diary, AFFTC, 4 July 1942, in AC/AS, Training files.
33. AFFTC to CG, AFFTC, 11 Aug. 1942, in AAG 363.9E, Training, General.
34. Daily Diary, AFFTC, 15 July 1942.
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. This constituted an average monthly rate of 1,229. During the first three months of this 15-month period, however,

the average monthly rate of production was far below this rate. 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. 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, the output from the navigation schools which was available to the using agencies was correspondingly reduced. Approximately 1,400 bom-

The dual training of bombardier-navigators was 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 biased 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 alternate bases for requirements and indicated the desired order for these goals to be attained.

41. Monthly Consolidated Flying Training Reports.
42. AFRT to CG, AFFTO, 2 Oct. 1942, in MG 353.9, Specialized Training, Daily Diary, AFFTO, 16 Oct. 1942.
43. Daily Diary, AFFTO, 24 July 1943.
44. See Chart 3 following p.
45. ERN, No. 2, Directorate of Bombardment to AFRT, 26 Dec. 1942, in AFRT files.
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. These three commands had requirements of approximately 2,500 in January, which rose to about 4,500 two months later. In the face of these demands, Individual Training directed the Flying Training Command to “expand 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. 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. 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. On 29 December 1942 the Flying Training Command directed a

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46. RFC, No. 1, AFDB to AOF/13, I-1, 15 March 1943, in AG 211B, Titles and Grades.
47. Ibid.
48. Daily Diary, AFTC, 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.
rurther overloading on the schools. The size of classes at PMA was increased from 200 to 250. The entrance of double classes at Hondo (500) on 7 January, at Monroe (400) on 8 February, and at Luther (apparently 400) 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 trainees 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 barrier graduates were to be entered in the advanced navigation schools.

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 7,760 by 1 July 1943 with production for 1943 expected to reach 13,596. These measures were still inadequate, however, and about 1 March there was a decision for an additional increase of approximately 1,000 graduates by mid-July. 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

52. Ibid., 29 Dec. 1942.
54. Daily Diary, FFG, 9 March 1943.
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 in all of these steps were taken. The Flying Training Command was opposed to abandoning the 12-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. 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, and plans were made to increase the school enrollment to 8,156 by 9 December 1943.

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 cadres in the navigation schools of the command and the crew and staff officer requirements of the OTU and RTO 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.

56. *Monthly Consolidated Flying Training Reports*.
57. *Ibid*.
The needs of the Air Transport, Troop Carrier, and Submarine
Command seemed to make the difference between success and failure in
meeting the overall navigator requirements. The expected requirements
of the Directorate of Bomber Command and the Flying Training Com-
mand for 1943, as indicated on 15 March 1943, totaled 14,402. The Flying
Training Command graduated during 1942 a total of 14,351, leaving a
shortage of only 101 for those using agencies.

In January 1943 the Air Transport Command increased Individual Train-
ing on its estimated 1943 navigator requirement which totaled 3,353.
About the same time the Troop Carrier Command's requirement was indicated
as 3,093, of which 1,095 should receive first priority, the remaining
2,093 to be assigned as available. 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 could use
navigators, and it was not until February 1943 that navigators were in-
cluded in the tables of organization of the Troop Carrier Command. The
requirement from this was 19 navigators per squadron. There was
also at this time an acute shortage of navigators in the Submarine
Command, that Command having only 33 per cent of its approved navigator
strength. In reply to the urgent request of this Command for more

59. RAIL. No. 1, AFESB to 10/13, 15 March 1943, in AG 211B,
      Titles and Graces.
60. Monthly Consolidated Flying Training Reports.
61. RAIL, CG, AFTE to AFTE, 7 Jan. 1943, in AG 211B, Titles and Graces.
62. RAIL, Directors of Air Support to AG/S, 9 Jan. 1943.
63. Ibid.
64. T/01-317, 3 Feb. 1943.
65. CG, AFESB to AFTE, 11 Feb. 1943, in AG 211B, Titles and Graces.

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navigators, the Directorate of Embarcation pointed out that "Navi
tors represent the greatest personal shortage confronting" the AEF; the anti-
submarines Command could not expect any immediate assignments, but an
effort would be made to provide some out of the March production.

No evidence has been found which would indicate only a "paper short-
age" of navigators in the Anti-submarines Command. Relative to the re-
quirements of the Air Transport and Troop Carrier Command, however,
there is considerable evidence that their demands went beyond their
actual operational needs. In September 1943 there was an apparent short-
age of navigators, varying from 4,887 to 5,771. In the following month
C.O./53, 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 43-6 and 43-7 in APO 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 Eiel 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 unemployes as
navigators, we have been assigned to jobs which are really too technical.

66. 1st Ind, 7 FEB 3 to CG, FSUB, 16 Feb, 1943, in TADB.
In F.GT files.
for men without prior training. They feel that "just one trip across the ocean" did not justify all the training they had undergone, and they objected either to be transferred to another theater, returned to the United States for reassignment, or returned for training as bombardier-navigators.

...then this matter was called to the attention of the AC/3 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 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.

...then, 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/3 Training conveyed the following information to the AC/3, CG&R. The table of organization requirements

70. CG, AFFR 2 to CG, A/F, 10 Dec. 1943, in AFAC files.
of 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 as the number of theaters 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." This questioning of requirements resulted, by January 1944, in a drastic downward revision of Air Transport and Troop Carrier Command quotas. Beginning in April 1944, Troop Carrier Command and Air Transport Command requirements were to be 50 and 200 per month respectively.

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 oral training could not be realized, and he announced a dramatic 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. The navigator shortage in these air forces had been so acute that navigators very soon 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 end of 1943 that the flow of navigators to the Second Air Force was sufficient to shift the average entrance rate of navigators from the first week of third phase to the first week of second phase training. 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. Furthermore, as late as 26 February 1944 there were 793 Second Air Force crews so which navigators had not been assigned. It should be pointed out, however, that the absence of navigators in crews in first phase training in the tactical units was not

75. CG, 2d AF to P.I.T., 5 March 1944, in AFAC Files.
76. CG, 2d AF to CG, 26 July 1943, in A/G 353, Navigation Training.
77. CG, 2d AF to P.I.T., 5 March, 1944, in AFAC Files.
prior to about the middle of 1943, as actuarial 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. 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.

The navigator production of the Training Command averaged 345 per month during the first half of 1943, but rose to a monthly average of 511 in July, August, and September. By the end of September, however, future requirements showed an anticipated shortage of 4,437 for the period ending 31 August 1944. The command was therefore requested to submit plans for increasing production accordingly. The plan submitted by the command provided for reverting to a 15-week program and transferring the school at Kather Field to Ellington Field in order to increase facilities and concentrate all navigation training in the

78. See AAF Historical Studies: No. 13, Pilot Transition to Combat Aircraft, 62-75, 78-91.
79. CG, 2d AAF to CG, AAF, 14 July 1943, in RG 332, Navigation Training.
80. See Chp. IV for some reports from theaters.
81. See chart I following this page.
82. Daily Diary, AFTC, 29 Sep. 1943.

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Central Flying Training Command. These steps 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 reemplacé 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.

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 12-week program. Neither the MG/3, Training Command nor the Training Command assumed to resort to this. In fact, in March and April 1944 plans were made to extend the period of instruction to 20 weeks. 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 navigator 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 (Nos. 111, 112) was set aside for the sole purpose of training graduate navigators as precision bombardiers.

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

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84. Memo for Col. H. L. Montgomery by Maj. H. C. Logan, 6 March 1944 in AF/CT files.

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Field to Ellington Field. This move, authorised on 14 October 1943, 86
was to be effected on 5 November 1943. A few days prior to the above
authorization the Training Command agreed to a revised contract with the
PAA to increase the rate of entering classes at its school from 200 to
a maximum of 270. Beginning in January 1944 the rate of classes at
the PAA school was increased to 250. By the middle of January 1944
the enrollment of the navigation schools soared to 8,000, with the es-
tablished annual rate of production being 20,000. With the required
production for 1944 being variously estimated at from 20,000 to 22,500,
there were good reasons for believing that during 1944 production would
meet contemplated requirements. In addition to the navigation training
to meet all the LF requirements, including a small number of Negro
navigators, arrangements were made to train 60 Chinese students as navig-
ators. By the end of March 1944 enough navigators and bombardier-navig-
ators to meet the requirements of the Second Air Force for April and
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
important of these were the fluctuating crew requirements ofbombar-
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 navi-
gator-ammunition. Those 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-
barier 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. Then the requirements of this program were added
to those of medium bombardment, which required usually trained men for
25 per cent of clear crews, it was difficult to meet the demand. It
appeared, however, that this demand could have been met. Then the very
heavy crew requirement which called for the precision bombardier-celes-
tial navigator-ammunition officers was established, however, both the capacity

1944; 36th, No. 1, Requires Div. .O/AS, O/A, to .O/AS, Train-
ing, 25 Jan. 1944, in .O/AS, Bombardier and Navigation Train-
ing, Daily Diary, Unit Training Div., .O/AS, Training, 24 April
1944, in .FIII Ficates.
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 radar 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 usual 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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Chapter II

PROCUREMENT AND PREFLIGHT TRAINING OF NAVIGATORS

Procurement of Navigation Trainees

Securing Trainees. Up to the spring of 1944 there were three sources from which navigation trainees could be procured. Prior to the establishment 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. The two sources utilized during this period were aviation cadets and non-commissioned aviation cadets, who had been eliminated from pilot training, and selected civilians. On these two types of personnel, preference was given to eliminated pilots.

During the first year of training in the specialized navigation schools, the number of trainees procured through these two sources appears to have been inadequate. Beginning in the fall of 1944, however, a shortage of applicants appeared, and it was necessary to resort to

1. No officers were given in-grade training in the navigation schools prior to November 1941. 2a Ind., C/L to AG, 24 Sep. 1941, in AG 353.9, Navigation (Advanced Aviation) and Instrument Training.
2. Exem. to AG, 22 May 1940, in AG 353.9, Training Directives and Programs; 323, 130 to Plans, 17 June 1940, in AG 353.9, Navigation and Instrument Training.
3. See a study on the use of pilots from airline training in preparation in Administrative History Branch, USAH.
other means. One of the steps taken was to allow cadets to undergo in-grade training in navigation, beginning in November 1941. At about the same time the educational requirements were lowered, and an intensive advertising program was employed in order to encourage applications for non-pilot training. The shortage of navigator trainees was so acute that military personnel proposed to take approximately 1,000 bomber training applicants who had six 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, one partly to the results exposed from the 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. J. Lear R. Johnson to "Get in touch with Hans Johnson, 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 brana now man who never had any navigation."

Brig. Gen. George E. Stratemeyer

5. Chief of Air Staff to G/.G, 24 Oct. 1941, in .G 353.4, Special-\n7
trim Training.
secured the names of a number of young men from the service. 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 these 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 assigned 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 AAF was determined by numerous factors. The effects of insufficient class material, and instructor and supervisory personnel on training efficiency were constantly emphasized. Of equal importance with these...

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11. See Chap. VII on material factors and Chap VI on instructors.
conditioning factors was that of the quality of the trainee himself.

General ability and aptitude for and interest in a particular type of training were necessary in 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.

Use of Eliminates. More navigation trainees were procured from eliminates than from any other source. Prior to the inauguration of the aviation cadet classification program in January 1942, virtually all navigation trainees were cadets and former cadets who had been eliminated from pilot training. When the navigation training program was launched in June 1942, it was expected that 70 per cent of all pilot eliminates would be available for training as navigators and navigators. Since the number of pilot eliminates was expected to be 5,000 and the bombardier-navigator requirement at that time was 3,000, it appears that virtually all such trainees were expected to be personnel who had been eliminated from pilot training.

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

12. For detailed treatment of these personnel functions consult the studies prepared by the Personnel Section of FSH.
13. See HISTORICAL SOURCES: No. 2, Initial Selection of Cadets for Pilot, Bomber, and Navigator Training, May 44.
15. Ex. to Exs. to Exs. to J.G., 2 July 1940, in MG 2112, Cadets.
16. Memo for Chief of Staff, by C.G., 24 May 1940, in MG 355-9, AC Training Directives and Programs.
both as to requirements and exact preference, however, the number of
new aces classified for and assigned to navigation training was ins-
17
sufficient. The required ratio of navigators to pilots was approxi-
mately 1 to 5 while the ratio of preference was about 1 to 18. Conse-
sequently, 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 aces.
During the year from March 1941 to March 1942 the elimination rate
among navigation trainees who had had previous aircraft training was
15.5 per cent. During the same period the elimination rate among
19
such trainees without previous training was 12.6 per cent.

In spite of the fact that there was no apparent alternative to
utilizing pilot eliminations 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. The matter later a
similar, though less positive, suggestion was made to the training
centers by the Assistant Chief of the Air Corps. In the following
March the Directorate of Military Requirements recommended to the Air
21
Staff that the practice be discontinued. A recommendation to this

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18. Ist Ind. (C:/S to CG, AFTC, 10 Sep. 1942), 2 Cpt. 1942, in AFTC
Files.
19. Director of Personnel to Col. Charles H. Glenn (Surgeon of AFTC),
22 May 1942, in MG 353.9, Specialized Training.
20. Memo for Cg. /S from by Air Inspector, 19 Aug. 1941, in MG 352.01D,
Establishment of Schools.
21. Ext. C:/S to CG of each TC, 19 Sep. 1941, in MG 353.9, Specialized
Training.
also effect was made by the Directorate of Reconnaisance in June 1942.

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.

The ratio of newly classified cadets to eligibles in navigational 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." In the following August the decision was made that at least 20 per cent of the trainees should be new cadets. In actual practice, however, the ratio was about 1 to 1 in October 1943.

Qualifications of Trainees. The standards of qualification for assignment of new cadets to navigational 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. 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.
28. 1st Ind. (Basic unknown), CG C to Parks Air College, 27 Aug. 1940, in LRG 353-9, Specialized Training.
cants be graduates of an accredited high school and pass the prescribed
battery of tests. When the new aviation cadre 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
at various times were:

<table>
<thead>
<tr>
<th>Date</th>
<th>Navigator</th>
<th>Bombardier</th>
<th>Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 1942</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dec. 1942</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>July 1943</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>10 July to 23 August 1943</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>24 August to 1 November 1943</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>1 to 23 November 1943</td>
<td>0</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>23 November 1943</td>
<td>7</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2 February 1944</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

**Preflight Training**

**Evolution of Preflight Schools.** Non-pilot aircrew training has
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

30. "Standards & Procedures for Recommending Assignment to Aircrew
Training," 20 Nov. 1943, AFTR, Psychological Dr., in AFHRI files.
The data for 2 Feb. 1944 were taken from Daily Diary, AFTR, 311
Div., 2 Feb. 1944, in AFTR files. This reaction, 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.
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 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 Commissioned Members of Combat Crews." 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 navigation 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

32. CG, SRACTC to C/AC, 1 July 1941, in AAG 353.9C, Training, General.
33. CG, SRACTC to C/AC, 16 March 1941, in AAG 353.922, Training, General; CG, SRACTC to CO, AC Advanced Flying School, Maxwell Field, 12 June 1941, in AAG 353.961, Training, General.
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 (Aircrew). Flights 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. 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 Maxwell, Ellington, and Santa Ana, Calif. In October 1942 the preflight school at Maxwell was moved to Salina Field, Ks. After a month of bombardier-navigator training it became a preflight school for navigators only.

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

34. CG 31020 to CG, AG Advanced Flying School, Maxwell Field, 12 June 1942, in AG 353-931, Training, General.
35. AG 320.2 (3-21-42), 30 Sept. 1941.
37. AG 320.2 (3-24-42) 12-21-42, 30 April 1942.

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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 mechanics 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) 3-1/2 "
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 (aircraft) in the fall of 1941; to the 10-week

40. "Master Schedules," A.F Pre-Flight School (Bombardier-Navigator), Ellington Field, Tex., in AFPH 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 No. 69, AFHS, Pre-flight Sec., 14 March 1944.
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
accelerating the tempo of instruction. No additional hours of instruc-
tion or other activities were included.

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

The second change was made in order to eliminate unnecessary am-
plication of training to core personnel. Heretofore all bombardier
and navigator trainees were required to undergo the entire prelight
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 prelight training. Also, any aircrew
trainees eliminated after the prelight stage could be assigned direct-
ly to the advanced stage of another category of training. Eliminates
from one type of training who were reclassified for another category
of training had heretofore been required to undergo prelight training.

41. Commanding Officer's General Bulletin No. 12, 16 Jan. 1942; CG,
Air Force to CG of each TO, 1 Mar 1943, AVAvation Pilot Training;
Daily Diary, 8THC, 8 March 1943.
in the second category.

By April 1944, preflight training had become almost completely standardized. At that time, the Training Command requested authority to un-
continue the schools at Selma and Ellington fields and to reassign the
school at San Antonio as an "AF Preflight School, without refer-
ence to type of training," since all three types of preflight were
being conducted at that school.

Fluctuations in requirements and production. The preflight navi-
gation 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 ad-
vanced schools. These conditions made it impossible to maintain an
adequate and even flow of preflight graduates. There were frequent
alterations in shortages and surpluses accompanied by overloading or
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
45
to the maximum. It was found difficult, however, to enter extra

44. Daily Diary, ARTC, 10 April 1944.
trainees for the training air forces because of the overload which 46 already had been entered for advanced navigation schools. The number 47 of students under instruction was increased from approximately 1,200 on 5 July to over 3,000 by the end of September 1942. Any excess graduates who could not be accommodated in the advanced schools and the air forces were to be sent to flexible ground schools.

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 instruction. 49 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 to the problem. In order to liquidate this backlog, the following steps were taken. Those cases 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 cases as navigators "except in necessary." Other graduates with the desired qualifications were to be used as assistant ground school instructors or as drill masters in military

46. Daily Diary, AFFTC, 23 July 1942, in HHD.
47. See Chart 1 following p. 23.
training. Part of the surplus also was taken care of by sending men to the flexible gunnery school. Others were absorbed by the increased capacity of the advanced schools, in which the number of students under instruction increased from about 2,700 in October 1942 to approximately 5,000 in March 1943.

