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ARMY AIR FORCES HISTORICAL STUDIES No 8

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BOMBSIGHT MAINTENANCE

Training

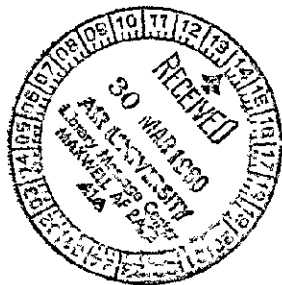
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Army Air Forces Historical Studies: No. 8

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BOEBCIGHT MAINTENANCE TRAINING
IN THE AAF

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

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By Authority of
The Commanding General
Army Air Forces
19 June 44
Date Initials

UNCLASSIFIED FOREWORD

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

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

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



THOMAS D. WHITE
Brigadier General, U. S. Army
Assistant Chief of Air Staff,
Intelligence

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

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CONTENTS

I	BACKGROUND OF BOMBSIGHT MAINTENANCE TRAINING	1
	The Purpose of Bombsights and Automatic Pilots	1
	Types of Bombsights and Automatic Pilots	3
	Levels of Bombsight Maintenance	5
	Selection of Bombsight Maintenance Men	8
	Training before 1939	12
II	THE EXPANSION PROGRAM BEFORE PEARL HARBOR.	17
	Training Enlisted men at Lowry	22
	Training Officers at Lowry	37
	Training Aviation Cadets at Lowry.	37
	Training by the Norden and Sperry Companies.	39
III	THE TRAINING PROGRAM DURING THE WAR.	54
	First and Second Echelon Maintenance Training for Enlisted Men at Lowry	57
	First and Second Echelon Maintenance Training for Aviation Cadets and Officers at Lowry and Yale.	62
	First and Second Echelon Maintenance on A.F.C.E. at Minneapolis-Honeywell and Armament Training Center	65
	Third and Fourth Echelon Maintenance at Armament Training Center and Lowry.	72
	Third and Fourth Echelon Maintenance at Sperry and Norden Factories.	77
	Bombsight Maintenance Training in 1943	82
IV	ADMINISTRATIVE PROBLEMS	86
	Types of Schools and Their Problems	86
	Procurement and Employment of Instructors.	87
	Training Methods	92
	Teaching Equipment.	93
	Training in Automatic Pilots	97
	Bombsights as a Classified Subject	100
	Navy Control over the Norden Sight	104
	BIBLIOGRAPHY	106

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APPENDIX **UNCLASSIFIED**

1. Course of Instruction at Lowry Field after 20 November 1940.	109
2. A.F.C.E. Instruction at Lowry Field, January 1941	110
3. Syllabus of A.F.C.E. Maintenance Course at Minneapolis-Honeywell Regulator Company.	111
4. Course of Instruction in First and Second Echelon Maintenance of A.F.C.E. at Armament Training Center, March 1943.	112
5. Snerry Bombsight Maintenance Course of Instruction at Armament Training Center, March 1943	113
6. Norden Bombsight Maintenance Course of Instruction at Armament Training Center, March 1943	115
GLOSSARY OF ABBREVIATIONS	116
INDEX	117

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Bombsight Maintenance Training in the AAF

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Chapter I

BACKGROUND OF BOMBSIGHT MAINTENANCE TRAINING

The Purpose of Bombsights and Automatic Pilots

If it were possible to send into Germany two hundred gangs of super-saboteurs and these gangs could fire explosive charges at precisely the right spots, the entire war fabric of the Reich would collapse. That is the premise underlying the daylight precision bombing which the United States Army Air Forces was employing in Europe at the time this study was written (early in 1944). Instead of gangs, the AAF used hundreds of giant bombers to dump thousands of tons of high explosives on the vital spots in the enemy's territory. Naturally, if these targets were to be permanently destroyed, the bombs had to be aimed with almost perfect accuracy. It was not enough that they fall in the general vicinity of the target. Successful aiming effected an enormous economy both in the matter of bombs and in the crews and planes that transported them.¹

By the spring of 1944, all the AAF heavy bombers and an increasingly large percentage of its medium bombers were engaged in precision bombing. The alternative type of bombing--so-called "area saturation" bombing in which larger bomb loads are scattered over wider areas during night raids--was still being carried on by the Royal Air Force and a diminishing number of AAF medium bombers.

1. This summary of the theory behind precision bombing is paraphrased from Francis V. Drake, Vertical Warfare, 102, 104.

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Precision bombing would be impossible without two remarkable devices which are interrelated and work together--the precision bombsight and the automatic pilot. To escape the antiaircraft fire of the enemy, a bomber must swerve and shift constantly. To drop a bomb squarely on a target, however, the plane must follow a straight, even course for a period of at least twenty to thirty seconds. The human pilot guides the plane through the evasive action as it approaches and leaves the target; but during the crucial twenty to thirty seconds of the "bombing run" over the target, the automatic pilot keeps the plane on its straight, even course. The bombsight and the automatic pilot working in conjunction enable the bombardier to watch the target, direct the course of the plane toward it, and determine the instant when the bombs are dropped so that they will fall squarely on the target.

The non-precision type of bombsight is a less intricate instrument because the function for which it is designed is a less difficult one. Inasmuch as it is unnecessary for the plane to follow a straight course during non-precision bombing, an automatic pilot need not be used.

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Types of Bombights and Automatic Pilots

Until the autumn of 1943 only two types of precision bombing equipment were used as standard equipment by the AAF: the Norden M-series bombsight with its associated Minneapolis-Honeywell C-1 automatic pilot, and the Sperry S-series bombsight with its associated A-5 automatic pilot.² A conference of a board of officers meeting 15 September 1943 determined that production of the Sperry equipment for the AAF would be discontinued; but as use of this equipment tapered off very gradually, it continued to merit consideration for a considerable period afterward.