In June 1943 there was again a surplus of navigation trainees. There were 1,500 on assigning 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 eliminated pilots, to navigation training.

In the following October there was a shortage of preflight navigator 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. This shortage did not prevent the filling of classes in the advanced schools, but it did affect the number going to gunnery schools from preflight. In February 1944 the preflight schools were directed to enter double quotas of students "to ensure that all bombardier and navigator graduates, subsequent to 1 June 1944, will have had Flexible Gunnery Training."

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53. See Chart 1 following p. 23.
54. Daily Diary, AFTC, 1-1 Div., 3 June 1943, in AFTC files.
55. Daily Diary, AFTC, 12 Oct. 1943.
56. Ibid.
57. Daily Diary, AFTC, 3 Feb. 1944.
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 3,050, by the end of 1943 to 24,332, and by the end of April 1944 to 33,524. The flow of preflight graduates to advanced schools had not always been even, but steps had been taken to ensure that enough navigation trainees would be entered into preflight schools to meet the heavy requirements for navigators.

53. See Chart 1 following p. 25 for monthly and cumulative flow of graduates.
Chapter III

INDIVIDUAL TRAINING IN TACTICAL UNITS

Early Training, 1942 to 1936

Exclusive of the navigation training begun by the Air Force Civilian contract school at Coral Gables, Fla., in August 1940, there was no training of navigation specialists in the special service schools of the CCS prior to November 1940 when such training was initiated at Larned Field, Kan. 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 AAF prior to 1942 was conducted in the tactical units of the USAF, Air Force and its successor, the Air Force Combat Command.

The training of navigation specialists to function as separate members of the aircraft 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

1. See Chart 1 following p. 25.
the increase in the range of action of airplanes. The first of such flights in army aircraft was made from California to the Hawaiian Islands on 25-29 June 1927. This was the “first long distance flight, at least by the army, on which celestial navigation and the radio beacon were used.”

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 internal division at Wright Field where equipment and texts 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. 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. On 12 October 1933 the Adjutant General approved the request of the Chief of the Air Corps to train 50 officers at these fields (two groups of 25 each

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
1933. Shortage of equipment and the content of the course later
causd the period of instruction to be extended to two months. The
units conducting this training were not designated as "schools," how-
ever, but were referred to as "advanced navigation training units."
The training at Rockwell Field was conducted by the 19th Bombardment
Group which is considered the pioneer in AF 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. After the termination of the advanced navigation
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, CEC air Force directed the
Commanding General, 1st BIB to assign the responsibility for developing
methods and equipment for advanced navigation training to the 19th
Bombardment Group. This special function was performed by this group
until June 1936, after which time it continued to operate as a group
in navigation training unit. It appears that prior to 1 July 1935 the
Chief of the Air Corps was allowed to assign students to the classes

10 Nov., 1935, in ibid.
8. Memo for C/O by Chief, T&D Div., 20 Sep. 1939, in MG 352.016,
Establishment of Army Service Schools and Staff Colleges.
10. ibid.

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conducted at Langley and Randolph on 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 1935.

**Attempts to Establish a Specialized School**

The individual training of navigators in the tactical units was subject to certain limitations. 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 any bases seriously interfered with the training of navigation specialists in tactical organizations. Consequently, the Commanding General of the G-3 Air Force indicated the desirability of conducting such training in the tactical units and recommended the "establishment of a centralized school to perform this function for the G-3 Air Force."

Even before this date, however, on 30 August 1935, the Chief of the Air Corps had suggested the desirability 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 aerial navigators."

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11. G/C to CG, GEQ AF (radio-man), 11 June 1935; CG, GEQ AF to G/C (radio-man), 13 June 1935, in memo.
ith both the Chief of the Air Corps and the Commanding General, GCS, the 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." 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 GCS Air Force. These plans too were abandoned because of the shortage of personnel and equipment.

Supplementary Training and Problems Encountered

The individual training of navigators, or sequentially, redefined the responsibility of the local station 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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with the transition stage of advanced pilot training, hereinafter
conducted in the Air Corps Training Center. The time and equipment
devoted to transition pilot training affected a corresponding reduction
in opportunity to conduct navigation and other specialized non-pilot
16 training. In September 1939, therefore, there was not only no central-
ized 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.
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
17 not contemplated. Navigation training in Air Corps schools was to
be conducted at schools engaged in one or more types of other special-
ized 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, HQ 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 it will enable them to undertake the responsibilities that would

16. Memo for CG by Chief, T&O Div., 20 Sep. 1939, in RG 320, OCS,
Establishment of Air Service Schools and Staff Colleges.
17. Ibid.
18. CG to CG, 14 March 1940, in ibid.
naturally be assigned to them in combat units, and that a considerable amount of individual training would necessarily be required in the tactical organizations. Before 1942 it was the established policy to assign navigator graduates to duty with tactical units for approximately six months before they were commissioned. 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 allocate 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 tactical 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 AAF was that individual training in the tactical organizations should merely supplement rather than duplicate or replace that of

20. O/3 to AG, 12 Aug 1940, in A.G 2112, Cadets; A/0 to CG, GH, AF, 30 November 1940, in A.G 353-9, Specialized Training; B-3 Diary, Training Dec., 17, 20 Dec. 1941, in GHK files.
Training of Prelight 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, the 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. Trains were to be assigned to the tactical organizations on a ratio of not more than one train 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.

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

for assignment to the air forces for the period 3 October 1942 to 1
June 1943. Meanwhile, plans were made to send 51 navigator cadets
graduating from preflight in August to the Caribbean and Hawaiian
departments.

The training of navigation cadets 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 could be conducted outside the Flying
Training Command would be that performed in the Hawaiian Depart-
ment.

About 1 November 1942, however, new plans were made to send 50 navi-
gation cadets in the Sixth Air Force. This air force, however, was
short of the necessary navigational equipment and requested that the
cadets and equipment be sent at the same time. For nearly three
months Individual Training and the Flying Training and Air Service

23. 1st Ina. (FFIT to CG, AFFTC, 8 Aug. 1942), FFIT to AFRIT, 11
24. AFIT to CG, AFFTC, 14 Aug. 1942, in AFR 333-9G, Navigation and
Instrument Training.
25. 2d Ina. (FFIT to CG, AFFTC, 8 Aug. 1942), FFIT to CG, AFFTC,
26. CG, 6th FG to CG, AFR, 6 Nov. 1942, in AFR 353, Bombing and
Navigation Training.
Command tried to get students and the necessary material ready for shipment. After the lapse of another month, military personnel 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 as completed, the Sixth Air Force informed the H/5, Training, that it would be unable to train navigation cadets after the current class graduated, about 4 September 1943.

The experience encountered in training navigation cadets in the 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 1942. In compliance with this directive, the Flying Training Command authorized the West Coast Training Center to initiate the necessary flow of cadets to the Hawaiian Department. By March 1943, however,

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30. A navigation school was in operation in the Seventh Air Force as early as the spring of 1942, M/N to CG, Hawaiian Department, 2 May 1942, in L.O. 353,952, Training, General.
the Directorate of Personnel could find the record of only three groups of cadets having been transferred to this department. In the following March navigation training in Kansas was "discontinued due to assignment of instructor personnel to other duties." Twenty-four cadets who were awaiting training were to be retained and entered in advanced navigation training at Eglin Field.

With the return of the entrained 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 training of navigation cadets to organizations outside the Training Company 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 Company 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 AGOS, Training. No indication that bombardiers and navigators could be sent to the Training Company schools to be trained in the second category of training and for refresher courses leading to certificates

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33. AGOS to CG, Hawaiian Dept. 5 March 1943, in AGS 353, Enlisted and Navigation Training.
34. Daily Diary, AGFS, 5 April 1943, in AGST files.
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 AIC policy on the issuance of certificates of proficiency, and asked whether the Second Air Force was authorized to qualify military personnel as dead reckoning and celestial navigators. To this request the IO/S, Training, replied that:

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

Program 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 assigned to train a particular type or 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

36. AG 211, Navigation Unites.
mostly of air training, and were calculated to effect the earliest possible attainment of combat proficiency of 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. The essential differences in both mission and method 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 summarize courses of instruction in both in order to rationalize the rating and commissioning of personnel trained in the tactical units.

The navigation training conducted in the group schools of the Air Force Air Force 1933 to 1938 was essentially experimental and developmental. The program of instruction under which navigation training at Langley and Rockwell fields was begun in October 1933 consisted of 160 hours allocated as follows:

| Ground Instruction in Aviation | 59 hrs. |
| Radio | 4 " |
| Meteorology | 20 " |
| Airmanship at Sea | 4 " |
| Air Training | 77 " |

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

38. Navigating Exec., CO 3 to AG, 18 Oct. 1939, in AMC. 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.
After this training was begun the time allocated was found inadequate 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 in each bombardment group. Serial celestial navigation was still in its infancy, however, and little was "known relative to the equipment and material 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 was plans to establish a "Celestial Navigation School," the operation of which would be the major mission of the 19th Bombardment Group. This development program extended 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 Air Force.

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39. G/5, G/6, 7 Nov. 1933; MG to CG's of Corps areas, 10 Nov. 1933, in ibid. No record has been found of any later changes in this program or instruction nor any of the programs subsequently used by the group schools of the Air Force.

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 to keep 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 progress of instruction, training schools, and training aids.

As early as June 1941 the Training and Operations Division of the CCG requested the service air forces (Caribbean, Alaskan, and Hawaiian) to submit reports on navigation difficulties encountered in tactical operations and suggested changes in the techniques of training certain 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

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 coordinating their course of instruction . . . and the actual application of that instruction with tactical outlets."

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.

Stanardization 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 visual reconnaissance and celestial navigator. In calling this to the attention of the

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Chief of the A.F., 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, or 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 of air forces and that such a curriculum should follow closely that used in the Air Corps schools.

The subsequent discussions on 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. 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 could have to be within the capabilities of the tactical unit conducting it. For this circle.

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44. AAF, No. 1, C.1/0 to C.1/7, 30 Aug. 1941, in ibid.
45. AAF, No. 2, C.1/9 to C.1/6, 30 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 standards of proficiency required for the rating of navigator in the Air Force Combat Command was the ability to navigate within an error limit of 1-1/2 minutes in estimated time of arrival (ET) 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 functions of navigator in the combat crew or be assigned and reconnaissance aircraft at the application" for rating. The Chief of the Air Staff concurred with the Commanding General of the Combat Command with 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 "qualifications as expert aerial gunner or aerial...

46. Ibid.
47. Ist Inc. (basic unknown), CG, ARC to 3/MF, 3 Sep. 1941, in ibid.
somewhat different approach was taken 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
prelight navigation schools. The Director, 7th Provisional TN,
indicated the flying training command on 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 "earn a navigation rating."
Factors to be determined were the number and qualifications of instruc-
tor personnel, the prerequisites to be required of trainees, and the
program of instruction to be followed. These requirements were fur-
nished by the command, but before training was inaugurated the command
indicated its non-concurrence with such a policy and requested that all
prelight graduates receive advanced training in the air corps schools.
This type of training was performed in various air forces for approxi-
mately a year, October 1942 to September 1943, but during that period
it appears that requirements established by the Flying Training Com-
mand were followed in the group schools.

49. ARN, No. 3, 6/13 to 6/5, 22 Sep. 1941, in ibid.
50. "Notes for Formulation of Policies," 27 Nov. 1941, in MG 321, 9-1;
see also 7 A3 Diary, item 11, 23 July 1942, and item 10, 25 July
1942, in ARN diaries.
51. FFRIC to CG, FFRIC, 27 April 1942, in MG 221-7, Tajes and Grades.
1st Ind., FFRIC to FFRIC, 11 May 1942, in ibid; Daily Diary, FFRIC,
22 July 1942, in MG 319, 1-3, Daily Diaries.
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 C.O.M.A. 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 furnished by Individual Training. In March 1943 the antisubmarine C.O.M.A., which had already been operating a group school, requested that graduates of the school be rated as aerial navigators. Apparently the C.O.M.A. had not coordinated with Individual Training when this training was initiated, and when the request for rating the graduates reached the I.C./S., 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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53. In the 29 March 1943 reorganization of the I.C.F., AFIT was succeeded by I.C./S., Training.
54. CG, FSUB to AFIT, 29 March 1943; 1st Inf., I.C/F., Training to CG, FSUB, 6 April 1943, in F.C.T. files.
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, 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 1C/15, 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. Nearly had all individual training of navigators been 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-raid personnel for the very heavy bombardment program was such that the Training Command special line 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 dual bombardier-

55. Air Crew Div., 13/13, Training, 26 Nov. 1943, in APHIL Files.
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.

Evaluation of Policy of Training in Tactical Organizations

The number of navigator crews 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 Air Force.

It is true that the rate of navigator production in the Flying Training Command from May to August 1942 was not up to expectations. It that time training was still being conducted at stations occupied by advanced flying schools, with the exception of Kather 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.

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 aircraft 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 aircraft destined for the Caribbean Air Force until about March 1943, though the decision was made in August 1942. With production already dependent upon the training personnel and training equipment, it appears that production was actually slowed rather than accelerated by the dispersal of these items.

This was pointed out by Individual Training when in February 1943 the shipment of a navigator training squadron to the Seventh Air Force was approved.

Furthermore, the tactical organizations found it difficult to conduct this type of training in addition to their regular OTU and BET 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.

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'".  

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 Komo, Tex., respectively. By 1 January 1943 total school enrollment had reached 3,637, and by 1 July 1943 it stood at 7,700. 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 13,000. 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-

60. Project Book of CG, 358, Navigation School, 6 April and 13 July 1943.
ment was pointed out as compared with the scheduled production of the navigation schools which indicated a production of 14,292 as against 13,200 requirement. Navigator graduates in 1943 actually exceeded 14,292, running well above 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 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 NR 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 had been learned that the antisubmarine Comair was starting a 12-week course, that Maj. Gen. Hazard P. Harmon was setting up a school in New Guinea, and "verbal" information from the Directorate of Bomber Materiel indicated that the IV Bomber Comair 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

61. ARB, No. 2, "FMT to 12/43, Program Manning, 4 March 1943, in FST files.
62. Ibid.

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excess of 1,400 per month.

While there was an excess of 643 preflight navigator graduates at the end of September 1942 and about 1,000 one month later, it does not appear that any sizeable portion of the surplus was sent to the training air forces. Thus 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 L.T.


5. Data were not available on the number of navigation cadets trained in tactical organizations. The only references found were to the one group, apparently 50 cadets, 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 combatant groups of the U.S. Air Force and its successor, the Air Force Combat Command. The monthly Training and Operations Reports of these organizations contained on "Celestial Navigators—Trained and Untrained") Combat Grp., as well as "Aerom Ter Training for Assignment to Combat Grp." These are status reports and do not reveal the production flow of trained personnel.
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 CAC would be given in specialized navigation schools which would be located at some of the advanced pilot schools. The first of these schools was scheduled to open at Barksdale Field, although training there on necessity would be very limited. Not only was there a 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 instructor, bombardier, and navigator.

With a view to initiating navigation training continued to that conducted in tactical organizations and with no large-scale production to be expected at Barksdale, 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 P.A. at Coral Gables, Fla.

2. B.O to Plans, 24 May 1940, in A0 353.92, Training in Navigation, Pilot.
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 I.A.A. At this time only 339 navigators had been trained in specialized schools.

Program requirements in mid-1941 called for an annual production rate of about 2,400 navigators, and the 20,000 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. Herefore 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. Accordingly, the personnel and equipment used at Barksdale were divided among new navigation schools opened at Turner, Kelly, and Luther Field. Instruction was scheduled to begin at these schools on 1 August 1941.

4. See Chart 1 following p. 23.
5. B.R. No. 1, Tab to Exec., 10 July 1941, in U.352,11E, 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. 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 Cables. One year later this number had increased to 1,572. Within three months after single-purpose schools were established, however, there were more than 3,000 students under instruction. This transfer of navigation training to single-purpose schools was effected by the construction and activation of two new fields, Selman Field at Monroe, La., and Honga Army Air Field at Honga, Tex., to which the navigation schools at Turner Field and Kelly Field were respectively moved. At about the same time the pilot school at Randolph Field was transferred elsewhere, leaving only navigation training at that field.

8. See Chart 1 following p. 23.

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Facilities for navigation training in LPT schools were expanded further in February 1943 with the opening of a new school at San Marcos, Tex. Within two months after opening, this one school had more students under instruction than all the other schools in the Central Flying Training Command. 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 Monroe, La., was transferred to command, and in November 1943 the school at Keesler Field was transferred to Ellington Field. Two months after this transfer was effected the number of students under instruction 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

11. Daily Diary, 3 Div., AFTC, 21 Aug. 1943, in files of AFTC.
12. Ibid., 19 Sep. 1943.
13. See Chart 1 following p. 23.
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 3 July 1940 to the 12-week program approved in January 1943. Early in 1944 it appeared that the course would soon be extended to 20 weeks. The content of programs of instruction varied in accordance with the time allotted, the navigational equipment and its availability in the navigation schools, and the experience gained in the training of other forces and in 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 3 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 3 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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"Tentative Program of Instruction,
July 1940 program ended 3 February 1941 or 15 weeks' duration; (4) another revision ended 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, piloting, 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:

<table>
<thead>
<tr>
<th>Phase of Training</th>
<th>Program of 6 July 1940</th>
<th>Program of 3 February 1941</th>
<th>Program of 15 July 1941</th>
<th>Program of 7 January 1943</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 weeks</td>
<td>15 weeks</td>
<td>15 weeks</td>
<td>13 weeks (23 July revision)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ground training</th>
<th>210 hrs.</th>
<th>253 hrs.</th>
<th>403 hrs.</th>
<th>359 hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air training</td>
<td>72</td>
<td>21</td>
<td>100-1/2</td>
<td>100</td>
</tr>
</tbody>
</table>

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.
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. 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 Enrascaille Field in November 1940, this program has 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 Enrascaille in November, and a second class of 20 entered about 1 February 1941. In the meantime a revised program has been approved. This program, as of 3 February 1941, called meteorology, increases the time allowed to celestial navigation and air training, reduces the time devoted to athletics and military training.

16. Memo for G/6 by Committee, by June 1940, in AG 352116, Courses of Instruction. The committee was composed of Maj. Isaiah Davis and John A. Morgan, Capt. J. E. infrared, 3. G. lasser, and R. A. Ryan.
The program of February 1941 was not considered entirely adequate, but was based on the availability and expected availability of personnel and material. The navigation program of instruction became reasonably well stabilized in July 1941. At this time training at Randolph was terminated, and three schools were established, one in each training center. These schools began training under the revised program 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, 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 changes 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 desires of the using agencies had resulted in a heavy overload on the students. The Flying Training Command pointed out that navigation

18. See Appendix I for the outline of this program.
students were "under approximately twice as much daily schedule inst-
struction throughout the course, as the pilot student." 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 graduates. It was about the same
line that this condition was recognized, a directive was issued to use 20
hours of instruction in first aid.

The directors of training in the navigation schools had been in-
sisting 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
of revising and standardizing the program of instruction. As a result
of these conferences and the pressing need for a new program of instruc-
tion, the Commanding General of the Flying Training Command strongly
recommended that the course be extended from 15 to 18 weeks and sub-
mitted a plan whereby it could be accomplished without a loss in navi-
gator production. Individual training concurred in the proposed
extension with the exception of the proposal that the flying time given

19. CG, AFTC to CG, 155, attn. FEN thru FNI, 20 Nov. 1942, in
   MG 352.11, Navigation Schools.
20. Ibid.
21. Fly Diary, 3-3 Div., AFTC, 3 Oct. and 19 Nov. 1942, in FTM files;
22. CG, AFTC to CG, 155, attn: FEN thru FNI, 20 Nov. 1942, in
   MG 352.11, Navigation Schools.
at Coral Cables be increased from 50 to 60 hours since this would require additional airplanes. The Director of Bombarding, however, disapproved the extension because of the planned conversion of bombardier and navigator training to a dual program. The dual training 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 low 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 Cables provided there was an increase of 5o students per class.

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 operation. The important changes effected by the new program of

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23. FIE, AFIT to AFAB, FTO, and FBO, 24 Nov. 1942, in .FCT Files.
24. FIE, No. 2, FDE to AFIT, 29 Nov. 1942, in .FCT Files.
26. CG, AFIT to AFIT, 12 Jan. 1943, in ibid.
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 astrograph, astrocampus, 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 assign it so as to facilitate the proposed bombardier-navigator training.

On 7 January 1943 the Flying Training Command was authorized to
place the program in effect immediately, pending formal approval. The program was formally approved for issuance to the navigation schools on 15 January 1943. Meanwhile, it had already begun at Hondo on

27. Ibid.

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7 January 1943, and was stopped at Coral Gables on 30 January 1943, at
Selma Field on 6 February 1943, at San Marcos, Tex., on 20 February
1943 (the date on which this school began operations), and at other
Field on 27 February 1943. In order to maintain the established flow
of graduates, two classes were entered at home, Mather, and Selma 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.

The 16-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 in a cycle 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 Com-
and preferred the 20-week program which was approved and scheduled to

30. 2a Inc. (OG, PPR to CG, 1IF, 20 Nov. 1942), CG, PPR to SMT,
15 Jan. 1943; [Appendix Project Book on CG, PPR, Navigation Inc.,
28 January 1943.
30a. T. G. Rine 30-11-1, 22 July 1943 and 22 Nov. 1943.
31. Note for Col. J. J. Montgomery by Maj. H. G. Boland, 6 March
1944, in F-61 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.

Ground Training. The over-all training portion of the individual training of navigators was ground training. The percentage of time allocated to this phase, including "allied" training, was approximately 32 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 map, identification, first aid, oxygen indoctrination, and map administration. 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.

32. Project Book of 40, PFB, Navigation Sec., 14 April 1944.
33. See Appendix 2.
Ground instruction in the four types or methods of navigation was
delivered in the following manner. Familiarization and an intro-
duction to the basic theories and principles of navigation were first
given to the student. These were followed by instruction on such in-
struments as compasses, aritmetests, 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. The primary need of the student was in-
doctrination 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 12-week ground instruction provided
for 20 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. T. T. (dead
reckoning trainer) and the C. N. T. (celestial navigation trainer), the
trainee could apply virtually all navigational techniques on the ground.

34. OX, FTR to ANM, 12 Jan. 1943, in N 35211, Navigation Schools.
and so on 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 of the most basic procedures the student was required to approach the 100 per cent level.

35. 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 short missions or four-hour each. The next three were day-night missions (two-legs each mission with the out-leg flown in the day and the return leg at night) or eight hour each. The last mission was a 12-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 schools.

35. This description of the essential procedures in ground training is based on navigation syllabi in FOG files.
36. See "Flight Missions" in syllabi in FOG files.
Air training was conducted with three trained, 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
method alone on the first 10 missions and combining this method with
the 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 remainder. The third navigator followed an extremely varied procedure,
performing one type of navigation on the missions, two on five,
three on five, and two plus "follow-the-pilot" on seven. His first two
missions were familiarization flights, and his first and second navigators combined all types of navigation in the last two missions.

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

navigate during daylight hours by dead reckoning means
with a maximum course error of 1 1/2° and a vertical
error of 1 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
aircraft.

There was a fair correlation between ground and air perfor-

37. T. J. San 50-12-1, 22 Nov. 1943
unce 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.

**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 1935 to 1940. Just prior to the opening of the three navigation schools in the summer of 1941, the Ginkgo Force and the defense air forces in the Mexican and Caribbean departments and Alaska were requested to submit certain information on navigation training. To ensure 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 naviga-
tion technique" be reported to the Chief of the Air Corps.

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38. Research Notes 44-4, Psychological Sec. AFT.3, 17 Feb. 1944; "Lectures on Navigator Proficiency Courses," by Dr. H. O. Jenkins, Psychological Sec., AFT.3, 19 April 1944, in .FNHI files.
before this request was made, however, the commanding general of the 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 inappropriate" in order to "insure that the navigation schools are presenting the latest information in their courses."

During the months of July and August 1941 the chief of the air corps received the reports requested and after analysis and consideration translated them to the three training centers for their information and comments. 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 grading efficiency of the schools would rectify these weaknesses. At the same 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 cadet school at Coral Gables.

41. C.O. G-32 AF (?), to G-3, 23a Composite Group, Orlando, Fla., 5 May 1941, in ibid.
42. C.O. to G-3 of each 10, 27 and 28 Aug 1941, in AG 353-921, Training, General.
43. 3a Ind. (250 to G-3, 258-619), 27 Aug 1941, in AG 353-92, Training, General.
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, 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 those 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.
Similar reports came from the African theater in August and October
1943. Surveys conducted in AAF navigation schools and the training
air forces in continental United States also indicated the need of
additional emphasis on pilotage, especially for night flying.

44. CG, VIII Bomber Command to CG, J.F., attn. G/C, OCT 33, 27 June
    1943, in J.OT files; CG, 7th J.F to CG, J.F., 21 Oct. 1942, in J.G
    353.9F, Training, General.
    CG, VIII Bomber Command to CG, J.F., attn. G/C, OCT 33, 27 June
    1943, in J.OT files.
46. G/C, Training to CG, 2d J.F, 11 Aug. 1943, in J.G 353.9, Foot-Point
    and Navigation Training; G/C/A, ACS to G/C, Training, 29 Oct.
    1943, in J.OT files.
47. CG, III Air Support Command to CG, 3a J.F, 4 Nov. 1945, in J.G 353,
    Navigation Training; Col. John M. Scan to J.G, 3-9, APFTC, about
    1 Jan. 1943, in J.OT files.

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apparently there was no appreciable increase in the time allocated to pilotage and map reading in the navigation program of 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 of phase of training. Instruction in map reading at night and at low altitudes was increased in January 1942. In August 1943 the C/O, Training Command, 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 clear 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

42. C/8, No. 2, 10/16, Training to WM, 30 Oct. 1943, in WM files.
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.

The original program of instruction of July 1940 allotted 19 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. 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..."

51. 3a Ind. (F-0 to CG, 25 CTR, 27 Aug 1941), 20 Sep 1941, in AMC 353.901 Training, General; 1st Inda. (F-01 to CG, 3FTO, 5 March 1943), 19 March 1943, in AMC 353.901 Bombing and Navigation Training.
52. See program dated 3 February 1941, in AF Library, 15 July 1941.
53. 1st Inda. (O-0 to CG, 27 June 1941), 7 Aug 1941, in AMC 353.901 Training, General; Col. John H. Owen to J-3, 1-3, 3FTO, about 1 Jan 1943, in AFST files.
54. F. T. C. Memo 50-1-4, 9 April 1943.
55. CG, 8th F to AFREB, 9 Feb 1943, in AMC 353, Bemardier Training.
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 tell 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. With reference to such complaints the Flying Training Command indicated that radio compass training was "not" adequate, but that the navigation schools were handicapped by lack of information on "existing radio fix 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

56. CG, VIII Bomber Command to CG, MAC, attn. JR/S, CKC, 27 June 1943, in AG 50 files.
57. FRIT to CG, APPX, 5 March 1943, in AG 353, Bombsight and Navigation Training,
bring their training up to the desired standard in this respect.

**Loran Training.** In the early part of 1943 a need to utilize Loran in establishing navigational fixes was perceived. 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 instructed.

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58. CG, 5FTW to CG, MEF, attn. Director of Communications, 13 March 1943, in AG 353, Navigation Training.
59. 5FTW to CG, 5FTW, 6 Jan. 1943, in 5FTW files.
62. 5th Ind. (CG, 5FTW to C-/S., Training, 12 Aug. 1943), C-/S., Training to CG, 31 July 1943, in 5FTW files.
63. T. C. Memo 50-12-1, 22 July 1943.
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 assured. With the exception of the South Pacific area, it appears that celestial means were seldom employed by 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. For a number of reasons, however, many navigators reached the combat theaters unprepared to utilize all navigational methods and aids. This was partly due to factors inherent in the individual, such as peculiar interests 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.

64. HQ, 632R to HQ, Training, 20 Oct. 1943, in W32T files.
66. HQ, 63, Training to CG, FFRC, 5 March 1943, in W32 files, Bomb-Sight and Navigation Training.
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 aero-reckoning, i.e., making good a track by knowing the time. Celestial, pilotage, radio and all others are simply a means of getting information to do aero-reckoning." Failure to utilize all available means resulted in navigators getting lost in the one method of 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

68 Cof, VIII Bomb Center to CG, ALF, attn. 19/13, Oklahoma, 27 June 1943, in F.G. files.
might assist them." This condition was attributed directly to the
schools where they were using the flying time to "supplement the pro-
gress 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 gradu-
ation," it was indicated, the student "may yet one flight where he can
combine anything he likes." It was therefore recommended that instruc-
tional procedures in the schools be changed so that all ground instruc-
tion would be given prior to any air training.

Although this recommendation was not placed in effect, action was
taken by the navigation schools to give increased emphasis to the com-
bination of all types of navigation. An examination of revised pro-
gress of instruction and syllabi in use in the schools about the end of
1943 indicates that 3 of the 23 ground missions and 14 of the 21 flight
missions specifically required a combination of various navigational
methods.

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 instruc-
tion conducted in the various schools had still not been standardized.

1943, in F.S.T. files.
70. See syllabi in F.S.T. files; T.C. Note 50-12-1, 22 Nov. 1943
Neither was there a textbook on arial navigation. Each navigation school determined the manner in which it could 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 procedures, it was the unwavering policy of both AAF 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. Apparently this was ineffective, since a year later a navigation conference was held in the headquarters of the Flying Command and to "standardize the navigation curriculum and to tie in the navigation program with prelight and bomb-radar training."

Following the December 1942 navigation conference, the 18-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..."

71. TSC to CG or each TSC, 2 Dec. 1941, in MG 352.1111, Course of Instruction.
In May 1943 the
C/3, Training directed the Air 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 the 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 prerequisites for standardization called for a standard textbook, syllabus, and other instructional materials. Based on the official program of instruction, which was simply a null outline on topics to be taught, each navigation school prepared its own syllabus and other instructional materials, and no two were alike.

73. T. C. Memo 30-12-1, 22 July 1943.
74. C/3, Training to CG, AFRS, 27 May 1943, in Msg 352.11, Navigation Schools.
Pursuant to the directive from the M/S, Training of 27 May 1943 to the Flying Trainee Command, a committee composed of all the interested agencies, including a representative of the Central Instructors School (Bombardier), was assembled at Kitter Field for the purpose of preparing a textbook and a navigator's handbook. This attempt proved abortive, and it appears that nothing was done until after the establishment of the Central Instructors School (Navigator) at Sylman 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." 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.

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 Sylman Field on 17-19 February 1944. The program submitted to this conference was not acceptable to all the schools, and a second conference was scheduled for 1 March 1944.

Guam Training for Navigators

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

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

34. Report, "Accomplishments of 9th Air Forces Flying Trains: Summary from July 1, 1941 to June 30, 1942," 23, F33 to G3, ...F, attm. to 23, Intelligence, 19 April 1943, in ABU files.
In July 1942 it was decided that navigation cadets could be sent to gunnery schools prior to entrance into preflight training. This policy could not be followed in every case, as 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 advance 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 the preflight graduates, and the 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 bomber and navigator quotas at the gunnery schools were suspended entirely because of the shortage of other types of officers.

By the first part of 1943 the capacity of the gunnery schools had been greatly increased. The Flying Training Command therefore requested that regular weekly quotas be allotted for bomber and navigator

86. AFIT to CG, FRIC, 27 July 1942, in MG 353.93 Gunners, Bomber Aircrew.
87. Ibid; AFIT to CG, FRIC, 10 Aug., 1942, in ibid.
88. AFIT to CG, FRIC, 27 July 1942, in MG 353.93 Gunners, Bomber Aircrew.
trainees. Effective on 24 May 1943 a quota of 1,500 bombardier-navigator precandidate graduates every three weeks was established at the gunnery schools. With the establishment 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."

It was 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 1,500 every three weeks, effective 15 July 1943. In September 1943 it was expected that all bombardiers and navigators would be receiving gunnery training within the next six weeks. In classes 43-17 to 14-4, 24 December 1943 to 15 March 1944, however, only about 90 per cent of the graduates navigators had received gunnery training. In 29 January 1944 the Training Command 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.

92. FM 1 to CG, NPTS, 10 Feb. 1943, in FJ 7 files; Daily Diary, NPTS, 20 Feb., 26, 27 March 1943, in MG 355.1-3, Daily Diaries.
93. CG, NPTS to CG, MS, 14 April 1943; 1st Ind., G/3, training to CG, NPTS, 19 April 1943, in MG 355.11, Navigation Schools.
94. G/3, Training to CG, NPTS, 15 April 1943, in FJ 7 files.
97. Ibia.

RESTRIC TED
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 27 to 15. 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 11,002 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 graduates navigators in a 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 advanced gunnery schools was increased to 1,000 every three weeks.

Avancee Navigation Training by RM

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

100. RR, WHFT-2 to FT13-1, 3 Dec. 1942, in FFCT files.
102. Project Book of JS, FT13, preflight Sec., 26 March 1943.

RESTRICTED
As early as January 1936 it was proposed that the Air Corps utilize the P-3'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 examining 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 P-3 in long over-water flights in the Caribbean and the Pacific could be utilized by the Air Corps. This officer suggested that the detailing of "a reasonable number of Air Corps officers to the P-3 for a period of training and participation in some of their long flights..." would be of inestimable value to the Air Corps. He added to be considered for such an assignment.

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

103. Capt. James Z. Parker to G/AC, thru channels, 24 Jan. 1936, in
AGO 3553-92, Training, General.
104. 2d Ind. (Capt. James Z. Parker to 3/13, 24 Jan. 1936), G/AC to G/AC 1936, in ibid.
105. 3d Ind., 24 Feb. 1936, in ibid.
however, the lack of utilizing the ... for navigation training in the 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 PFI. On 18 July 1940, therefore, the Chief of the Air Corps asked the Adjutant General for authority to negotiate a contract for such training.

The agreement executed with PFI 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 entering 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 American airplanes. The cost of training was to be $495 per student. This agreement was approved by General Arnold 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...

106. Ibid.
107. Ibid. to AG, 13 July 1940, in AG 353-9, Navigation and Instrument Training.
108. Ibid., to AG, 21 July 1940, in AG 353-9, Specialized Training.
naval core. The iron training conducted under the auspices of the Chief of the Air Corps.

United European Training at Cord Cables. From August 1940 to March 1941 training at Cord Cables proceeded according to the original agreement. By 8 February 1941 the first two classes had completed 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 115 airmen could be trained at Cord Cables. The number of Air Corps students was to be reduced by the number of R.A.F. students entered. In March and May groups of only 10 R.A.F. students entered. Beginning in July, however, Air Corps students were reduced to 50 per class to enable the R.A.F. classes to be increased to 150.

British training continued until either July or August 1942. This training was scheduled to terminate in October with the first class of 200 R.A.F. students to enter on 29 July 1942. It was 31 August, however, before the first full contingent of R.A.F. students began training.

Though three-fourths of the trains at Cord Cables were British students, the Air Corps furnished all the equipment not required to be furnished by P.L.I. This arrangement was based on the understanding that

110. See Chart 1 following p. 23.
111. RO to OS, 30 OCT, 20 May 1941, in A.O. 353.382, Training General.
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. This arrangement appears to have
been the cause of a misunderstanding as a result of which the Co-
manding General of the Southeast Training Center ordered the com-
manding officer of the Air Corps detachment to assume complete supervision over all
trainees, including the RAF cadets. It was also clear that British
training was conducted under a separate contract and the distinct iron
Air Corps training, the commanding officer was ordered to relinquish
control over the RAF students.