The first of the Norden sights, the so-called M-1, came into use by the Air Corps about 1933. The Navy had a contract with Carl L. Norden, Inc., of New York City, for its entire output; but through the Navy Bureau of Ordnance, the Army Air Corps arranged to obtain a small percentage of the firm's output. Various modifications of the Norden sight were adopted in the years that followed: the M-4 and the M-5, used in conjunction with the C-1 automatic pilot, were standard about 1937 and 1938; the M-6 and M-7, models incorporating "automatic erection" features, were produced around 1940; and the M-8 and M-9, abandoning these features, became standard toward the end of 1942. To meet the increased need for these sights, the AAF obtained equipment of the latest Norden model from the Victor Adding

2. Report of conference of a board of officers appointed by the Commanding General, AAF, to consider precision bombsights and their associated automatic pilots, 15 Sept. 1943, in files of Armament Section, AG/AS, Material, Maintenance, and Distribution.

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Machine Company, in addition to its quota from the Norden Company. By December 1943, however, the total number of sights obtained from Victor was only about 100.

About 1937 and 1938 the Norden Company began manufacturing an automatic pilot for use in connection with its N-4 and N-5 sights. The Navy used this equipment only on bombing runs and referred to it as S.B.A.E. (Stabilized Bombing Approach Equipment), a term it classified as "secret." When the Air Corps adopted this equipment, it employed it not only for bombing runs but for general use as an automatic flight control. To avoid the Navy's secrecy restrictions it was called A.F.C.E. (Automatic Flight Control Equipment), and information about it was classified "confidential" and later reclassified "restricted." The most recent model automatic pilot used in connection with the Norden sight is the G-1, made for the AAF by the Minneapolis-Honeywell Company of Minneapolis.

Different in most details, if not in basic principles of operation, are the bombsights and automatic pilots made by the Sperry Gyroscope Company of Brooklyn, New York. The G-4 bombsight, made by this firm, was in general use in the Air Corps from about 1933 to 1936. Later Sperry sights, of which the Air Corps made small use, were the H-1, introduced about 1938, and the O-1, introduced about 1939. The most recent Sperry

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sight, the S-1, was first produced in 1941.

Non-precision bombsights are considerably less complicated than precision bombsights and therefore require far less maintenance. In March 1944 only one type was used by the AAF, the "D" series sight originated about 1930. The most recent model, the "D-8," was developed about 1938; the principal producer was the National Cash Register Company of Dayton, Ohio.³

Levels of Bombsight Maintenance

To keep these ingenious devices in perfect operating condition requires the constant attention of numbers of well-trained men-- bombardiers and armament officers, enlisted and civilian mechanics.

The role of the bombardier in the maintenance of sights and pilots differs from that of the other three groups. In the continental United States and at many air bases in foreign theaters the bombardier must be able to diagnose a malfunction well enough to give intelligent directions and counsel to the mechanic. At air fields in advanced stations there may be no mechanics, and he must be able to perform at least the simplest repairs and adjustments himself. To this end, cadets in training as bombardiers are taught to perform the "trouble-shooting" routine necessary at a fifty-hour inspection.⁴ The individual

3. Conversation of Martin P. Claussen, Historical Division, AC/AS, Intelligence, with I. G. Boehm, Armament Section, AC/AS, I&ED, 8 Dec. 1943.
4. Interview with Maj. E. O. McTeague, Aircrew Training Division, AC/AS, Training, 4 Jan. 1944.

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training of bombardiers has been treated extensively elsewhere.⁵

The work of the three groups of men concerned primarily with maintenance of the bombsights and pilots--armament officers, enlisted and civilian mechanics--is divided by the Air Forces into four levels:

First echelon maintenance of bombsights and automatic pilots is a responsibility of all squadrons equipped with bombardment airplanes. It consists of preflight checks, cleaning, oiling, and replacement of parts.⁶ Normally for each bomber a bombardment squadron has one enlisted man and a bombardier concerned with this work. Closely supervising the work of the enlisted men as part of several duties is an armament officer.⁷ Second echelon maintenance is a responsibility of the air base group. It consists of calibration checks, replacement of unit assemblies and parts, and all other maintenance which can be performed by mechanics with equipment available at the air base. For this purpose the facilities of the armament maintenance base shop are used whenever possible; in the field, the facilities of the semi-trailer instrument shop are utilized.⁸ In each air base group there are customarily four enlisted men qualified to

5. See Individual Training of Bombardiers, prepared in AFIED.
6. AFCC Memo No. 65-5, 13 Oct. 1941.
7. Unsigned letter to Chief of the Air Corps, 27 July 1940, in AAG 357.2-1A, Bombsight Training.
8. AFCC Memo No. 65-5, 13 Oct. 1941.

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perform second echelon maintenance on bombsights; and two enlisted men qualified to perform second echelon maintenance work are attached to each air base. The work of these men, too, is strictly supervised by an armament officer.⁹ Enlisted men qualified by training and experience to perform first and second echelon maintenance are entitled to be rated as Military Occupational Specialists, number 683.¹⁰

Third and fourth echelon maintenance is a responsibility of the depots and sub-depots operated by the Air Service Command. It involves the diagnosis and correction of all trouble, short of the manufacturing of the parts, by highly trained enlisted men and civilian employees working "under general supervision." A depot repairman "balances gyros and sub-assemblies; adjusts optics for parallax; selects and replaces bearings; and replaces, adjusts, and maintains all parts and components" of the equipment. At the end of 1943 the Air Service Command had 162 enlisted men and 289 civilians assigned to it who were capable of performing this type of work, although not all were actively engaged in it.¹¹ Enlisted men qualified by training and experience to perform third and fourth echelon maintenance are entitled to rating as Military Occupational Specialists, number 574.¹²

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- 9. Unsigned letter to Chief of the Air Corps, 27 July 1940, in AAG 353.9-1A, Bombsight Training.
 - 10. AR 615-26, 15 Sept. 1942.
 - 11. CG, Air Service Command to CG, AAF, 8 Feb. 1944, in AFHHD files.
 - 12. AAF Reg. No. 35-46, 11 Dec. 1943.