113. TRAINING. Instruction at Coral Cables 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 Cables. The program at Coral Cables, however, consisted of
356 hours of allotted time in contrast to the 449 hours in Air Corps
schools. A comparison of the allotted to the various phases of in-
struction is indicated below:

<table>
<thead>
<tr>
<th></th>
<th>Coral Cables</th>
<th>Air Corps Schools</th>
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<tbody>
<tr>
<td>Ground training</td>
<td>240 hours</td>
<td>253 hours</td>
</tr>
<tr>
<td>Air training</td>
<td>65</td>
<td>81</td>
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<tr>
<td>Meteorology</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Allied training</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Total hours</td>
<td>350</td>
<td>449</td>
</tr>
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113. CG 333.922 to CG 30 Training Detachment, Coral Cables, 2 Oct.
1941, in CG 353.921, Training, General.
114. CG 333.922 to CG 333.923, 17 Sep. 1941; CG 333.923 to CG 333.924, 23 Sep. 1941;
CG 333.924 to CG 30, CG 30 Training Detachment, 2 Oct. 1941, in ibid.
115. Director of Navigation, P.E. to Capt. C. L. Henderson, CG 333.923,
15 April 1941, in CG 353.9, Navigation Training.
116. Ibid.
Instructors at Coral Cables were civilians employed by the F.M. company. The number of aircraft used in training was very limited. "The minimum amount of aircraft used by the detachment has been 8 seaplanes and one Sikorsky S-40 in training 250 men at one time." The F.M. did not supply any trainer aircraft for the school.

Training at Coral Cables had not been under any very long before its effectiveness was questioned. About 1 February 1941 the C.I.C 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 F.M. company was reluctant to make any changes in its own course of instruction in order to make it conform to that in Air Corps schools.

In June 1941 the Training and Operations Division of the C.I.C 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, but of the deficiencies indicated were applicable to the graduates of Coral Cables.

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

117. History of F Training Detachment, Coral Cables, Fla., 15, in AFRC files.
118. CG, A/F to CG, A/FRC, 8 July 1942, in AAF 353.9, Navigation and Instrument Training.
119. Director of Navigation Sec., F.M. to Division l.A.C., Eastern District, 19 Feb. 1941, in ibid.
120. 3d Inc. (T.O. to CG, 27 Aug. 1941), 20 Sep. 1941, in AAF 353.9, Training, General.
To remedy this condition, Turner Field gave a supplementary course to the graduates of Coral Cables who were assigned as instructors at that school. In order to correct as many as possible of the deficiencies at Coral Cables, 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 Cables 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 Cables because of the shortage of trainer aircraft, it was recommended that the "training of all navigators for the Air Forces be accomplished in schools operated by the Air Corps."

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 Cables be increased to 60 hours. The new program of instruction was made applicable to the school at Coral Cables upon condition that the size of classes be increased by 50 students and that no increase in flying time be made. As late as September 1943 the problem of bringing the training at Coral Cables up to standard

121. Ibia.
122. 5th Inf., CG, 320TH to 6/13, to Sep. 1941, in ibia.
123. CG, 17TH to 29, AF, 31st, FJT 26-31 thru FJT 26, to Nov. 1942, in CG 352.11, Navigation Schools.
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 crew training to a minimum and allowed
no training on piloting.

By April 1944, steps had been taken to rectify one of these problems,
that of the length of the air training missions. Flight training regula-
tions of the ASF prohibited flights to destinations outside the United
States. In November 1943 the commanding officer at Coral Cables re-
quested special permission to take training flights to Cuba. Per-
mission to perform such flights was given on 30 March 1944.

Since the training at Coral Cables could not be tied to parallel
that conducted in the ASF schools, some felt that the graduates were
not adequately qualified for assignment to bombardment units. In April
1942 the Directorate of Bombardment informed Individual Train-
"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 Air Armament School at Miami." It was indicated that
all Coral Cables graduates would be available for the Ferry Corrals.

125. G.C., FMTS to C/3, Training, 11 Sep 1943; 2d Ind. (G.C., Coral Cables
to 20, FMTS, 20 Nov 1943), 13 Jan 1944, in F/T files.
126. G.C., Coral Cables to G.C., FMTS, 20 Nov 1943, in F/T files.
127. 6th Ind. (to same), C/3, Training to G.C., FMTS, 30 March 1944,
in F/T files.
128. G.C., FMTS to FMTS, 20 April 1944, in GC 353.93, Navigation
Training.
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 10/15 Training authorized the assignment of Coral Gables graduates to these two commands “in numbers up to the monthly quotas assigned these commands.”

In view of all the problems encountered with the navigation training conducted by F.T.A., the Training Command considered plans to discontinue this training. In November 1943 the Central Flying Training Command was requested to ascertain the possibility of increasing the size of navigation classes in the A.F. schools in order to discontinue, without loss of graduates, training at Coral Gables as of 30 June 1944. In January 1944, however, navigation requirements were such that the above proposal had to be abandoned. It seemed unlikely that such training could continue after the summer of 1944, and on 3 June 1944 the 10/3 Training informed the Training Command that neither it nor F.T.A. “desired to renew the contract.” A.F. navigation schools were to expand facilities to make up the loss in production occasioned by the termination of training by the F.T.A. company.

Chapter V

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 aircrew 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 area 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 the
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 establishments sending the graduates of one type of school to the other for the second category of training. Of lesser importance perhaps was the problem of what to do with the 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.

Early Lineament and Mandate, 1941

The original instructions calling for the dual training of navigators and bombardiers were issued on 3 September 1941. Dual training was contingent, however, upon maintaining the required ratio of both types of specialists to the tactical units. There was to be no relaxation of this ratio until 945 navigators and 1,350 bombardiers had been trained. Navigation and bombardier schools were to be gradually integrated, and the annual training rate was to be reduced from 4,900 navigators and 5,590 bombardiers to 5,590 bombardiers—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

1. "3 Diary, 3 Dec. 1941, in ADH files.
2. ADH, No. 1, 3/5 to 6/8, 25 Sep. 1941, in AD 353, Specialized Training.
to predlight 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. The first class scheduled for air training entered the reception centers on 1 November 1941 and was scheduled to graduate on 1 August 1942.

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 air training as one of the many steps taken to expedite the flow of individually trained specialists to the tactical organizations. On 5 December 1941 the instructions of 5 September 1941 were rescinded, and a complete revision was made of "course procedure, qualification requirements, 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 direct bombardment.

Revival of Plans and Beginning of Training

Reasons for Resuming Ground Training. The decision to resume ground training was the result of 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 bo-

4. N.R. No. 6, 5 Dec. 1941, in ...G 353.9, Specialized Training.
5. 13 Dec. 1941, in ...G 353.9, Specialized Training.
6. Ibid., ...G 353.9, Specialized Training.
barriers and the end of 1943 in the case of navigators. 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 bomb sights. Therefore, potential navigators could be given a relatively short course in bombing with the D-8 bomb sight 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 area reconnaissance navigation in the airplanes equipped with precision bomb sights.

The Directorate of Bombardment referred General Doolittle's recommenda
tion to Individual Training which in turn requested comments and recommenda
tions 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 might be as proficient as those in heavy units and that dual training would cut bombardier and navigator pro-
duction by half. If such training were to be conducted, it should be performed in the operational training units. On the same day that the command registered this objection to dual training, the Directorate

7. FR, FM to ORR, 19 Feb. 1943, in G 3320, Courses of
   Instruction; 02, 20 June to 02, 12 June 1943, in
   FM 3320-12, Standard Training
   3. Ind. (basic uniform), 02, FM to ORR, 10 July 1942, in
   FM 3320-02, Standard Training
   9. FM to ORR, 3 July 1942, in ibid.
   10. Ind. (basic uniform), 02, FM to ORR, 10 July 1942, in ibid.

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of military requirements increased the Ninth 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.

The decision to conduct dual training, it was explained, was not calculated to "increase operational 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 bomb sites and precision training 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 could be proficient "in the operation of B-24 bombers, map reading, piloting, and dead reckoning navigation." This type of training was considered as only temporary, since the shortage of medium bombardier or navigator, or both, continued, the situation was largely set by incorporating and reckoning navigation into the regular bombardier course in the summer of 1943. Until then was done, however, three types of dual training were conducted to meet the most immediate needs. One consisted of giving B-24 bombardier training to graduate navigators, while another was to give dead reckoning navigation to graduate bombardiers. The third

11. HFM to CG, 3d IF, 16 July 1942, in ibid.
12. HFM, HFRS to HFM, 10 Aug. 1942, in ibid.
13. 1st Ind. (BG, 3d IF to CG, 1 Sep. 1942), HFRS to CG, 3d IF, 16 Sep. 1942, in G 553.7, Training, General.
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 ready trained personnel for the first bombardiers and to utilize the experience gained to ascertain the best plans for conducting unit training.

**Navigator/B-3 Bombardier Training.** As early as August 1942 the Directorate of Bombardier indicated the necessity of establishing schools for the special purpose of continuing area correction navigation and non-precision bombardier training. On 25 August 1942 the Flying Training Command was directed to select one of the bombardier schools which was scheduled to open in the following month and use it for B-3 bombardier training. The bombardier school at Carlsbad, N. M., was selected, and training began on 3 October 1942. From October through December 1942, however, the training in this course, though trained to meet Eighth Air Force requirements, were not graduated navigators, but eligible junior graduates.

The desirability of having the navigators assigned to the Eighth Air Force proficient in the use of non-precision bomb sights was pointed out at the time training at Carlsbad was inaugurated. It was agreed to begin such training in December, and the first class of graduates navigators to begin B-3 bombardier training at Carlsbad began instruction

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14. USA, FME, 10 Aug. 1942, in ibid.
15. FMT to CG, 28 Aug. 1942, in FMT files.
17. FMT to CG, 2 Oct. 1942, in FMT files.
on 23 December 1942. The B-3 training for navigator 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-week training.

**Bomber-Dead reckoning Navigator Training.** In January 1943

the decision was made to change from the policy of training graduate

navigators as B-3 bombardiers and to train graduate bombarders as

dead reckoning navigators. This was the more profitable policy since

75 per cent of the bombardiers and navigators who went 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 B-3 bombardiers, and the bombarders not

trained at Carlsbad had to be given some reckoning navigation by men

of on-the-job training. The Third Air Force requirement for bombarders

with dead reckoning training from March through December 1943 was

approximately 2,400. A total of 1,475 trainees in 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 De-

cember 1943 a total of 1,475 trainees graduated from the course, main-

19. ibid., p. 12, 10, 2, PRT to 27, 30 Sep. 1942, in PRT files.
20. ibid., p. 1 to 5, PRT to 31, 1942, etc., 6-9 Jan. 1943, PRT to

33, 27 Nov. 1942, in PRT files, training, general.
21. PRT to 17, 313, 17 Feb. 1942, in PRT.
22. See chart 2 following this p. 3.
23. ibid., Training to 17, PRT to 14 Apr. 1943, in PRT files,

Training Schedule and Directives.
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Source: Consolidated Flying Training Reports (monthly), prepared by Engs., TT13 (.FT3).
a total of 2,900 bombardiers trained as area reconning navigators.

anterior anticipated source of this category of personnel was the graduate bombardiers eliminated from the celestial navigation course.

Experience proved, however, that most of such eliminations occurred before the area reconning 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 area reconning navigators.

**Beginning of Complete Dual Training**

The third type of dual training was that 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 apply graduates of one of the specialties to the tactical organizations while those specialists were undergoing the second category of training. It was felt the tactical organizations could not forego these graduates. Requests from the combat theaters for fully trained personnel and approaching delivery of the superforts made

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27. Report, CG, 7th AF to CG, 11 Oct. 1942, in A.G 353.5F, Training, General; Cable, 26, South Pacific Area to C/5, Training; Message No. 812, 18 April 1943, C.-E-10880, in AF Message Center.
23.

In order to provide personnel for the first B-24'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.

With training already initiated on a limited scale, the Flying Training Command was requested to make a study of the promotion of qualified 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 months, 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 B-24 bombardier training at Carlisle. 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 in training.

The Flying Training Command's plan was not concurred in by the Directorate of Bomberament because of the loss of navigators for nine weeks. As a transition program it was requested that the needs of
medium bombardment be met by giving D-6 bombardier training to graduate 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 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 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 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 requirements for June and subsequent months. The requirements for June, July, and August, and estimated requirements for the remainder

32. RAR, No. 2, AFRDB to AFRIT, 26 Dec. 1942, in AFACI files.
33. RAR, No. 3, AFRIT to AFRDB, 9 Jan. 1943; RAR, No. 4, AFRDB to AFRIT, 30 Jan. 1943, in AFACI files.
34. RAR, AFRIT to AFDIR, 24 Oct. 1942, in AFACI files.
35. RAR, No. 1, AFRDB to AFDIR thru AFRIT, APPMP, AFACI, and AFAAP, 30 Sep. 1942, in AFACI files.
36. RAR, No. 1, AFRDB to AFRIT, 27 Nov. 1942, in AFHII files.
of 1943, as anticipated in November 1942, were as follows:

June ........................................... 1,332
July .................................................. 1,495
August ............................................... 1,437
September ......................................... 1,391
October ........................................... 1,440
November .......................................... 1,490
December .......................................... 1,505

In addition to these requirements for 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.

The Directorate of Individual Training took steps in December 1942 to select the bomber pilot graduates who could be expected successfully to complete the course in navigation. Difficulties were not anticipated since there was expected to be a surplus of bomber pilots in the early months of 1943. By selecting those with the highest 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 training of six or better. Then directive to select those with a score of five or better, the command found that approximately 50 per cent of the bomber pilot graduates could

37. Ibid. The requirements for bomber-navigator were scaled down considerably in January 1943. See Individual Training of Bomber-Bombers, 72.
38. ERA, INF to INF, 1 Dec. 1942, in FJT files.
quality for navigation training. This was more than could be accommodated in the navigation schools, and with the surplus, above the requirements of the using agencies, was sent to service schools.

During January and February 1943, groups of bombardiers were assigned to navigation training. In the actual, 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 or reducing the bombardier course to nine weeks and the fact that some instruction was common to both courses; whether to commission trained 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 courses 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 70 men had been graduated from dual training, and by the end of May this number had increased to 132.

41. See Individual Training of Bombardiers, 38-59, for a more detailed treatment of these issues.
42. Ibid., 39-92.
On the basis of the experience gained in this training and the numerous proposals which had been made, several changes in the initial 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 initial 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 55 bombardiers taking navigation training were eliminated. 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 hence to combat. These often resented having to go through another course of initial training. Also, there is some evidence that bombardiers were sometimes subjected to ostracism at the navigation schools. To alleviate these conditions as much as possible, the Flying Training Command directed that "in so far as possible" no bombardiers be sent to navigation schools unless

42. Daily Diary, 451st BG, 2-3 Div., 13 April, 16 May 1943, in 531st files.
44. Conversations by the writer with various persons at 451st bombardier schools; 451st Training to CG, 451st, 16 March 1944, in 451st files.
they declined such training.

The several advantages of offering the navigation course first caused the Flying Training School to reconsider, in April 1943, that graduate navigators be sent to a six-week bombardier course, with reliance on CM-1 as IFU training to increase the backing proficiency of such individuals. But the continued shortage of navigators produced the retention of this policy. Finally, however, in July 1943 the flow of bombardier training was reversed, and to bombardiers were no longer sent to bombardier 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.

By April 1943 it had become obvious that individual bombardier and navigator training could not be converted to dual training in 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 bombarda-
ment, two completely qualify trained bombardier-navigators; one for medium bombardment, one completely qualify trained officer for 25 per cent of such crews and one bombardier-grade ranking navigator for 75 per cent of the crews. These crew requirements necessitated the training of all bombardiers as area reckoning navigators. The Flying Training Command was therefore authorized to extend the bombardier course of instruction to 10 weeks and to incorporate area reckoning navigation in the program. All the bombardier schools were converted to the new program between June 1943 and December 1943.

In October 1943 the status of dual training was that all the bombardier schools, except Roswell, trained bombardier-grade ranking navigators for all heavy bombardment crews and 75 per cent of the medium bombardment crews. All of the navigation schools were engaged in the production of navigators for heavy bombardment, air transport command, and troop carrier command crews, instructors for training command schools, and graduate navigators for assignment to Roswell 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 ETO. Graduates of this school were to be used as bombardier-navigators in the B-29 program and as lead bombardiers in medium bombardment crews.

51. RO/3, Training to GB, FTB, 14 April 1943, in AG 353.01, Training Schedules and Directives.
52. Ibid.
54. RO/3, Training to GB, FTB, 13 Nov. 1943, in AG 353, Bombardier Training.
With the graduates of Rosehill "in every case destined for a most important position in the Air Force," every effort was made to see that trainees and instructors in that school were the very best. In November 1943 the 10/3, Training, requested a final report on the first class at the school. The comparative proficiency, number of eliminations 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 in that only those navigator
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who volunteered and were "extremely desirous" of receiving further
55
navigators be assigned to this training.

In reply, the Training Group 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 promising in every respect.

In the first class of 150 students, 50 were held over and 55 eliminated. 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 cover the rapid phase of the course and to make possible the scheduling of missions "for the exclusive purpose of maintaining navigator proficiency."

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

57. In Report of Flying Training, Students Under 50 80% of Flights were made over 15 miles.
58. 88, 763 to C/3, Training, 3 sec. 1943, in RAF files.
59. 10, 100, training to 88, 763, 11 sec. 1943, in RAF files.
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<tr>
<td>April</td>
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Source: Consolidated Flying Training Reports (monthly), prepared by Maj, AFIT (AFFT).

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CHART 3
The B-29 Program was Dual Training

The principal objective of dual training at the beginning of the B-29 program was to provide bombardier-navigators for the crew. The first mission for which the B-29 was designed was the B-29. The crew requirements for this type of aircraft called for the completely trained bombardier-navigator, the primary crew member being for the bombers qualified as navigators. The first XB-29 was delivered on 31 December 1942, nearly a month before the first group of 59 completely trained men graduated. The first XB-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 trained. Consequently, training was started on 15 January 1943 at the B-29 program was concerned, priority on such personnel was given to the B-29 program. At first, only 15 per cent of assigned bombardiers were bombarding units among the first year of dual training.