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Selection of Bombight Maintenance Men

The selection of men for bombight maintenance training has presented the AAF with a number of considerations which do not apply in other categories of technical training. Physical qualifications, however, follow the general technical training pattern. Armament officers have simply to meet the physical standards of all technical officers; enlisted men, those of all ground crew personnel. A single exception exists in the case of color-blindness. Army regulations require that all prospective enlisted students "must be able to correctly interpret at least 75 per cent of the test charts in either the American Optical Company or the Ishihara color vision textbooks."¹³ This requirement was inserted by Headquarters, Army Air Forces in the latter part of 1943 at the request of the school authorities at Lowry Field who found that color-blind students were unable to complete their bombight maintenance course because they were unable to distinguish the different colors of wires in the instrument.¹⁴ Apparently no need has been felt for such a requirement in the case of armament officers.

Because of the delicate and intricate nature of bombights and automatic pilots, exacting mental, mechanical, and experience

13. AAF Reg. No. 50-12, 10 Sept. 1943.
14. Es., Lowry Field to CG, IV Dist., AAF Technical Training Command, 6 March 1943, in AG/13, Training files.

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qualifications are required for training in their maintenance. The type of skill is that possessed by a good watchmaker, and indeed many men who were watchmakers or repairmen in civilian life have served creditably as bombsight mechanics.

Before the start of the expansion program, the only enlisted men who were eligible for maintenance work were those who had had three years of experience in the Army, presumably in that type of work, and who held the rating of qualified aircraft armorer.¹⁵ The latter part of this requirement was sharply criticized by a bombardment officer in June 1940. The maintenance of bombsights and automatic pilots, according to Captain Harold Q. Huglin of the School for Bombardment, Third Wing, General Headquarters Air Force, was entirely unlike any other work performed by the armament section. Most armament equipment was of rugged construction, while bombsights and pilots resembled electrical and similar instruments. Captain Huglin asserted that a bombsight maintenance man ought to have mechanical ability equal or superior to that required for an electrical or instrument specialist. Therefore, qualified airplane mechanics should be eligible for the training.¹⁶

15. C/AC to AC/S, G-2, 29 Dec. 1939, in AAG 353.9-1A, Bombsight Training.
16. Capt. Harold Q. Huglin to CG, 3rd Wing, GHQAF, 1 June 1940, in ibid.

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The criticism found general favor when it was forwarded to the Office of the Chief of Air Corps and led to a general liberalization of requirements. The Training Section recommended that graduates of advanced electrical, instrument, or airplane courses, as well as graduate armorers, be considered eligible for the course. In the event squadrons desired to send men to the course who did not have the above requirements, those provisions might be waived provided the applicant possessed "a satisfactory degree of mental alertness as determined by the Army Alpha and Mathematics tests," possessed mechanical aptitude, and was especially recommended by his commanding officer.¹⁷ With the adoption of the General Classification Test in the summer of 1940, a score of 100 was set as the minimum for acceptance for training in bomb-sight maintenance and 100 the lowest "satisfactory" score for the mechanical aptitude test. Both these scores were considered to be average.¹⁸

The requirement that only men with three years' Army experience be eligible for the course was modified as the Air Corps expanded. By the latter part of 1941, many command and individual air forces could not spare the men to fill the quotas allotted them at the technical schools.¹⁹ The result was that

17. PPR, Training Section, CCAC, to General Jacob T. Dickel, 25 July 1940, in *ibid.*

18. AAF Reg. No. 50-12, 2 Feb. 1942.

19. CG, ACTTC to CCAC, 17 Sept. 1941, in AAG 363.9-1A, Bomb-sight Training.

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men with less than three years' experience--even relatively recent inductees as yet unassigned to any unit--were admitted to bombsight maintenance courses if they had graduated from an armament course and met all other prerequisites.²⁰

The requirements for appointment as a commissioned bombsight or armament officer resembled those for other technical categories: a score of 110 or better on the General Classification Test and demonstrated qualities of leadership. Training in an engineering college or a minimum of two years' experience in industry were considered highly desirable.²¹

The most notable prerequisite for bombsight maintenance training, and the one which gave AAF authorities the thorniest administrative problems, was that dealing with the prospective student's loyalty to the United States. Because bombsights and automatic pilots were long considered classified subjects, the AAF until June 1943 maintained special requirements for persons who used and serviced bombsights and pilots, whether they were officers, enlisted men, or civilian employees. The details of these requirements varied from time to time; and a discussion of them will be postponed until later in the paper, when the

20. Memo of telephone conversation, W. Mitchel and E. R. Baldwin, 18 April 1942, prepared by W. Mitchel for J. S. Canterbury, 20 April 1942, in files, Administrative Management, Bureau of the Budget; P&R, Directorate of Bombardment to Directorate of Individual Training, 8 June 1942, in AG 353.9-1A, Bomb-sight Training.

21. AR 625-5, 26 Nov. 1942.

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ways in which they affected the administration of the training program will be considered.²²

Training before 1936

Before 1936 training in first and second echelon bombsight maintenance for air crew and ground crew personnel, officers and enlisted men alike, was conducted by the tactical units under the GHO Air Force. Occasionally tactical units would send maintenance men to Wright Field, research center maintained by the Office of the Chief of the Air Corps, for informal instruction in third and fourth echelon maintenance. At Chanute Field, the Air Corps' only technical school, some instruction on bombsights was given to officers taking a ten-month maintenance engineering course.

In the spring of 1936 Chanute Field proposed that this type of training be placed upon a more systematic, formal basis through the establishment of a bombsight course in its Department of Armament. Inasmuch as bombsights controlled the dropping of bombs, it appeared logical that their maintenance should be charged to aircraft armors, the ground crew men among whose duties was the care of bombs and bomb racks. On 8 May, 1936 the Chief of the Air Corps authorized the Chanute authorities to initiate such a course.²³ Accordingly, the Chanute Department

22. See Chap. IV.

23. C/AC to CO, Chanute Field, 8 May 1936, in AAG Bombight Training.

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of Armament began instruction in bombsight maintenance the following October.

Owing to the meagerness of the available records dealing with the early days of Chanute Field, as well as the secrecy surrounding all information about bombsights, the initial experiences are shrouded in haziness. Plans called for a course to last eight weeks, with four members in each class. Quotas for the classes were to be distributed among the various tactical units by the Office of the Chief of the Air Corps.²⁴ Beginning with Class No. 4 there were six students to a class, and plans were drawn up to increase the number to eight in later classes.²⁵

In February 1929, sixteen months after its establishment, the bombsight maintenance course was moved, along with the Armament Department, from Chanute Field to recently opened Lowry Field, Colorado. The new site was regarded as a considerable improvement, for a near-by bombing range was available which possessed a high altitude bomb target, three bombproof observation cubicles, a set of circuit targets, and a set of attack targets. The Armament Department felt that these features would facilitate testing the accuracy of the student's work as well as checking the methods of instruction.²⁶ The following July,

24. History, Armament Dept., Lowry Field, Vol. 2, p. 124; statements based chiefly on Annual Report of Armament Department, Lowry Field, 1926-27. All citations to this report refer to Chap. II.

25. *Ibid.*

26. Memo by the Department of Armament, Lowry Field, 6 April 1929, cited in *ibid.*, 124-25.

when instruction on new equipment was incorporated into the curriculum, the course was lengthened from eight to twelve weeks. At the same time the size of each class was increased to twelve students.²⁷

During this early period the standard of instruction was restricted by a number of factors beyond control of the Armament Department. The expected advantages to be derived from the new bombing range were cancelled by the inability of the school authorities to obtain a sufficient number of airplanes for the students' use. The effectiveness of the training was further reduced by the circumstance that all bombs had to be stored and loaded at the Denver Municipal Airport, in an area fairly densely populated by civilians, making it impossible to use anything but ^{practice} bombs during flights. The secrecy which shrouded bombights created a problem which was to perplex school authorities from that time forward. The Army had issued no textbooks on bombight maintenance and repair; for literature on the subject reliance had to be placed on whatever could be begged from the manufacturers and the Chief of the Bureau of Ordnance of the Navy Department.²⁸

From 1936 to 1939 instruction in bombight maintenance for officers followed roughly the same pattern as that for

27. Memo by the Department of Armament, Lowry Field, 15 July 1938, quoting paragraph 51 of the minutes of the Chief of Staff meeting held at Crane Field, 6 June 1938, as cited in ibid., 126.

28. Annual Report, Armament Dept., Lowry Field, 1939-39, in ibid., 125-26.

enlisted men. In June 1936, four months before the Chanute authorities had their enlisted men's course in operation, they began a course for armament officers distinct from the old maintenance engineers' course and lasting for seven months. This change and the transfer of the course to Lowry Field early in 1938 along with all armament activities made it possible to triple the amount of time devoted to bombing instruments. Three classes, one starting in 1936 and two in 1938, spent an average of 135 hours on the subjects. The number of officers trained during these early years, however, was very small. Records for fifteen of the maintenance engineering and armament classes, from April 1938 to December 1938 inclusive, show that a total of 140 officers took the course.²⁹

The establishment of the enlisted men's and officers' courses at Chanute and Lowry, however, did not mean an end to the occasional, semi-informal courses. Tactical units continued to teach first and second echelon maintenance to their bombardiers and mechanics. Wright Field continued to teach third and fourth echelon maintenance from time to time. Toward the end of 1938, for example, the Chief of the Air Corps made arrangements with the Materiel Division and the GEC, Air Force for a special fifteen-day course for thirty officers and thirty

29. History, Armament Dept., Lowry Field, Vol. 2, pp. 82-89.

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enlisted men. Subsequently quotas were granted for three officers and three enlisted men each from Hamilton, March, Langley, and Mitchel fields, and one officer and one enlisted bombsight instructor from Lowry Field. The course began, after a postponement or two, on 15 February 1939.³⁰

30. ECR, No. 3, C/AC to CO, AC Technical School, Chanute Field, 22 Oct. 1938; 1st Ind. (C/AC to Chief, Materiel Division, Wright Field, 22 Oct. 1938), Chief, Materiel Division to C/AC, 5 Nov. 1938, in AAG 355.9-1A, Bombsight Training.

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Chapter II

THE EXPANSION PROGRAM BEFORE PEARL HARBOR

As the rumblings of war abroad grew louder and more menacing during 1938, the Air Corps began drawing up the first of a series of great expansion programs. The "Augmentation Program," as this was called, projected the production of a great many bombardment planes with a corresponding increase in the number of bombsights and personnel to service them. On the basis of the proposed 16 heavy and 21 medium bombardment squadrons, a total of 149 qualified bombsight mechanics would be required under the tables of organization. An additional 16 mechanics would be required for air base squadrons, making a total requirement of 164.¹

In drawing up its plans for the training of additional bombsight mechanics, the Office of the Chief of the Air Corps was handicapped by the fact that its information about the number and present location of men already qualified was extremely meagre. The available records of graduates from the Lowry course were contradictory; the computation of men trained at Wright Field was little better than an intelligent guess; information about training in the various

1. SAC, Plans to Executive, 9 Feb. 1940, in AAG 353.9-1A, Bombsight Training.

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tactical units was fragmentary and confused.² At any rate, it seems clear that in 1939 there were not more than 75 qualified bombight men in the Air Corps.