Bombardier-Navigator Training. The flow of graduates from all training in November 1942, indicated that the bombardier-navigator section of the B-29 program would be adequately met. Within four months, however, the entire program of complete dual training was immediately suspended. This was the result of developments...

60. AS, No. 1, F113 to F117, 10 Sep 1942, in PAC files.
61. AS, No. 2, F113 to F111, 17 Sep 1943, in PAC files.
which brought about training requirements beyond the productive capacity of the schools. If possibly beyond the capacity of trained to train in proficiency. The first factor was the addition of radar training to each training requirements. Radar equipment applicable to navigation and bombing has been developed to the point where training on such equipment was necessary for all bombarders and navigators. It is essential that navigators be trained to proficiency in the operation of radar beacons, the Loran receiving system, OBE (the British equivalent of Loran), and "other radar navigational aids." For a number of years research and experimentation in BRU (bombing through overcast) has been conducted. By the end of 1943 it seemed that the radar bomb sight has been the answer to this long search. Consequendy, it was necessary for bombardiers to be trained in the use of radar bombing aids (BRU) or H/F-13 and H/J-19. Additional training in radar 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 10/13, Training informed the Training Section that the dually trained personnel earmarked for B-29 organizations, except those for the 58th "Red" in China, should be sent to the NAF technical school at Boc Raton, Fla., for training on radar equipment H/F-13 (radar bomb sight or BRU). This training was scheduled to begin at Boca Raton on 13 December 1943 for

63. Daily Diary, JFTRC, 1-3 Div., 29 Nov. 1943, in JFC files.
64. Ibid.
65. 10/13, Training to CG, JFTRC, 41 Sep. 1943, in JFC 353, Bombing and Navigation Training.
the graduates of Roswell.\textsuperscript{66}

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 operators, at Boca Raton. In November the Training Command requested the Eastern Technical Training Command to retain the instructor personnel necessary for such training. The idea of prior to the scheduled beginning of such training, it was announced that the XX Bomber Command would perform this instruction in on-the-job training in the 50th and 73rd Wings in lieu of such training by the Training Command. The Air Communications Officer did not occur in the complete discontinuance of the training planned for at Boca Raton. The graduates for such training were more extensive than the needs of the 50th and 73rd Wings. There were some 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.

67. Daily Diary, 11 Nov. 1943, in AFTTS files.

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The training of bombardier-navigators at Boco Raton did not remain in abeyance very long. In the discussions on radar training at the training conference at Headquarters, 10-13 January 1944, the opinion was expressed by Lt. Col. Andrew S. Ellis of the Eastern Technical Training School 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. Experience apparently substantiated this view since training at Boco Raton was begun in February 1944. The first personnel trained in this special course were approximately 30 instructors from the navigation schools and were navigators returned from the North African theater. This instruction was scheduled to begin on 7 February and was on L/1F3-15 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. All classes except the first one were to consist of bombardier-navigator teams from the Second Air Force.

The original plans contemplated the training of essential navigator-bomber pilots. The experience of the second term in the United Kingdom, however, indicated that better performance was obtained from bombardier-navigators.

72. 63, 1F3 to 3/13, training, 24 Feb. 1944; 1st Ic., 3/13, training to 63, 1F3, 10 March 1944, in AAG 5533, Accidents and Investigating Training—Daily Diary, 1F3, 27 March 1944.
and reasoning navigators trained on H2X equipment.

Dual Training instituted, 1944. With rear training added to the dual training, requirements for B-29 personnel, in impossible condition was created. The same problems encountered in rear training were now more acute in品类 category training. Rear crew another month to the training period was the time then the requirements for B-29 personnel were increasing, and it was another idea in which proficiency was to be maintained. It also was more real the problem of how much training a student could absorb in a given time. Faced with these problems the Command 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 promotion from training bases schools was inadequate to maintain proficiency in both specialties. Furthermore, bombardier-and-reasoning navigators had been found adequate as assistant navigators in the very heavy crews.

The 3/5, 3/5, and 3/15, training did not favor the discontinuance of dual training, though they conceded that supervisory rear 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 area-reasoning navigation before assignment to a tactical organization.

74. 3/5. Training to OC, 10 Feb. 1944, in L.R. 35553, Navigation Training.
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-bombarider-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 AFD training. In the light of
these conditions the C/3, Training agreed that the Second Air Force
should not be held responsible for this on-the-job training.

With the Training Command schools unable to produce the required
number of radar-bombarider-navigators and the tactical organizations
unable to assume the responsibility for the necessary individual train-
ing, or even to maintain adequate proficiency of multi-specialists in each
category of training, it was decided to discontinue temporarily all
bombarider-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 usual training. In lieu of usually
tually trained personnel, one bombarider-navigator and one
celestial navigator could be supplied for each B-29 crew. Bombariders
were scheduled to receive radar training at Max Jetten, and navigators
were to receive on-the-job radar training in the Second Air Force during
the period of their operational training.

75. 1st Ind. (CC, 2a.1 to CG, 2a.1, attn: C/3, Training, 10 Feb. 1944),
2a.1, Training to CC, 2a.1, 1y Nov. 1944, R24, No. 2, 10/38, CR
to 1a.1, Training, 17 Feb. 1944, in R24.
76. 2a Ind., CC, 2a.1 to CG, 1a.1, attn: C/3, Training, 1 March 1944,
in R52 files.
77. R24, 1a.1, 1a.1, Training to 1a.1, 2a.1, 17 March 1944, in R24 files.
78. 2a.1, Training to CC, 1a.1, 5 Apr. 1944, attn: COR, SAR 1a.
by Col. 1a.1, 17 Jan. 1944, in R92 files.
In line with this policy the dual training at Roswell was discontinued, with the last class scheduled to graduate on 23 June 1944. 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 220 of these during the next four months, leaving 320 available for the B-29 units. These 320 qualify trained on were sufficient to meet the demands on the B-29 units until June 1944 at least. The requirements of medium to heavy units 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 to begin enlisting graduates 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 50th Inc, the first B-29 organization to go to combat, went to its mission 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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81. 507/3, Training of B-29, S-7-3, 10 March 1944, in F CT files.

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**SECRET INFORMATION**

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240 crews by 1 September 1944.

The existing means for conducting the necessary rear training were entirely inadequate. There were no training schools, 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 observers and mechanics on J/15-15 equipment for assignment to the First Sea Search Attack Group at Langley Field and similar personnel in J/15-13 equipment for B-25 units. The Second Air Force was charged with continuation of training for the bombardiers who were at Boca Raton and the entire rear training for graduate navigators on J/15-13.

In order to meet the critical situation in the 55th Air Force, plans were made to send 12 well-trained rear instructors to conduct on-the-job training for this unit 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 rear instructors. In order to exploit the training at Boca Raton, a new rear training directive was issued in April 1944 requiring the establishment of the rear observer (bombardier)

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32. 100,000 by 3/15, training, 1 April 1944, in AFOSI files.
33. Ibid.
34. 10/15, training, 247, 247, 5 April 1944; 10/15, training to 247, AFOSI, 3 April 1944, in AFOSI files.
courses (.1/.F-13 and .1/.PS-15) at the earliest possible date.

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

85. 1C/1J, Training to CC, AFHC, 17 April 1944, in FJST files.
Chapter VI

NAVIGATION INSTRUCTORS 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 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 1942, 10 months after a convertible 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. R. B. Har-
hold and Lt. John V. Tjon had been connected with navigation training since its inception in 1926. 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.

It appears that the problem of a sufficient number of instructors was not serious prior to December 1941. 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.

The number of instructors required can be generally approximated since the ratio of instructors to trainees appears to have varied from 1-2.7 to 1-4.9. Too 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 aircrew personnel. The using agencies were numerous (Second and Third Air Forces, and the Air Transport, troop carrier, antisubmarine, and Flying)

1. AIR, 0/40 to 0/41, 13 Sep. 1941, in Air 3-8.11h, Courses of Instruction.
2. Since Air Corps instructors were provided irregularly for the civil contract school at Corry Cables, data used in this study are applicable only to the Air Corps navigation schools.
3. See Chart 1 following p. 25.
Training courses), and no replacements could be retained for instructor purposes without the prior approval of the Director of Education, until 29 March 1942, and 10/38, training until July 1942. After the latter date the training command had the right to retain personnel 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 enrollment. The number of students under instruction increased approximately 150 per cent in the three-month period following 27 December 1941, and 120 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." He emphasized the fact that this "will be done at all schools." It seems that the ratio was either not put into effect or was in effect only a short time. In April 1942 the number of instructors reported as on hand was 301, or a ratio of 1 to 1.2. From August 1942 through July 1943 the ratio of instructors to students was as

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4. E.O., 12103 to 12103, 7 Feb. 1943, in AAFI Files; memo for 3-2 Div., 12104, 30 J. L. Schiller, 2-1 Div., AAFI, 3 Nov. 1943, in AAFI, 4-2 Div. Files.
6. AAFI Chart 6-1, 3 April 1942, in AAFI 2115, Pilots.
Follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Students under instruction</th>
<th>Flying instructors assigned</th>
<th>Students per instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Aug. to</td>
<td>1,207</td>
<td>323</td>
<td>3.7</td>
</tr>
<tr>
<td>23 Sep. 1942</td>
<td>1,587</td>
<td>673</td>
<td>2.4</td>
</tr>
<tr>
<td>Oct. 1942</td>
<td>2,350</td>
<td>619</td>
<td>4.0</td>
</tr>
<tr>
<td>Nov. 1942</td>
<td>2,875</td>
<td>612</td>
<td>4.7</td>
</tr>
<tr>
<td>Dec. 1942</td>
<td>3,214</td>
<td>669</td>
<td>4.8</td>
</tr>
<tr>
<td>Jan. 1943</td>
<td>2,133</td>
<td>1,134</td>
<td>2.7</td>
</tr>
<tr>
<td>Feb. 1943</td>
<td>4,049</td>
<td>1,135</td>
<td>4.0</td>
</tr>
<tr>
<td>March 1943</td>
<td>6,039</td>
<td>1,147</td>
<td>4.4</td>
</tr>
<tr>
<td>April 1943</td>
<td>6,767</td>
<td>1,640</td>
<td>4.7</td>
</tr>
<tr>
<td>May 1943</td>
<td>7,216</td>
<td>1,798</td>
<td>4.3</td>
</tr>
<tr>
<td>June 1943</td>
<td>7,220</td>
<td>1,499</td>
<td>4.9</td>
</tr>
</tbody>
</table>

In August 1943 the established ratio was 1 to 3.22. By April 1944, when the navigator shortage was somewhat less acute, the ratio was established at 1 to 4.166.

The shortages and assignments to fill these 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 hold an allotment of graduates for instructor purposes, but before the time for actual assignment that such graduates were indispensable to some other unit; hence, thus leaving the

7. It appears that these data on instructors, taken from the monthly Consolidated Flying Training Report of AFAS, include supervisory personnel in addition to actual instructors. The instructor-student ratio is, therefore, materially lower than indicated.

8. 03, AFAS to AG/AS, Training, 22 Aug. 1943, in AFAS files.

9. 03, AG/AS to AG/AS, Trainign, 7 April 1944; 1st Ind., AG/AS, trainings to 03, AFAS, 11 April 1944, in AFAS files.
navigation schools without the necessary instructors. Because of the
nature 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 distinguisn between the requirements
existing at the moment and those anticipated for planned expansion.

In July and August 1942 the demands of the tactical units pre-
cluded any assignment for instructor purposes. While the Flying Train-
ing Command did not "absolutely require" additional instructors in July,
249 were requested from classes 42-12 to 42-15, resulting in October
and November. It was pointed out also in August 1942 that if the
production of navigators scheduled for the first of 1943 were
attained, the navigation schools would need to increase the number of
instructors by almost 500 per cent. There were approximately 500
instructors in the navigation schools at this time. Against these
anticipated requirements, the number expected to be available varied
between 170 to 492.

Although the Flying Training Command requested 249 instructors
from the October and November classes, the allotment made for Octo-
ber, November, and December totalled only 138. The command then re-
quested 35 for December, but received none. During 1943 instructor

10. Daily Diary, 8 MA, 23 June, 23 July 1942, in AAG 509.1-6, Daily
    Diaries.
11. Daily Diary, ARF, 23 Aug. 1942, in ibid.; R.2., AABE to AAR, 27
    5113, Titles and Grades.
13. Daily Diary, 8 MA, 7 Sep., 1942, in AAG 519.1-63, Daily Diaries;
    Project Book of 03, AABE, Navigation Sec., 11 Dec. 1943.
requirements appear to have been met more satisfactorily. On 1 January the schools had 537 instructors on hand, and an additional 120 had been requested for the first three months of 1943. During this three-month period 438 were received, raising the total on hand on 31 March 1943 to 1,045. The command requested 740 additional instructors for April, May, and June 1943 and received approximately this number.

At the end of July 1943 the instructor-student ratio was approximately 1 to 6 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 480 over July 1943. From July 1943 to April 1944, however, 336 graduates had been retained by the Training Command for instructor purposes. This increase in instructor personnel against the relatively small increase in school population currently 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 357 instructors obtained by the command. The progressive conversion of the bombardier course to bombardier-dreadnought training between June and December 1943 required the assignement of 231 navigation instructors to the bombardier schools.

14. Distribution of Bombardier and Navigator Graduates by AAF Flying Schools, 1943, in files of Officers Branch, AAF.
15. Diary Diary, AAF, A-1 Div., 1 June 1943, in AAF files.
Instructor 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 QN and RN 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 gunner 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 'diving' 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 excessively condition of navigational equipment adversely affected his training. As a result of these conditions navigators in tactical units frequently not only failed to increase in pre-


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iciency but actually lost some of their skill.

As a result of reviewing this condition the Director of Training at
Mother Field recommended that an advanced navigation course be inaug-
urated for the purpose of training selected school graduates and selected
combat crew navigators who had completed their operational training.
Graduates from this type of instructor course would be skill navigation
officers for squadrons, groups, and air forces. Such officers would be
charged with supervising and coordinating the "continued training..." of
navigator," this contributed course should be of six to eight weeks' duration.
The FC Training Command approved this plan and submitted it to the Director of
Military Requirements with a request for approval. The school at Mother
Field also was requested to prepare a program of instruction and submit
estimated requirements for personnel and equipment for conducting the
course.

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

19. Director of Training, AM Aviation School, Mother Field, to OS,
ARCD, 18 June 1942, in AASS 5014, Courses of Instruction; OS,
AM Aviation School, June, ex., to OS, AAS, 27 Jan., 1943, in
AAM CFP, Navigation Training.
20. Director of Training, AM Aviation School, Mother Field, to OS,
ARCD, 18 June 1942, in AASS 10015, Courses of Instruction; Daily
Dairy, AMCD, 10 July 1942, in AAS, 129, Daily Diary.
21. OS Inc., (Director of Training, AM Aviation School, Mother Field,
to OS, ARCD, 18 June 1942), OS, ARCD to OS, 13111B, 25 July 1942,
in AAS 310, Titles and Orders; OS, AMCD to AMCD, 22 July 1942,
in AASS 5011, Courses of Instruction.
duced in the tactical units. Though disapproving the plan, individual training submitted the letter from Kethar Field to the Directorate of Bombardment for the information it contained on the state of navigation training in tactical organizations.

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 combat navigational procedure during the period of operational training. . . . Inspections have revealed that because of the lack of proper supervision many navigators have become lackadaisical in their training to the point of adopting improper methods and poor techniques in general." The directorate felt that navigational staff officers could correct the situation and recommended that advanced navigation schools in the Flight Training Command be organized for the purpose of training such officers for "squadrons, wing, Air Force Bomber Command, 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. Those 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 then replaced in the Air Forces by an equivalent number of .

22. AIR 7 to 03, AIR 10, 31 July 1942, in AAG 5G7.113, Courses of Instruction.
23. RR, No. 1, AIR 3 to AIR 3, 31 July 1942, in Ibid.
supervisory navigators.

Because the production of navigators had fallen behind schedule, which meant that instructor requirements could 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 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 37 instructors to the Air Forces if men with combat experience were unavailable and if they were to be returned to the schools when other 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 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 extended service. Sixteen of these were expected to return after six weeks and the remainder as soon as combat personnel were available.

24. 22R, No. 2, 20th to 20th, 7 Jan., 1943, in ibid.
28. Ibid., 1st Nov. 1943.
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. 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."

According to a plan approved by Individual Training, the Flying Training Command must to supply the 325 navigation instructors requested. The Directorate of Bombardment desired 203 of these by 1 May 1944. There were only 445 instructors in the schools, only 133 of whom had more than one year's experience. It was felt, therefore, that the transfer of 203 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 1944. While agreeing to furnish the 325 instructors the Flying Training Command was unable to furnish them on the schedule requested by the Directorate of Bombardment. By 1 May 1947,

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29. A.1. No. 1, ARMB to ARMI, 21 Nov. 1942, in 50B 092.11L, Courses of Instruction.
30. A.1. No. 2, ARMB to ARMB, 2 Dec. 1943, in ARMB files; ARMB to GC, ARMI, 1 Dec. 1942, in 50B 092.11L, Courses of Instruction.
32 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 55 instructors were to be released from 1 June 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 4 1/2 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 was approved on 10 April 1943, but was abandoned after about six weeks.

The practice of using school instructors as staff navigators was

34. OS, ATIC to OS, AA, 6 April 1943; 1st Inc., 10 April 1943, in AND 212, Navigation Officers.
not entirely satisfactory, in the early stages at least. By April 1943
complaints were being received that such personnel were not being as-
signed 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 main 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
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 conceivably the
instructor, the nature of their assignment without certain 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 were common to all bombardment units.