To meet the shortage, the "Augmentation Program" provided that between March 1939 and June 1940 bombight mechanics were to be graduated from Air Corps technical schools at the rate of 144 per fiscal year, or on an average of twelve a month.³ Responsibility for meeting this quota was placed upon the school at Lowry Field. Less formal training offered through informal classes and "on the job" in tactical units and at air depots continued as before, making available additional trained personnel. As the program progressed, considerable use was made of the facilities of the schools of the Sperry and Norden companies.

During the spring and summer of 1940, before the Air Corps had a chance to complete its training under the "Augmentation Program," the "sitzkrieg" which Germany, Great Britain, and France had been waging came to an abrupt end. Germany overran all western Europe and threatened to invade the British Isles. In the space of a few

2. Statement based upon a comparison of the material in the following: RAR, Plans to Executive, 9 Feb. 1940, in AAG 353.9-1A, Bombight Training; Lt. Col. Roy A. Dunn to Col. Ira Baker, 6 July 1940, in AAG 353.9 A, Denver, Miscellaneous Training; school records of Lowry Field, in History, Armament Department, Lowry Field, Vol. 2, pp. 279-280.

3. Memo for Director of Armament Dept., Lowry Field, by School Secretary, 23 April 1939 in History, Armament Department, Lowry Field, Vol. 2, p. 253; RAR, Plans to Executive, 9 Feb. 1940, in AAG 353.9-1A, Bombight Training.

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that convulsed the United States, Air Corps officials set to work drawing up a new expansion program that was to make the first one look like a pygmy by comparison.

In the course of this planning, Lieutenant Colonel Roy A. Dunn made a study of the status of bombight maintenance men already available to the Army. To date, he reported, Lowry Field had graduated 148 enlisted bombight mechanics, of whom all but four remained in the service. Thirty-two more were undergoing instruction at Lowry on that date--6 July 1940. There were records of seven enlisted graduates of courses at Wright Field. He was able to list only eleven Air Corps civilian employees highly trained in bombight maintenance. Not all of the enlisted men mentioned were still available for maintenance work, as it was the practice of many GHO/units^{AF} to use them as bombardiers.

On the basis of this study, Colonel Dunn recommended a number of policies to be pursued in conducting the second expansion program. Some of these were: (1) In selecting enlisted men for training as bombardiers, only those who had never had maintenance training should be considered eligible. (2) Between August 1940 and October 1941 the average Lowry class should be increased to forty-eight, with the school on a two-shift basis. (3) Continued and increased use should be made of the courses given at the Sperry and Forden factories. Enlisted men should be sent to these schools

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"only when new equipment or maintenance methods warrant it."
Normally, maintenance men and Army instructors would compose the groups sent to these factory courses. (4) Schools should be established at various depots for the training of civilian employees.⁴

There is no record of any official action having been taken upon Colonel Dunn's recommendations, although the spirit of most of them appears to have been carried into effect. Perhaps it was the lack of exact information about the status of qualified bombsight maintenance men, which his study revealed, that led the Plans Division of the Office of the Chief of the Air Corps to recommend that the Enlisted Section of the Personnel Division be directed to compile and keep up to date a record of all bombsight mechanics, showing the date of completion of their training, units to which they were assigned, discharges, reenlistments, and the like. The Chief of the Air Corps approved the suggestion and ordered the Training and Operations Division as well as the Personnel Division to carry it out.⁵

Out of these studies and discussions emerged a plan for increasing the enlisted strength of the Air Corps to 136,000 men--

4. Lt. Col. Ray A. Dunn to Col. Ira Baker, 6 July 1940, in AAG 353.9 A, Denver, Miscellaneous Training.
5. E2R, Plans to Executive, 25 July 1940; Executive to Personnel and EEO, 23 July 1940, in files of AG/AS, Training.

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21

the so-called 136,000-Man Program. That part dealing with bombsight maintenance training called for Lowry to produce 603 mechanics between the latter part of September 1940 and 1 April 1942.⁶ As before, other training was to be performed by factory schools and the schools of tactical units and air depots. A new source of bombsight training was the bombardier schools then being set up.

Training problems during this period were multiplied by changes in types of bombsight equipment used by the Air Corps. More and more tactical units were discontinuing the use of the Sperry O-1 sight in anticipation of a new model, necessitating several revisions of the course at Lowry and elsewhere.⁷

Automatic flight control equipment, employed in connection with the Norden sight, was coming into ever increasing use, with even further reaching consequences. A report prepared by the Experimental Section of the Materiel Division in February 1941 declared that there was a widespread shortage of properly trained A.F.C.E. maintenance men in the Air Corps, and that too few armament officers had had this training. To remedy this situation, more visits should be paid to tactical units by factory representatives; and local schools should be established at as many stations as practicable.⁸

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6. CCAC to Comdt., Chanute Field, 27 Sept. 1940, and flow chart in reference to it, dated 30 Sept. 1940, in History, Armament Dept., Lowry Field, Vol. 2, pp. 12, 13.
 7. See below, Training Enlisted Men at Lowry.
 8. Chief, Experimental Section, Materiel Division to Chief, Materiel Division, 24 April 1941, enclosing report on "Automatic Flight Control Equipment--Bombsights--Training OTI--190, dated 19 Feb. 1941," in Armament Section, Materiel Division, AC/AS, M&D files.