36. 13/13, Training: to CC, 2d AF, 27 April 1943; 1st Ind., 8 May 1943;
CC, AIRC (?) to CC, 2d AF, 7 April 1943; 1st Ind., CC, 2d AF to
CC, III Bomber Command, 23 April 1943; 2d Ind., CC, III Bomber
Command to CC, 2d AF, 23 April 1943; 2d Ind., CC, 2d AF to CC,
CC, 2d AF, 27 April 1943, in AAF 22L, Navigation Officers.
the Third Air Force had more on-the-job navigation and bombardier training to perform than any other training air force. It would seem 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 were 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 "review of the points to be stressed" in the navigation program of instruction and of instructional techniques to be employed. This review has been the general requirement in the various schools. The details of examination and the techniques and procedures employed varied widely from school to school.

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

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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. 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. 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" for which he was best suited.

Refresher training for returned combat men was on a very limited

scale. The course lasted only 20 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 or-
organizations for each class were:

<table>
<thead>
<tr>
<th>Air Force</th>
<th>Navigators per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Air Force</td>
<td>5</td>
</tr>
<tr>
<td>Third Air Force</td>
<td>3</td>
</tr>
<tr>
<td>AAFMC</td>
<td>1</td>
</tr>
<tr>
<td>AFSub</td>
<td>1</td>
</tr>
</tbody>
</table>

As the number of navigators returned from combat mounted and the requests
for tactical organizations for refresher training increased, the train-
ing at Kather became inadequate. There was already an increasing realiza-
tion of the need for a central instructors school for navigators com-
parable to those already established for pilots, controllers, 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 Trainin: Command decided to convert the refresh-
er course into a regular central instructors school. Pursuant to this
decision the refresher school at Kather was redesignated as the "Army
Air Forces Central Instructors School (Navigator)," effective 1 August
1943. The mission of the school was stated as follows:

- To give standardized instructor training to all naviga-
tors selected for duty in the Army Air Forces Navigation
Schools.

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41. Lt. Col. (AAC, Training to 03, Aviation, 9 June 1943), 25 June 1943,
in ibid.
42. "History of Kather Field, Army Instructors School (Navigator), 31
43. Ibid.
44. T. C. Memo 19-12-2, 8 Sep. 1943.
b. To conduct refresher courses for navigators returning
from combat and other personnel as may be authorized
by this [TRAIN] Command/Headquarters.

c. To experiment with training aid, thus preventing
duplication in this effort at the schools.

d. To collect, write, and revise instructional material in
accordance with the provisions of T.O. Memorandum
No. 3-2.

The program of instruction for the instructors school was to con-
sist of a total of 250 hours allotted in the followi-

1. Navigation technique

   (1) Instruments 25 hours
   (2) Theory 10 hours
   (3) Procedures 56 hours

2. Instructional technique

3. Allied training

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
portion of instruction, which was too brief a time for the accomplish-
ment of its objectives. Also, the school was to remain attached to
one of the training groups at either 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 Selman Field in connection with the regular
navigation school there. To make definite and detailed plans for the

45. Ibid. For complete outline of this program of instruction see
Aeronav 3.

46. 25, AFRS to AG/AS, Train., 23 Sep. 1945, in AG 352, Naviga-
tion Training; Project Book of 25, AFRS, Navigation Sec., 2 Sep.
1947.
proposed school, a navigation conference met at Trainin, Command Head-
quartes 2-22 September 1943.

The purpose of instruction in the new school differed somewhat
from the school at Katter which it superseded. In reality, three dif-
ferent programs were conducted. Combat navigators who were already
with one of the training air forces or were to be assigned to such or-
ganizations were given a three-week refresher course followed by a basic
instructor course of three weeks. Similar personnel for the Trainin:
Gradual were given these same two courses plus three weeks of advanced
instructor training. New graduates of the schools who were to be re-
tained as instructors were given six weeks of training, the three-week
basic instructor course followed by the three-week advanced instructor
course. Some of the trainees were to become navigation staff officers,
and others regular navigation instructors. The instruction for
the latter students consisted of "advanced training, techniques, prac-
tice in civil lectures, in instructor flying technique, and in the
practic of low." In addition to its principal mission of training
instructors for the navigation schools and staff officers for the tacti-
cal 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 operating the instructors school from

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47. Daily Diary, ATCNO, 29 Sep. 1943, in AFHRI file.
48. "History of Selma Field: 4-04 Instructors School (Navigator),
49. Ibid., 10.
one of the regular navigation schools in order to facilitate an expansion of its student population. The new school began instruction on 6 November 1943 with a class of 90 students, with the enrollment scheduled to increase to 300 by 22 January 1944. The policy of assigning quotas to the training air forces was continued, but the number of students under instruction in the first few classes was divided equally between the new school, roster, and aircraft personnel. By the middle of December 1943, however, a new policy was adopted. The number of returned combat navigators increased rapidly 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 process, 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 canceling the quotas of the

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51. Ibid.
52. ANRO, Training to 39, ANRO, 22 Dec. 1943, in ANRO 211, Navigation Officers.
navigational 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 Selma Field or by discontinuing the preflight navigation school there. Since the demand for navigator graduates would not merit any considerable production, it was decided to transfer the preflight school from Selma Field back to Maxwell Field where it had been located prior to October 1942.

Training of Officers as Aviation Instructors. From the beginning of the navigation training program officers had been permitted to train in roles as navigators. Apparently there were no unusual problems in such training, before the latter part of 1942. In dual training programs 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 understandings 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 certain naval majors were to be permitted to take the second category of training. When the entire basic cadre program was converted to bombardier bombardier/navigator, there was a need for "fully trained officers in the rank of 0-1 train

54 Monthly Consolidated Aviation Training Report.
55 ANL to 03, April 30, 31 Dec. 42; 1st Ind., 2nd Ind., 3rd Ind., 10, 21
and labor to insure its success." With this in mind, Personnel requested
information on which to base a reply to the request for such training.
The AO/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. The training of bombardier instructors
in desk rectifying navigation was discontinued after the course which
entered training at the navigation instructors school on 21 November
1943.

At some uncertain date into the training command established the
policy of retraining all officer members of the navigation schools as
instructors for a period of six months. The practice of retraining all
officer members regardless of their teaching ability meant the loss
of good instructor personnel and thus worked to the detriment of the
training program. To remedy this situation the minimum period of stay
of such 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

56. CR, ALR5 to AO/AS, Personnel (?), July 1943, in ALR files.
57. CR, No. 1, ALP to AO/AS, training, 1943-44, in ALR files.
58. CR, No. 2, AO/AS, training to ALP, 1943-44, in ALR files.
59. Kelly Diary. 3-10, 13 Nov. 1943, in ALR files.
60. CR, ALR3 to AO/AS, training, 22 Sep. 1943; 1st Lt. E. M. Lane,
9, 27 Oct. 1943, in ALR files.
personnel in the training room, it was decided to assign them for supervisory and other key positions by selecting them from the list of officers holding such assignments. It was also strongly recommended that returned combat navigators continue to the instructors school by the Redistribution Center should be seen to the extent to be either instructors or supervisory officers in the training. 

Post-Battlefield 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 secure that the school graduates 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.

61. Note for Col. A. J. Lockwood by Gen. H. C. LeDoux, 3 March 1944, in AAF/C files. In this connection it is interesting to note that relative to the problem of returning combat personnel at their proper grade to non-combat functions, navigators were able to adjust more easily than any other category of personnel. Letter of Gen. H. C. LeDoux to Mr. R. S. McRae, 13/8, AAF/C, 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 AAF/C files.
with that the air forces expected of instructors.

In February 1943, 50 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 Carlisle as instructors for the new course in bombardier-navigator navigation which began in the following month. 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 OTU examinations for a period not to exceed 10 days for the purpose of "observation and familiarization with training."

By January 1944 this procedure seems to have become an established policy. At that time the regular flow was established of four instructors a month to the Second Air Force "to observe and participate" in operational training.

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 Katterfield made arrange-

63. Another means of keeping navigation instruction abreast of the latest navigational experience was that of sending 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 AAF to make such examinations or refresher in July and August 1943. See Daily Diary, ATC 19, 29 July 10, 22 Aug. 1943, in AAF 319-L, Daily Diaries. This policy was followed until the instructors school was established, after which time returned combat men were normally to constitute the principal source of new navigation instructors.

64. Daily Diary, ATC 19, 29 July 1943, in AAF 319-L, Daily Diaries.

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 Salmon Field in February or March 1944.

**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 in obvious. It was necessary that these pilots rate among the best in the AF. This was necessary from both the point of view of training; efficiency and student morale. As longer 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 requires 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.

67. OS, Salmon Field to OS, AS, taru channels, 29 Nov 1943; 6th Ind., AO/AS, training to OS, ATWPO, 26 Feb 1944, in AFACI files.
68. Daily Diary, ATFC, A-1 Div, 1 Oct 1943, in AFACI files.
69. OS, ATFC to ATFC, 9 March 1943, in AFACI files.
70. OS, ATFC to ATFC, 9 March 1943, in AFACI files.
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 50 twin-engine pilots from the Air Force Combat Command for bombardier, flexible gunnery, and navigation training. 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.

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. 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 view of the 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 effective use of resiging pilots.

already under its jurisdiction. If the student-pilot ratio at Selma
man Field was representative of some other navigation schools, the
ratio rarely reached 9 to 1. The ratio at this school in 1942 was be-
tween 7 and 8 to 1, was 8 to 1 in 1943, and in February 1944 was 7.2
to 1.

Because of longer and probably superior training and experience,
navigation pilots, like pilots in the bomber and gunnery schools,
were especially desirable to the tactical units. Until mid-1942, in
fact, these types of pilots were the sole source of four-engine trans-

sition school trainees. From these schools they moved to the Second
Air Force as heavy bombardment pilots. By December 1942 it had beco-
me the established policy to release 50 experienced pilots from the navi-
gation schools each 4 \textsuperscript{th} weeks. Forty-two days prior to the release of
these experienced pilots to the 4-engine transition schools, the navi-
gation schools received an equal number of twin-engine graduates.

Shortages of navigation instructors and pilots were severe handi-
caps to the advanced navigation schools. In addition to these per-
sonnel problems, the lack of material necessary for individual train-
ing of navigators was even more restricting in its influence.

74. OS, AFFO to AHQ, 9 March 1945; 1st Inc., 20 March 1943, in AAF files.
75. "History of Selma Field AAF Navigation School, 6 June 1942 to
29 Feb. 1944."
76. Daily Diary, 6130, 6-1 Div., 25 Dec. 1943, in AAF files.
Chapter VII

Material Factors in Navigation Training

Material Factors and Production

There were many factors which operated to curtail production of navigators, the basic factor being the shortage of man-hour 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 one 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 upon the delivery of airplanes and other equipment. The length and

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.

**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. Owing to the shortage of AT-7's, several other types of aircraft also were used, for example, AT-11's, AT-12A's, A-20A's, B-18's, B-24'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

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-50'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. By September 1942 the ratio had risen to 11.4 to 1, and there was very little change in the ratio after that time. In May 1945 the ratio was established at 12.5 to 1. 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. By April 1944, however, the actual ratio was down to approximately 11 to 1.

**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. 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 a day. All of this increased production, however, did not re-
fleet itself in trainers available to the navigation schools. Many of the AE-7's were lacking in the necessary navigation installations such as compasses, driftmeters, and other items. Furthermore, some of these airplanes were assigned to agencies other than the Flying Training Command and to activities within the command other than navigation training. These diversions of AE-7's seriously threatened the expansion in the schools which was scheduled for September 1943.

The failure to procure sufficient AE-7's made it necessary to utilize any other type aircraft which could be used immediately or modified for use. Throughout the first half of 1942 attempts were made to secure AE-19's for the navigation schools. A considerable number of these airplanes appears to have been obtained during 1942. 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.

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

15. RR, AFRIC to AFRIC, 3 June 1942, in ibid.; CG, AFRIC to AFRIC, 10 July 1942, in AAC 452.1A, Training Airplanes; AFRIC to CG, AFRIC, 20 Sep., 1942, in AAC 452.1A, Training Airplanes.
16. CG, AFRIC to AFRIC, 10 July 1942, in AAC 452.1A, Training Airplanes.
to receive 29 A-25's, 90 B-24's, 115 C-60's, and 100 C-45's. At that time none of the A-231's were available. The B-34's were to be converted at the rate of four a day, 56 of the C-60's by February 1943, 20 and the first C-45's in November 1942. The B-24'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 in the delay in delivery that subsequently occurred." While all of this difficulty was being encountered in securing modified trainer aircraft, the delivery of A-7's was behind schedule, and the number of A-25's which had been allocated to navigation training was reduced from 300 to 23. In December 1942 an additional allocation of 20 A-7's, 25 A-18'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 undelivered.

The demand for trainer planes increased at the same rate as did the enrollment of the navigation schools. In December 1942 there were 3,236 students under instruction in the navigation schools. By March

23. Ibid., 11 Dec. 1942.
1943 this number had increased to 4,999 and by June 1943 to 7,797. By June 1943 the ratio of students to civilian had risen to 14.2 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, South Carolina. Scant resources the entire bombardier program was expanded to include dead reckoning navigation. This necessitated the modification of all bombardier trainer aircraft (AT-11’s) to provide for installation of navigation equipment.

Demands for Tactical Type Trainers. The AT-7, though it was the basic type of navigation trainer airplane, was never entirely satisfactory 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 bombardier 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 would meet the demands of both bombardier and navigation training.

One of the most important reasons for desiring a new type bombardier-navigator trainer airplane was the vast difference in the performance

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27. RTR, No. 1, A0/AS, 15D to AFSC thru A0/A3, training, 3 June 1943, in AFSC files.
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 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: 1,800 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, AG/AS, Training had indicated to the Training Command the 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 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-60's and in acquiring C-47's. The superiority of these

29. 03, APIRO to AG/AS, Training, 17 March 1944, in HAC file.
31. RL, no. 8, AG/AS, CER to AG/AS, Training, 11 April 1944; 1st Ind. (06, APIRO to AG/AS, Training, 17 March 1944), 13 April 1944, in HAC file.
Aircraft over the AT-7's is indicated by the following comparative data:

<table>
<thead>
<tr>
<th></th>
<th>AT-7</th>
<th>C-60</th>
<th>C-47</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel capacity (gallons)</td>
<td>200</td>
<td>644</td>
<td>820</td>
</tr>
<tr>
<td>Range (miles)</td>
<td>770</td>
<td>1,200</td>
<td>1,500</td>
</tr>
<tr>
<td>Endurance (hours)</td>
<td>4</td>
<td>7.7</td>
<td>10</td>
</tr>
<tr>
<td>Number students</td>
<td>3</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

The status of trainer aircraft in the navigation schools at the end of April 1944 was: AT-7's, 660; AT-13's, 43; A-23A's, 17; and C-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 indispensible to navigation training as the trainer alone 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.

33. These were given as approximate figures. Ibid.
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. 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 outdated navigational instruments. The obvious result of this was the assignment of such aircraft 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.

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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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 1944. 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 cirrhale 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 Mar- cos 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.

35. Director of Training, AAF Navigation School, Honolulu, to C1, AAFAC through C3, AAFAC, 1 Nov. 1943, in AAFAC files.
37. AN1715 to C3, AAFAC, 6 March 1944, in AAFAC files.
38. 71d Ind. (to same), 10 May 1944, in AAFAC files.
39. 1st Ind. (C3, AN196 to A3A3, Training, 10 June 1943, 17 July 1943, in AAFAC files.
41. 31d Ind. (same), 15 Feb. 1944; 71d Ind., No. 7, A3ASH, I22D to A3A4, Training, 6 April 1944, in AAFAC files.
The item of equipment for which there was the largest quantity demanded in the navigation schools was navigation kits. The kits contained approximately forty items of equipment, including sextants, American watches, computers, plotters, log forms, calibration cards, air almanacs, flashlight, Hydrographic Office publications, Technical Manuals, and other items. 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 shortages of kits were so severe, however, that it was February 1943 before it was possible to issue kits upon graduation. Attempts were made continuously from April to October 1943 to secure kits in sufficient quantity to issue them to students entering training. At the end of October 1943 the status of navigation kits (celestial navigation, torpedei-dead reckoning navigation, and hydrographic navigation) was indicated as 3,880 on hand as against a requirement of 15,286. In other words, there was a shortage of 9,606. Furthermore, in addition to this shortage the navigation schools needed 61,431 kits in order to supply them to entering students to the end of 1944. 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.

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53. Ibid., Diary, ATRC, 13 Div., 13 Jan., 1945, in ATRC Files.
54. Ibid., to C3, 2d A2, 30 Jan., 1945, in AAS Files; Navigation Officers.
56. Ibid.
57. Ibid., No. 1, AS/AS, 111 to AS/AS, Training, 7 Jan., 1945, in AAS Files.
The problem of driftometers, compasses, and navigation kits is merely an example of conditions which prevailed in general to virtually all items of navigation equipment. Differences in shortens of various items 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 ending of dead reckoning navigation to the regular Bomber streamer course. These two conditions created an unusual shortage which was met partially by cannibalization; 3-23's and 3-25's used in pilot transition training. The Flying Training Command was authorized to remove navigational equipment from these airplanes, except that needed for pilot navigation training. 47

By April 1944 there were still problems of material 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 material problem unlikely.

47. 03, ATCIC to ARIT, 28 Feb. 1943; 1st Ind., 10 April 1943, in AMC files; Daily Diary, ATCIC, 3rd Div., 8 Feb., 10 April 1943, 2nd Div., 23 Feb. 1943, in AMC files.
Chapter VIII

SUMMARY

Before 1939 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 extension program began in 1939 a program requirement of 500 officer navigators was established. There were then only 166 qualified navigators on duty with the GHQ Air Force.

Program requirements for navigators and other aircrew categories pyramided 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.
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. 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 Nather 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 1,369.