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Training Enlisted Men at Lowry

While the details of the first expansion program were being drawn up, the Lowry authorities had an opportunity to offer suggestions as to how their course might be modified to meet the new conditions. They successfully opposed any move to admit recruits from civil life to the course. They did concede that it was possible greatly to increase their production rate. During the calendar year 1933 the Lowry school had produced 24 bombsight mechanics. Colonel Jacob H. Rudolph, Assistant Commandant, felt that it would be possible to increase this by nearly 200 per cent, or at the rate of 63 a year. This could be accomplished by putting the course on a two-shift basis, training 17 men every three months--9 on one shift, 8 on another. The increase, Colonel Rudolph declared, would require few additional materials other than expendable items for instruction purposes. He did not explore the question as to how many more instructors would be required under this plan.⁹

Such a rate would fall far short of the 223 bombsight mechanics desired by the Office of the Chief of Air Corps by 7 July 1941. Accordingly, the Lowry Field authorities were directed to expand their facilities gradually until they were entering twenty-four students a month--an increase of more than 1100 per cent over their

9. Comdt., Lowry Field to Comdt., Chanute Field, 3 Feb. 1939, in History, Armament Dept., Lowry Field, Vol. 2, p. 127.

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pre-expansion rate.¹⁰ By stretching material, personnel, and school housing facilities, the Lowry school was able nearly to achieve the pace the higher authorities had set for it. By October 1939 the school was entering twelve students a month; beginning November 1940-- although a new expansion program had since superseded the Augmentation Program--it matriculated well over twenty-four students a month.¹¹

This record is the more impressive when one considers the various handicaps created by changes in curriculum, shortages of personnel and equipment, and other difficulties under which the Lowry authorities labored during this period. In late 1939 and early 1940 they not only had to substitute instruction on the new Sperry C-1 sight for that on the Sperry N-1 sight, but added instruction on the new automatic pilots used in connection with Sperry and Warden sights. Although these automatic pilots required considerable explanation, it was felt that the length of the entire course ought not to be extended beyond the twelve-month period already allotted to it. As a consequence, the other subject matter in the curriculum had to be condensed to make room for this new material, and the course as a whole became correspondingly more difficult.¹²

10. Memo by the School Secretary, Lowry Field, to Director, Armament Dept., 25 April 1939, in ibid., 252.

11. Ibid., 280, 281.

12. Ibid., 129.

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In this form, however, the course pleased neither the Lowry officials nor the Air Corps officials in Washington. Both agreed that twelve weeks was too short a period for the amount of material course the/attempted to cover. As the Director of the Lowry Armament Department pointed out, the Navy was devoting four months to instruction on the Norden sight and its associated pilot alone, whereas the Air Corps was giving only twelve weeks of training on the Norden sight and its pilot plus the Sperry sight and its pilot. By comparison with the Navy, the results in the Army Air Forces were admittedly poor.

One possible solution was to train students only on the particular type of sight and pilot they were to be assigned to maintain. The drawback to this, expressed by the Office of the Chief of the Air Corps, was that enlisted personnel were frequently moved from squadron to squadron, and that changes were often made in the equipment used by tactical units. Therefore, the service would be severely handicapped if its personnel were capable of maintaining only one type of equipment. Another solution, which was favored by the Lowry authorities, was to lengthen the course to four months, devoting three months to the Norden sight and pilot equipment, as well as to the mathematical and scientific principles necessary to its understanding, and one month to the Sperry sight and pilot. Admittedly this plan had one shortcoming: it would require one-third

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were time, one-third more space, and three additional instructors.¹³

In forwarding these observations to the Chief of the Air Corps, the Office of the Commandant, Chanute Field, added:

It is believed that instruction on Sperry equipment should be as accurate and as thorough as that given for the Norden Bomb Sight, even though fewer sets of Sperry equipment are available to the Service. It is the experience of the Armament Branch that the Sperry sight is the more difficult of the two types to teach and that instruction is simplified if the course in Sperry follows Norden.¹⁴

Out of these discussions a new curriculum was developed which was put into effect 1 July 1940.¹⁵ The course was lengthened to sixteen weeks; instruction was given on both Norden and Sperry equipment, the latter first. This curriculum is interesting also because it is the earliest for which there is a record:

44 hours	Theory problems
4 "	Camera obscura problems
16 "	Elementary electricity
16 "	Principles of gyroscopes
16 "	Disassembly of M-1 by instructor, and wiring
12 "	Clock, theory and maintenance
12 "	Trainer wiring, theory and practical
16 "	Complete disassembly of M-1 by instructor
24 "	M-Series sight, operation by trainer
33 "	A.F.C.B. classroom work; study of units and their functions
16 "	A.F.C.B. maintenance and inspection of equipment in plane
16 "	A.F.C.B. adjustment in flight
16 "	M-3 disassembly by students
16 "	M-3 maintenance and cleaning

13. Memo for Comdt., Lowry Field, by Director of Armament, 28 Jan. 1940, in ibid., 129, 139; CGAC to Comdt., ACTS, Chanute Field, 16 Jan. 1940, in AAG 383.9-1A, Bomb Sight Training.

14. 1st Ind., Comdt., Chanute Field to C/AC, 30 Jan. 1940, in AAG 383.9-1A, Bomb Sight Training.

15. 2nd Ind., CGAC to Comdt., ACTS, Chanute Field, 16 Feb. 1940, in ibid.

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a day of instruction here than they did during the entire time at Lowry Field. I have to prove to them that about half of what they were taught at Lowry Field is wrong. . . . I don't know who there may be in the Air Corps that could change this condition over-night. . . . Wright and Lowry Field can't tell them because they themselves do not know.¹⁷

The criticism offered by Dixon stung an officer at Berkeley into investigating the subject personally. Colonel Haglin, who as apparent officer of the Fairchild Wing, GHQ Air Force, was in charge of the training of bombardiers and bombight maintenance men at Berkeley, rounded up his twenty-odd Lowry graduates and questioned them. What he learned did not impress him favorably. In the course of the reports to his commanding general, Colonel Haglin drew up a bill of particulars against the Lowry school, objecting to the type of men chosen for the course, the material included in the curriculum, and the spirit in which the instruction was conducted.

A bombight maintenance man, Captain Haglin maintained, should be primarily a careful mechanic. He should possess intelligence, native mechanical ability, and pride in his work. The existing regulations, limiting admission to the course to aircraft graduates, produced men who had no appreciation of the delicacy of the instruments they were to maintain, and as a result they abused them. Much of the Lowry course, he continued, was devoted to mathematics

17. Report, Carl L. Jordan, Inc., to Chief, Materiel Division, 27 May 1940, in ibid.

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16 hours	M-4 maintenance and cleaning
16 "	M-3 calibration by instructor, students observing, taking notes and practicing adjustments
24 "	M-3 calibration by students
24 "	M-4 calibration by students
8 "	M-series summary
6 "	O-1 general study of units and their functions
8 "	O-1 calibration by instructor, students observing and practicing adjustments
32 "	O-1 calibration by students
24 "	O-1 trainer operation
4 "	O-1 installation in airplane
12 "	Flying (day runs)
<u>16</u> "	O-1 summary
640 hours, total	

The exact order in which these subjects were offered varied because the personnel and instruction equipment were limited.¹⁶

During the spring of 1949 considerable criticism of the Lowry course, as well as all Air Corps bombight maintenance training, was made by manufacturers of the sights and by military personnel from tactical units. The target appears to have been set off by the visit of L. A. Dixon, a field representative of the Norden company, to Earlsdale Field, Louisiana, late in May. Dixon undertook to give instruction on his company's equipment to some ninety officers and enlisted men assigned to its operation and maintenance at the field. Some twenty of them were graduates of the Lowry course.

Jords will not describe the conditions existent at this field [Dixon wrote in a frantic report to his employer]. They do not know a thing about the equipment. . . . I have been told by the men that they learned more in half

16. Third Wrecker Ind., School No., Lowry Field, to Comdt., Charnite Field, 2 July 1949, on ^{letter} Comdt. H. G. Englin, Earlsdale Field, to CG, Third Wing, GSCAF, 1 June 1949, in ibid.

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and the theory of bombing, subjects indispensable for bombardiers, but totally unnecessary for men who simply maintained sights. Almost as much time was devoted to Scurry instruments, a type not used by the Third Wing. He estimated that one-half of the time the men had spent at Lowry was wasted as far as their duties at Borndale were concerned. Moreover, the spirit of the instruction was too theoretical. A mechanic, he felt, needed "plenty of practice on the equipment he is expected to maintain." But Lowry graduates arriving at Borndale were "at a loss when put to work." They seemed to be primarily concerned with what happened to a bomb after it left a plane and arguments on the relative merits of the Norden and Scurry sights.¹⁸

A number of varying conclusions were drawn from Captain Haglin's letters as they passed through channels. The Headquarters of the GHQ Air Force declined to back the recommendation that instruction in mathematics and the theory of bombing be omitted from the course. It did assert, however, that the need for qualified mechanics was so great that the length of the course ought to be reduced as much as possible. It seconded Captain Haglin's proposal that students be taught either the Norden instruments or the Scurry instruments, but not both, because three weeks might thereby be

18. Capt. H. Q. Haglin to CG, 3rd Wing, GECAF, 1 June 1940, in ibid.

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sliced off the course. The setting up of separate courses in the two types of instruments would entail additional administrative work, but the gains would make it worth while.¹⁹ The Materiel Division of the Office of the Chief of the Air Corps, on the other hand, concluded that Dixon's findings indicated that far from reducing the length of the course, it should be increased "to at least six months."²⁰

In one respect Captain Euglin's recommendations bore fruit promptly. The Headquarters of the Third Wing, GHQ Air Force, at MacDill, and the Headquarters of the Office of the Chief of the Air Corps agreed that the course should be opened to electrical and instrument specialists as well as radar operators. Final approval was granted on 9 August 1940.²¹

The Army officials concurred in the modification of entrance requirements, but against the other criticisms made by Captain Euglin and Dixon they offered stout defense. It was vital that the portion of the course devoted to mathematics be retained, Lieutenant Clifford M. Reed, Assistant Director of the Army's Department, assured the Army School executive. Although Air Corps

19. 2nd Ind., Ho., GECAF to C/AC, 12 June 1940, in ibid.
20. P&R, Materiel Division to C/AC, 6 June 1940, in ibid.
21. 1st Ind., Ho., 3rd Wing, GECAF to CG, GECAF, Langley Field, 5 June 1940; 2nd Ind., Ho., GECAF, Langley Field to C/AC, 11 June 1940; 3rd Ind., CGAC to Comdt., Chanute, 14 June 1940; 4th Ind., Comdt., Chanute to CGAC, 9 July 1940; P&R, Executive to Inspector, 9 Aug. 1940, in ibid.

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Circular 33-7 stated that ability to handle simple problems in arithmetic and proficiency in fractions, decimals, square root, and ratio and proportion were requisite for admission to the course, great numbers of the men arriving at Lowry had been found to be deficient in them.

Lieutenant Bees was equally opposed to the suggestion that separate Norden and Sperry courses be established. He pointed out that the existing dual-aim curriculum had been adopted at the instance of the Chief of the Air Corps "after mature consideration." Some of the factors behind this decision had been: the frequent movement of enlisted men between units in the Air Corps, the instability of assignment of flying equipment, the expense of sending men from tactical units to Lowry, and the comparatively short time required for training on both types of instruments.²²

Another Lowry officer, Lieutenant William H. Travis, who was in charge of the low-sight maintenance course, offered further rebuttal to the criticism levelled at the school. It was the practice at Lowry to state on the qualification card of each graduate whether his instructors felt that he was competent to work alone or only under supervision. If squadron commanders would pay close attention to these comments when assigning men to duty, he declared,

22. Director, Arsenal Dept. to School Executive, Lowry Field, 1 July 1940, in History of Arsenal Dept., Lowry Field, Vol. 3, p. 137.