Late in 1941 and continuing thereafter plans were made to increase the size of classes and to expand facilities at the schools. Nather 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 Selma Field replaced Turner Field. Delays in be-

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.
ginning training, however, caused "extremely acute" shortages in 1942, and the Flying Training Command was instructed that "immediate and 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 16 to 12 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 1942 there was an apparent shortage of about 5,000 navigators. The Training Command opposed return to a 16-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 quotas. 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.
Despite continued difficulties in meeting production requirements, the Training Command and AG/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 aircrew 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 aircrew training. Although the pressure of the expansion program forced abandonment of earlier high academic prerequisites, the attitude requirements for navigator training remained higher than those for bombardiers and pilots.

By the fall of 1943 the equivalent of the later preflight bombardier-navigator schools had been established. The official preflight program 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 1942 practically all of the training of navigation co-
cielists was carried on in the tactical units of the CEF, 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 CEF, 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 AEF 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 presflight 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. Some small 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 183 hours were allotted to all ground training in the tactical units.
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 70 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 1942. 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 1942, and the hardship on the air forces involved in giving individual training in addition to their regular CTU and RTU missions. There was a rather general belief that the product of the Flying Training Command schools was far superior to
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 that was expedient rather than on what was possible or theoretically possible. These 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 16-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 16-week program; (4) a further revised program of 15 July 1941, still 16 weeks in length; (5) an 18-week program approved on 7 January 1942 and changed slightly in July and November 1942.

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.

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

The overwhelming proportion of the individual training of aviators 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
node we about 75 per cent of navigation instruction, since a large
port of the navigator's proficiency could be attained on the ground.

Theoretical instruction was not extensive. Indoc trination in
procedure, the primary need of the student, was provided by ground
problems, followed by ground missions. The 12-week program provided
for 26 ground problems and about the same number of ground missions,
which were simulated flight missions. The ground problem was essen-
tially instructional, the ground mission mainly a testing procedure,
and the flight mission the laboratory phase of training. Examina-
tions 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 naviga-
tion were progressively combined on single missions and applied on
simulated day and night combat missions. Under the 12-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 un-
able 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
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 28. Complaints came in from combat theaters early in 1943 that navigators were often entirely ignorant 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-
ators familiar with long-range navigation caused the amendment of the January 1945 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, AAF and the Training Command to try to effect standardization.
In December 1942 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 AG/AS, Training di-
rected the Flying Training Command to take immediate steps to standard-
ize 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 Selma 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 Selma 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 pre-
requisites 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 gun-
nery as well as bombardier training for all navigators. But both bom-
bardier and gunnery training had to be abandoned after 7 December 1941.
In the spring of 1942, however, navigator graduates were "scheduled"
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 pre-flight training. In July it was decided that they would be sent before entrance into pre-flight, 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 28 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 14-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 standards was
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 AO/AS,
Training informed the Training Command that neither it nor PAA "desired
to renew the contract" and navigator training at Coral Gables was to end.

From the beginning of specialized navigation and bombardier train-
ing it was considered desirable to train these specialists in dual ca-
pacities. 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 train-
ing 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 acce-
dite 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 bom-
bardier-navigators be trained for use in medium bombardment. The Fly-
ing 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
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-3 bomb sights, map reading, piloting, 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-3 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-3 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 personal and approaching delivery of the B-29 superbomber made it imperative that at least a be-
training of such training be made. In October and November 1942 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 evacuation 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.
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 XX 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 XX 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-deck reconnaissance navigators trained on B2X 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 matched. Consequently, the Commanding General of the Second Air Force recommended that complete dual
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/dead 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.
Shortages of trained navigators and the inevitable 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 8. On 15 December it was directed that this be changed to 1 to 6, but apparently it was not done. In April 1942 the ratio was 1 to 5.5. In August 1942 the established ratio was 1 to 5.22, and by April 1943 it had been established at 1 to 4.16. Apparently the instructor-student ratio was close to the authorized figure by April 1943, 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
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 223 navigation instruct-
ors to meet the needs of the air forces for staff officers. It was
unfeasible, however, to furnish them on schedule. By 1 May 1943 it seems
that only 43 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 need-
ed, 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 re-
turned combat navigators, took place at Lethal 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 Lethal became inadequate. The Training Command decided
to convert the refresher course into a regular central instructors school,
still to be located at Lethal. The program of instruction consisted of
300 hours--91 on navigation technique (35 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 Lethal rather than established as
a separate school. Consequently, a new central instructors school was
established at Salmon Field in September.

In Salmon 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.
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 Selma 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 force. 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 Selma, 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.
to the tactical units, and by December 1942 it had become established
policy to release 30 experienced pilots from the navigation schools
every 42 weeks.

Of all the many factors curtailing the production of navigators,
the basic retarding influence was the shortage of material items nec-
essary for the conduct of training. Shortages adversely affected the
opening and expansion of schools and the length and content of pro-
grams of instruction. In fact, virtually every effort made to expedite pro-
duction met the obstacle of shortage of equip - 
ent, especially airplanes.

The basic type of aircraft used in navigation training was the
AT-7, although AT-11's, AT-13A's, A-33's, 3-13's, 2-54's, and C-50'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 11:1 to 1 by September 1942. There was little chance in the ratio
after that time. From September 1942 through April 1943 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 airplanes resulted

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from slowness in delivery and modification.

The AE-7 was never entirely satisfactory because of its limited performance characteristics. Consideration was given to stopping production of it and the AE-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 O-17's for navigation trainers, expected release of combat type airplanec, 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 O-60's and in acquiring O-17's.

The demands for equipment also extended to such items as compasses, astro-compasses, driftometers, 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 outdated 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 production. 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
credible 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 airplane member in the combat theaters. Mistakes were made and there were many deficiencies in the training. The training agencies sought to find out that the principal weaknesses were—especially from the all-important point of view of combat needs—end, within the severe limitations under which they were operating, attempted to correct them.
GLOSSARY

AAF  Army Air Forces
AG  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
AG/AC  AC/AS, A-1 (Personnel)
AG/AC  OC/AS, Training
AG/AC  Materiel Command
AG/AC  Air Service Command
AG/AC  Air Transport Command
AG/CO  Budget and Fiscal Office
AG/CO  Air Force Combat Command
AG/CO  Central Flying Training Command
AG/CR  Directorate of Military Requirements
AG/CP  Directorate of Personnel
AG/CR  Flying Training Command
AG/CR  Historical Division
AG/CR  Administrative History Branch
AG/CR  Military Personnel Division
AG/CR  Directorate of Air Support
AG/CR  Directorate of Base Services
AG/CR  Directorate of Bombardment
AG/CR  Directorate of Individual Training
AG/CR  Directorate of War Organization and Movement
AG/CR  Antisubmarine Command
AG/CR  Air Surgeon
AG/CR  Training Command
AG/CR  Western Flying Training Command
AG  Adjutant General
AG  Assistant
AG  Army Post Office
AG  Branch
AG  Bombing through overcast
AG  Chief, Army Air Forces
AG  Chief of the Air Corps
AG  Chief of the Air Staff
AG  Commanding General
AG  Commanding Officer
AG  Chief of Staff
Div. Division
ETA Estimated time of arrival
Exec. Executive
F. T. O. Flying Training Command
GCAATC Gulf Coast Air Corps Training Center
GHQ AF General Headquarters Air Force
Ind. Indorsement
JAG Judge Advocate General
MAD Material, Maintenance, and Distribution
OGAC Office, Chief of the Air Corps
OCOR Operations, Commitments, and Requirements
OTU Operational Training Unit
PAA Pan-American Airways, Inc.
PSA Public Works Administration
R&R Routing and Record Sheet
RTU Replacement Training Unit
Reg. Regulation
Sec. Section
SEAC TC Southeast Air Corps Training Center
TC Training Center
TCD Training Command
TCC Troop Carrier Command
T/O Table of Organization
TCD Training and Operations Division
TDX Teletype Teletype exchange (message)
WCAATC West Coast Air Corps Training Center
WD War Department

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211D Pilots
211D Titles and Grades
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The materials in these classified and unclassified files 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 Assist-
ent Chief of Air Staff, Training. Many documents, however, particularly for the earlier years, were found only in Central Files.

Office Files

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 aircraft training. Daily diaries of training schools, the Project Book of the Commanding General, Flying Training Command, After Training Command, special 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

Miscellaneous materials in files of Officers Branch and Aviation Cadet Branch, Military Personnel Division

Sources pertinent to this study were called to the author’s attention by the Personnel Section, Administrative History Branch.

Assistant Chief of Air Staff, Training

Miscellaneous materials

The large collection of correspondence, program of instruction, daily diaries, and reports in the files of the Air Crew Training Division were exceedingly valuable for this study. Some correspondence was not found in Central Files, and much other material was more accessible than in other files.

Training Command, A-2 Division, Historical Section

Miscellaneous materials

Personnel of the Historical Section of the Training Command coded files in the Headquarters of the Training Command for data on mvi-
tion 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.

Special Studies

AAF Historical Studies [prepared by Historical Division, Assistant Chief of Air Staff, Intelligence]


Deals with procedures for initial selection of cadets from World War I to the summer of 1943.

No. 5: Individual Training of Bomberdiers. May 1944.

A companion study which treats detailed training in considerably more detail than is found in the present study.

No. 15: Procurement of Aircrew Trainees. August 1944.

Describes policies and methods in recruiting pilots, bombardiers, and navigators, from 1939 to March 1944.

No. 18: Pilot Transition to Combat Aircraft. September 1944.

Discusses transition training in tactical units and the Training Command.

Unit Histories

"History of the Army Air Forces Flying Training Detachment, Pan-American Airways, Inc., Coral Gables, Florida, 1 August 1940-1 January 1943."

"History of Hondo Army Air Field, Activation to 1 January 1943."

"History of Selman Field, Army Air Forces Instructors School (Navigator), 31 July 1945-29 February 1944."

"History of Selman Field, Army Air Forces Navigation School, 1 January-31 December 1943."

Restricted
"History of Selren Field, Monroe, Louisiana, 13 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.
Appendix 1

PROCEDURE OF TRAINING

TRAINING OF AERIAL NAVIGATORS

for military students to be given in

AIR CORPS FLIGHT SCHOOLS

[15 July 1941]
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.
   a. Familiarization
   b. Calibration
   c. Navigation Flights (Day)
   d. Navigation Flights (Night)
   
   Total Hours: 100:30

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

2. Ground School.
      (1) Instruments
      (2) Data and Charts
      (3) Dead Reckoning Procedure
      (4) Dead Reckoning Problems
      (5) Interrogation and Orbits
      (6) Radio Navigation
      (7) Review and Examination

      Total Hours: 203:00

      (1) General Theory
      (2) Time and Your Watch
      (3) Instruments
      (4) Time Determination
      (5) Time Determination
      (6) Astronomical Triangle

      0-13:00, 7-3:40
      Rev., 9-20:00
      Rev., 2-3:40
      Rev., 13-5-41
(5) Precomputed Data
(7) Celestial Navigation Procedure
(3) Preparation and Critique
(7) Review and Examination

Total Hours: 200:00

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**Meteorology**

(1) Theory and Principles; Weather Analysis; Weather Reports
(2) Interpretation of Weather Maps; Discussion of Forecasts
(3) Special Weather Influences; North and South America
(4) Ocean Meteorology - Facilities and Influences
(5) Thunderstorms; Tornadoes; Icing Conditions
(6) Practical Exercises

Total Hours: 65:00

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**Athletics and Military Training**

a. Athletics
   - Exercise of at least one (1) hour per day.

b. Military Training
   - Reviews, Inspections, Duties of Jr. Officers.

Total Hours: 50:00

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**TEXTS:**

<table>
<thead>
<tr>
<th>Phase of Instruction</th>
<th>Texts Now</th>
<th>Proposed Texts</th>
<th>Supply Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Dead-reckoning Navigation</td>
<td>TM 1-205</td>
<td>Spec. Pub. #127</td>
<td>AG</td>
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<td></td>
<td></td>
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<td>CG</td>
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</tbody>
</table>
# AIR NAVIGATION TRAINING SCHOOL

## Details of Curriculum

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<td>3-3-1</td>
<td>1:00</td>
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<tr>
<td>23-2-2</td>
<td>2:00</td>
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<tr>
<td>27-3-3</td>
<td>2:00</td>
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</tbody>
</table>

### 1-1-1 General Definitions of Navigation.

- 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.

### 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.

### 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.

### 23-2-2 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. Derivation of the common projections, polar, and modifications of the polar and the mercator projections. Use of plotting sheets in navigation.

### 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.
Index

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 planning chart will be illustrated. The great circle distance and the Hecato course and distance will be determined and compared; factors influencing the decision on which route to fly, the great circle route or the Hecato course; method of determining the Hecato legs of the great circle route. Practical exercises illustrating all the uses of these two types of charts on both projections will be given.

6-4-1 Map Reading and Elementary Dead-reckoning.
Map symbols; how to do piloting. 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 on a map by latitude and longitude. The use of elementary dead-reckoning to assist the navigator in piloting will be illustrated by calculation of Hecato for landmarks along fictitious route, or check points on a normal route, ground speed having been determined by piloting.

17-4-2 Piloting 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.

4-5-1 Magnetism and the Compass.
Theory of magnetism; explanation of variation and deviation; Isometric and Magnetic 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 "Tiller to the Pilot" procedure.

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 polaris method; explanation of operation of the Drift Sight.

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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 Direc-
tional 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 com-
pass 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 2D-8 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 cali-
bration. 4:00

12-5-8 Practical Exercises in Air Swinging of the Compass by Terres-
trial 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. 2:00

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.

85-5-12 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.

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.

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.

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.

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 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.

22-7-2 Practical Problems in Standard Navigation Procedure; Dead-
reckoning;
Additional work in keeping log sheet, using E6-3 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 L.T....
Index

24-3-1  Chronometers and Time Signals.
Determining the rate of the watch by time signals; Zone time
and the time zones of the world; Greenwich time. Use of the
back intelli. Students will be assigned in turn to rate master
watch placed in the classroom. 1:00

25-9-1  Radius of Action.
Explanation of the Radius of Action problem and discussion of
the ideal solution. A brief review of vector diagrams 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.
The stereotyped pattern for patrol missions will be illustrated.
Method of obtaining ground speed from drift determination,
and averaging ground speed on the long legs of the pattern
will be explained. Method of determining F.T.M. and closing
entries in log book at end of each leg will be explained. 1:00

29-9-3  Interception.
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.
Search and search patterns will be illustrated; terminology used
in reconnaissance work will be explained. 1:20

31-9-6  Review of Radius of Action and Interception.
Review of the Ideal solution and practical problems. 4:30

36-10-1  Interpretation of Bearings, Lines of Position and Plims.
Definition of a bearing and a line of position; application
of the necessary for the running fix; practical exercises
in the use of line of position or bearing fix. Practical exercises
in using a combination of bearings to obtain a fix. 4:00

37-10-2  Practical Problems on Bearings and Plims and Review of Theory
of Bearings and Plims.
Practical solutions of the interpretation of bearings, lines
of position and fixes. Practical problems to illustrate lecture. 3:00
Index

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.

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.

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.

52-12-3 Conversion of Bearings.
The necessity for the conversion of bearings will be fully explained. Explanations 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.

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.

45-13-1 Observations - Parallax and Refraction.
The limitations of the bubble sextant 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 sextant 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 sextant practice.

36-14-1 Introduction to the Celestial Sphere.
A brief introduction to the celestial sphere illustrating by diagrams 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.

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41-14-2 Name of Constellations and the Navigational Stars.
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
name of the principal navigational stars in each con-
stellation will be memorized. The pointing system as an
aid to locating stars will be explained. This method of
star identification will be followed in all the night
star classes.

43-14-3 Location of Stars on the Horizon Projection.
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.

47-14-4 Making the Observation; Use of the Octant.
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.

55-14-5 Observation of the Stars and Solution for a Line of Position.
The first part of this period the instructor will explain the
use of an Astrolab solution together with the observation
to determine the 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.

59-14-6 Plotting, the Line of Position.
Additional practice in making observations and plotting the
lines of position.

61-14-7 Completion of Horizon Projection for Use as a Star Finder.
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.

64-14-8 Observation of Stars and Plotting, Lines.
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.

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70-14-9 Observation of the Planets.
Practise in observing planets, working solutions by
Apert, and plotting lines of position. Fix will be
made if practicable. Identification of new stars will
be maintained.

75-14-10 Observation of the Moon.
Observations will be taken on the Moon; Apert solutions
will be worked, and corrections for parallax and refraction
applied. Lines of position will be plotted; identifi-
cation of new stars will be maintained.

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 celes-
tial 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.

83-14-12 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 ob-
tained.

92-14-13 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 which the student is unfamiliar. Observa-
tions will be taken on Polaris for latitude determination.
Bodies on the meridian will be observed to determine
latitude. Recurring lines of position will be plotted and
if favorable, fixes will be obtained.

161-14-14 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 identifi-
cation.
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 dealt on to show the calculation of distances on the sphere as the first practical method of calculating flying.

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 particular problems crossing the Equator and the Greenwich Meridian and the International Date Line.

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.

Additional practical exercises solving Mercator solutions for course and distance.

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 outlined, 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 Maters."

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 be

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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.

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."

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 ver will be completed. Reference should be made to mimeographed pamphlet "Precision Dead-reckoning Applied to Tactical Missions."

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."

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.
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| 68-17-2 | Review of Celestial Definitions.  
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.  
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.  
Explanation of the apparent motion of heavenly bodies and the conception 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.  
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.  
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.  
The time diagram will be explained and its use as a means of depicting the angles concerned in these problems will be practiced by several exercises.  
1:00 |
| 74-21-1 | Solution by A.O., 214.  
A brief explanation will be given of the method of solving the astronomical triangle by A.O., 214. Practical problems to illustrate this lecture will be given by the instructor. 1:30 |

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76-21-2 Elements of the Astronomical Triangle.
Elements of the astronomical triangle will be shown on the slotted sphere; discussion and explanation as to how each element is obtained will be made; explanation of a position circle, that 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.

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 N.O. 21L. Laying down the lines of position.

39-5-5 Use of Polars and Calibration of Turret.
Description, explanation and use of polars. Method of calibrating turret. Practical problems in calibration.

40-21-1 Solution by N.O. 21L.
The students will be taught how to use the almanac and N.O. 21L 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.

40X-22-3 Air Charting of the Compass by Celestial Azimuth.
The procedure in operating the polars to observe the heavenly bodies, and the operation of the 3-2 or 3-3 drift meter to observe the shadow of the airplane by which the relative bearing from the real rood 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.

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.
Index

105-23-2 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

105-23-3 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

30-24-1 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 explorations 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

80-24-2 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, the necessity of additional duties during the tactical flight, will be explained. The different methods of precomputation, 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 outputs and chronometers will be explained. Mention of its use in the landing will be made. Practical exercises in making the stationary curve using Agaton solution.

81-26-3  Practical Problems in Taking Stationary Curves.
Additional practical exercises in making a precomputed curve by Agaton solution.

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.

92-26-5  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.

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 earlier or is later 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 hardly in this work.

113-27-2  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

U-1233, 4.3., 7-1-40
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Rev., 8-3-41
Rev., 7-15-41
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.

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 problem samples will be prepared which can be used on flight mission 716.

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° of the azimuth, or its reciprocal; show how the distance to run in 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 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.

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Celestial Preparation for Running Curve Flight.

Navigation plan for flight will be made. Select celestial body 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 making observations, determining intercept, plotting lines of position, show effect of early or late take-off and effect of an actual ground speed factor 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 J-6.

Landfall by Intercept Method (Course Equal to Mean Hourly Azimuth + 2°).

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 those intercepts and determination of the azimuth, plus or minus 2° 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.

Landfall, course within 30° of Azimuth or Analogue.

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 points 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 time the azimuth + 2° will be selected as the course to the destination. Practical problem illustrating this method will be given.

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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

105-29-6 Practical Problem on Day Landfall Flight.
Data for flight mission J7 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 intercepts and azimuth from precomputed curves. Lines of position will be plotted and distance to dead-reckoning 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

The Double Curve Method—this variation of the landfall must be performed with two precomputed curves on each of the 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 R/A and mean time of observation on each body can be applied to this method. Explain how to determine time to turn and course (bar. 190°) to destination. Explain how, when working with stars, precomputed solutions or curves can be used by changing the time 360° 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 data for mission J7. Students will determine the 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.

3:00

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Rev., 2-3-41
Rev., 7-15-41
107-28-10 This lecture is a continuation of the Problem begun in Lecture 103-22-7. Data simulating observations will be given to 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 track 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.

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 navigator chart and all necessary data entered in log.

111-28-12 Practical Problem on a Night Celestial Flight.
Theoretical Flight using the data required in flight mission 219-A will be given.

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 navigator 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.

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.

A brief review of all the methods of celestial navigation and a theoretical flight illustrating all these methods will be performed by the students.
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 #13-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

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

The preparation for this flight was outlined in detail in Lecture 121-28-19. 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 whenever practicable. The student will solve given data, determining fixes by azimuth, 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 nautical chart, and the necessary entries concerning dead-reckoning made in the log book.
3:00

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 precomputer 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. "Riddles 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.

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.

Time in Class

4:00

2:00
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 #5.

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, in the absence of the student, the navigator's report, together with the navigator's log sheets, will be turned in to him and the critique given when possible.

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 review the flight mission with the student 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)

Alignment of the Drift Sight

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 drift angle is zero. Instructors will be present to supervise students.

Mission #2 (Weight 4)

Calibration of the Airspeed Meter

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 2/3 complete runs and then exchange seats with 3rd navigator. 3rd navigator will time the first 2/3 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. Your 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 in flight.

Mission #3 (Weight 4)

Air Swingings of the Compass by Terrestrial Bearings

The navigator's compass will be swung in the air, using the B-2 or B-3 drift meter, to determine the relative bearings between the heading of the plane and a terrestrial line of bearing such as a railroad, 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 swingings 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 mastor rate.

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Duties: 1st navigator will read drift meter and 1st compass and
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

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 15% at next check point. All work will be entered on
navigator’s log. The 2nd and 3rd navigators should be able to accu-
rately 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
discontinued because of pilotage. The 2nd and 3rd navigators will deter-
mine the dead-reckoning ETA and the Pilotage ETA at destination.

Mission #5 (Weight 3)

Familiarization Flight

The flight will be over a triangular course with all legs
approximately equal. Each navigator will occupy 1st navigator’s
position on the 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.”

U-109, 8-2, 7-3-40
Rev., 9-30-40
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Rev., 2-5-41
Rev., 7-15-41
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 low the Pilot Mission and reckon their error by Pilotage 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)

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 EVA.

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. Mission #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.

U-1339, A.C., 7-8-40
Rev., 9-30-40
Rev., 2-3-41
Rev., 7-13-41
Mission 7A, 7B, 7C — Dead-Reckoning Between Indistinguishable Points
(with concurrent Mission 7J)

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 7J as outlined in Details of Missions for the approximate headings to be flown on mission 7J. 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 piloting. The error will be determined by the difference between the actual position of plane and their dead-reckoning position.

Mission 8A (*eight 6*)

Alignment of the Pelorus

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 89, covering Calibration and alignment of Pelorus in AT-7 turret. Instructors will be present to supervise the work of the students.

Mission 89 (*eight 6*)

Air swinging of the Compass by Celestial Navigation
(Performed concurrently on Missions Nos. 12A, 12B, 12C)

Compass will be swung at 15° intervals around pole through 360°.

U-1399, 7-27-43
Rev., 7-28-43

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

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

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

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

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

Since only 3 men are available to operate the Polaron and the 3 compasses, it will be necessary to read only a second time to obtain deviation corrections for 3rd compass.

2nd navigator will operate Polaron 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 sun compass readings.

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

1st navigator will continue to operate 2nd 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: To sight 8

Follow the Pilot

Follow the pilot procedure should not be considered as a 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 1st and 2nd navigators can perform the necessary procedure while solving other navigation problems.

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Rev., 6-10-40
Rev., 2-19-40
Rev., 7-22-40
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 3rd 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 4 (eight 1)

Octant Practice
(Performed on Missions Nos. 120, 122, 125)

Duties: This mission will be performed by each navigator on the Radius of Action mission. 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 last 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 bracketed 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.
Mission 712 (Weight 2)

Mission 712A, 712B, 712C - Radius of Action
(10th 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.

Note: On the first leg the Radius of Action problem will be worked twice by the Ist navigator.

The 2nd navigator will work radius of action problem once after the second variable 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 712I concurrently as outlined in Details of Mission.

Mission 713 (Weight 9)

Combination Patrol, Interception and Search
(11th concurrent Mission No. 9)

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 mission, 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.)

Note: Mission 712A - As soon as the oil is on course, Ist navigator will operate relays and take relative bearings on sun and moon on the correct GMT. The 2nd navigator will record heading of 1st course, relative bearing which the 1st navigator obtains from relays, and correct time. The 3rd navigator will record and record corrected readings of the 2nd navigator's course. This will then be an Actual Navigation solution. Additional readings will be worked by Ist and 2nd navigator to date position as accurately, and correct duration corrections other than for Ist and 2nd course. 3rd navigator will use standard correction chart in plane.

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7-24-49
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 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 (Reight 6)

Radio bearings and fixes 4:00

The course will be flown in three legs, each leg being of at least 11/2 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.
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 piloting 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 Ist 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 Ist 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 Ist 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 O.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 #1: (Height 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 made on Mission #4. 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 plot 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 lead 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 H.O. 21A, or adjusted H.O. 21B or 21A solutions that have been precomputed. At least two of the solutions for the lines of position will be precomputed.

**Mission #16 (Weight 7)**

**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 ensuring that he is making the course good, the secondary navigator 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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Mission #17 (Height 6)

Mission #17A, 17B - The Day Landfall

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 from 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, the destination will be made by him 3PA. 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 (Height 6)

The Night Landfall

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 (Height 2)

Mission #19A - Flight Celestial Using Astrolab or L.O. 214 to Obtain Time

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 their simultaneous observations are necessary, only one

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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 naviga-
tor will change places with one of the other members of the element.

Mission #: 98 - Night Celestial Using Star Altitude Curves

Procedure same as on 98A; Star Altitude Curves will be used
for all fixes.

Mission #: 20 (Write flight)

Long Celestial Flight

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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<td>General Definitions</td>
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<td>-2-</td>
<td>1</td>
<td>Earth's Surface</td>
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<td>-3-</td>
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<td>Lambert-conformal Conic and Pseudocylindrical</td>
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<td>Cylindrical and Stereographic and other</td>
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<td>projections; Plotting Sheets</td>
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<td>Magnetism and the Compass</td>
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<td>Drift Meter; Its Purpose and Use</td>
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<td>Preparation of Compass Deviation Cards</td>
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<td>Pelorus; Use and Calibration of Turret</td>
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**SUBJECT: -6-  
Wind and Ground Speed:  
(weight = 4)**

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<td>Various Problems Solved by the Computer</td>
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**SUBJECT: -7-  
Standard Navigation Procedures; Dead-reckoning;  
(weight = 3)**

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<td>Practical Problems on Standard Navigation Procedure; Dead-reckoning</td>
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**SUBJECT: -9-  
Chronometers and Time Signals;  
(weight = 1)**

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<td>Names of Constellations and the Navigational Stars</td>
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<td>Location of the Stars on the Horizon Projection</td>
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<td>Making the Observation; Use of the Octant</td>
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<td>Observation of the Stars and Solution for the Line of Position</td>
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<td>Completion of the Horizon Projections for Use as a Star Finder</td>
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<td>Midnight Star Identification; Observations of Bodies on the Meridian and of Polaris</td>
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<td>Early Morning Star Identification</td>
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<td>Plain, Traverse, Parallel and Mid-latitude Flying</td>
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<td>Mercator Flying</td>
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<td>Great Circle Flying</td>
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**Standard Navigation Procedure; Tactical Missions:**

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| 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 | 1 | Review of Tactical Missions | 4 |
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**Celestial Navigation, General; Celestial Definitions:**

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| 68 | 2 | Review of Celestial Definitions | 2 |
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| 69 | 2 | Time | 2 |
|           | Total Hours | 4     |

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<td>1 Relation of Time, Hour Angle and Longitude</td>
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<td>Astronomical Triangle, Its Solutions, and Position Circles</td>
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<td>Determining G.M.A. and Declination</td>
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**Standard Navigation Procedure, Celestial:**

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Use of Special Computers and Instruments:

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**SUBJECT: -30-**

Standard Navigation Procedure on Celestial Missions:

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<td>Instructions on: Mission 5, Familiarization Flight; Mission 6-A, Simple Dead-reckoning Flights</td>
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<td>Instructions on: Mission 7-A, 7-B, and 7-C, Dead-reckoning on Dog Leg Course</td>
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Rev., 9-28-41

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Rev., 2-3-41
Rev., 7-15-41
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Total Hours: 15
Appendix 2
HEADQUARTERS
ARMY AIR FORCES TRAINING COMMAND
FORT WORTH, TEXAS 22 July 1943

TRAINING

Navigation Training, General Training Program

(This Memorandum supersedes T.O. Memorandum No. 50-12-1, dated 15 April 1943, and T.O. Memorandum No. 50-12-1A, dated 9 June 1943.)

1. Mission: The mission of the AAF T.C. 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 AAF T.C. 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 AAF T.C. Navigation Schools are as follows:
   Army Air Forces Navigation School, Monroe, Louisiana
   Army Air Forces Navigation School, Huffman, Texas
   Army Air Forces Navigation School, San Marcos, Texas
   Army Air Forces Navigation School, Hastings 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:
      (1) Able to navigate during daylight hours by dead reckoning means with a maximum course error of ½° and a maximum E.T.A. error of 1½ minutes per hour of flight from the last known position.
(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-63, Aerial Dead Reckoning Computer, to include proficiency in the following uses of the E-63 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 bomb equipment.
(5) Proficient in the calibration of aircraft instruments, to include:
(a) Air and ground swing of course.
(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 1-70. (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:

(1) Pilotage
   (a) Basic Principles
      1. General Definitions
      2. Earth's Surface
      3. Map Projections
      4. Tim, Speed, and Distance
      5. Time, Speed, and Distance TR Computer (Glide Rule Face)
      6. Pilotage Log Book Procedure
      7. Magnetics and the Compass
   (b) Instruments
      1. Gyrocompass
      2. Altimeter
      3. Other Airplane Instruments
   (c) Airmanship

(2) Calibration
   (a) Basic Principles
      1. Compensation, Ground Swinging and the Sighting Compass
      2. Deviation Analysis
      3. Compass Swinging by Terrestrial Bearing
      5. A. S. Meter Calibration
      6. Alignment of the Gyrocompass
   (b) Instruments
      1. Astrometry

(3) Dead Reckoning
   (a) Basic Principles
      1. Dead Reckoning Tables
      2. Ground Speed by Timing
      3. DF Log Book Procedure
      4. Controlled Ground Speed
      5. Vector Diagrams and Ortho 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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14. Navigation Plan
   (b) Instruments
      1. Range of Action on Computer
      2. Vector Diagrams Solved by Computer

14. Radio
   (a) Basic Principles
      1. Chronometer and Time Signals
      2. Radio Aids to Navigation
      3. Conversion of Bearings
      4. Interpretation of Bearings and Fixes
   (b) Instruments
      1. Radio Compass Receiving Set
      2. Operation of Loran Equipment

5. Celestial
   (a) Basic Principles
      1. Celestial Sphere
      2. Motions of Heavenly Bodies
      3. Time, Hour Angle and Longitude
      4. Parallax, Refraction and Coriolis Force
      5. Latitude by Polaris and Meridian Altitudes
      6. Use of Almanac
      7. Solution by N.O. 211 and N.O. 216
      8. Plotting the L.O.P.
      9. Interpretation of L.O.P. and Fixes
     10. General Precorrection and Adjustment
     11. Use of Stationary Curve in Securing Time Check
     12. Landfall, Single L.O.P.
     13. Po-No Curves
     14. Star Identification
     15. Star Altitude Curves
     16. Celestial Log Book Procedure
     17. Chart Navigation
     18. Proflight Planning
   (b) Instruments
      1. Sextants
      2. Star Identifier
      3. Astrograph

6. For All Ground Training
   (a) Practical Problems and Ground Missions
   (b) Preparation and Procedure for Flight Missions
   (c) Critiques for Flight Missions
   (d) Exams, and Exam Analysis
   (e) Review and Directed Reading Periods

3. Aerial Navigation air training will consist of the following:
(1) Familiarization
(2) Instrument Calibration
(3) A.R. and Pilotage
   (a) Straight 8
   (b) Dog leg 8
   (c) Combined Radius of Action
       Interception and Search 24
(4) Navigational and Radio
(5) Night Navigational - Radio - Night
(6) Pilotage

(c) Allied training will consist of the following:
   (1) Military 50
   (2) Physical Training 100
   (3) Identification 3
   (4) Code
   (5) Weather
      (a) Weather Observation, Sequence and Wind Aloft Reports 12
      (b) Temperature, Pressure, and Moisture 5
      (c) Ocular Discussion 5
      (d) Air Mass and Frontal Weather 6
      (e) Thunderstorms, Turbulence, Holing and Terrain Effects 4
      (f) Special Weather Influences, North and South America 4
      (g) World Weather 2
      (h) Ocean Weather 3
      (i) Maps
      (j) 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 process, purchase of uniforms, physical examinations, etc.

This program will be followed explicitly in the manner best fitted to the local conditions and the equipment and other training facilities available at the individual stations.

The size of classes and size of students will be as prescribed by the Department.
8.9 Recommendations and comments on the training prescribed above will be submitted through normal channels.

By command of Major General YOUNT:

DAVID H. SCHLATTER,
Colonel, A.S.C.
Acting, Chief of Staff,

OFFICIAL:

J. H. HILLS
Colonel, A.S.D.
Adjutant General.

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1 cpy MAC
1 cpy NAFC
1 cpy ANF
5 cpy Stewart Fld
1 cpy Air Arm., Eq. S G
1 cpy on Div., this Hq
1 cpy GS, GDS
1 cpy GS, SERO
1 cpy GS, WPC

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Appendix 3

T. C. MEMORANDUM

HEADQUARTERS
ARMY AIR FORCES TRAINING COMMAND
FORT WORTH, TEXAS 6 Sept 1943

NUMBER 50-12-2

1. TRAINING

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.

b. Navigation Technique:
   (1) Instrument: Proficient in the installation, calibration, operation, use and first overhaul 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.
(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.
   4. Codes.
   5. Identification.
   6. Observation.
   7. Scouting and Gunnery.

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.

Secondary personnel of the school will not be transferred without orders from the Headquarters.

The order of classes and flow of students will be as prescribed by the Headquarters.

3. Observations and comments on the adequacy of the course, with suggestions for improvement, may be submitted at any time. Direct correspondence with the Headquarters in matters of this nature is authorized.

4. The length of the course of instruction at the Army Air Forces Central Navigation Instructors School will be one month.

5. **Arrangement of instruction at the Central Navigation Instructors School:**

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<td>(4) Navigating the compass</td>
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<td>(5) Command and control</td>
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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
       10:00
   TOTAL
       51:00

   c. Allied Training
   (1) Combat Intelligence for Air Crews
       8:00
   (2) Meteorology
       10:00
   (3) Reconnaissance
       4:00
   (4) Bombing-Gunnery
       12:00
   (5) Chemical Warfare
       6:00
   (6) Physical Training
       24:00
   TOTAL
       58:00

   TOTAL
       209:00

By command of Major General YOUNT:

WALTER F. KRAUS,
Brig. Gen., G.S.C.,
Chief of Staff.

DISTRIBUTION:
1 cpy TMG File
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30 cpy AFAC
1 cpy AFACG
5 cpy AFAC
6 cpy Stewart Fld
1 cpy Air Lt 0, Hq 0 SC
322 cpy CG, CGU
426 cpy CG, EPAC
344 cpy CG, EPAC
1 cpy ex Div, this Hq

OFFICIAL:
J. H. MILLIS,
Colonel, A.G.C.,
Adjutant General.
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