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much of the mistrust of equipment Dixon mentioned would be
 stopped. Lieutenant Ervick had a practical suggestion to offer as
 to how calibration and instruction therein might be standardized
 throughout the Air Corps. This called for each bombight manu-
 facturer to issue a step-by-step calibration chart and an operation
 chart for his product. These would be roughly comparable to the
 take-off, landing, and other charts used in airplanes. Such cards
 would not endanger the security status of the bombights and related
 equipment if they were classified as confidential material. Lieut-
 enant Ervick felt that a number of the shorter days which Dixon had
 found in Lowry instruction could be traced to the scarcity of sights.
 The most recent model Norden sight, the M-4, was in general use at
 Barksdale, but as yet only one of them had reached Lowry where it
 had to be used in an airplane most of the time. The consequence
 was that, in the main, Lowry students got only operating--as
 opposed to maintenance--training on this new model.²³

Steps were immediately taken by the Office of the Chief of the
 Air Corps to correct many of the conditions at Lowry pointed out
 in this exchange of letters. Through the Materiel Division and the
 Navy, it arranged that a representative of the Norden firm visit
 Lowry to demonstrate the latest Norden models to all enlisted

²³ SAC, Lt. W. L. Travis, Lowry Field, to Chief, Materiel Division,
 3 June 1940, in files of AC/AS, Training.

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instructors and officers concerned with the boresight course. It recommended that thereafter Lowry be given a high priority for visits by factory representatives, and that new models of equipment be furnished the school as promptly as possible so that one would be available for every six students.

In line with this policy, Ward B. Marvelle of the Norden company spent three days at Lowry in the middle of June 1949. He was distressed to learn that none of the recent Norden models with "automatic erection" features was available--or indeed any information about them. When his complaint was brought to the attention of the Materiel Division, Wright Field replied that "rights of the type desired are not yet available." As a stopgap it forwarded six M-8 sights, which possessed the automatic erection feature. In accompanying correspondence, the Materiel Division requested that, inasmuch as these sights were later to be put into practical use, they should not be assembled and disassembled more than was absolutely necessary for instructional purposes. They added that no data on the installation, operation, or maintenance of this model had been furnished by the manufacturer. They had compiled some data on the subject themselves and were forwarding it to the manufacturer for review. When this was approved, they would publish

CC. CSAG to CSAC, WFO, 4 June 1949, in ibid.

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it as a confidential letter of instruction.²⁰

The surer originally set off by Dixon and Captain Euglin led to one other result--the dispatching of Lowry Field personnel to the schools operated by the eight manufacturers. On hearing Dixon's comments, the Materiel Division proposed that "all Lowry Field instructors should be sent to both the [Norden and Scerry] factories for intensive training" in classes which would be attended also by its own depot personnel.²¹ In line with this suggestion, a short time later an officer and an enlisted man were sent to the Norden factory for a four-month course.²²

As the Lowry school had barely begun operation under the 133,010-Man program, which went into effect in September 1940, before the consequences of the discontinuance of use of the Scerry O-1 night were felt. No instruction was given on that type of instrument after 20 November. With only the Norden model to teach, the course was reduced to twelve weeks and again placed on a single-shift basis. The rate of production of students remained as before,

20. Asst. Comd., Lowry Field to C/AD, 18 June 1940, in AAG 358.9-1A, Worklight Training.

21. Ltr, Materiel Division to R/O, 4 June 1940, in ibid.

22. Asst. Comd., Lowry Field to C/AD, 18 June 1940, with insertments in ibid.; History, Armament Dept., Lowry Field, Vol. 2, p. 140.

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receiving additional equipment, but no additional personnel.²³

Only two weeks were devoted to training in A.F.C.E. maintenance. (See Appendix 1 for the course of instruction.) But about this time reports began to reach the Army officials complaining that their graduates were inadequately prepared to do work on these instruments. The justice of these criticisms was readily admitted by the school authorities. Only superior students, they agreed, could master the material in the time permitted; it would take the average student four weeks to become proficient. To correct this situation, barely 3 weeks after the reduction of the course to 12 weeks, it was increased to 16, the 3 weeks' extension being devoted to further instruction on A.F.C.E.

Under this program the sixth to ninth weeks inclusive were devoted to A.F.C.E. (See Appendix 2 for breakdown of this phase of the course.) During the eighth and ninth weeks twenty-four hours were designated as "flying time." Although the bombardier was not expected to fly in the normal course of his work, this feature was incorporated because it was felt that he would have a keener appreciation of the importance of his work if he had such experience. The school officials desired to make the final flight a sort of examination in which the student would have to show his

23. Memo for the School Executive, Army Field by Asst. Director, Army Field, 12 Nov. 1940, in His Log, Army Field, Army Field, Vol. 2, p. 331.

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~~RESTRICTED~~~~SECURITY INFORMATION~~

35

ability to adjust instruments in the air as well as on the ground. It was impossible to achieve such a goal because of the shortage of airplanes and flying personnel available at Lowry. In actual practice, only one-half of an eight-man class could fly at one time, with the result that only twelve hours were actually spent on the aerial instruction of a student.²⁹ Efforts by Lowry officials to obtain seven additional airplanes to remedy this situation were unwilling.

It was likewise in the belief that maintenance men would profit from some knowledge of the operation of bombsight instruments that a training film intended primarily for bombardiers, TF 1-277, "The Theory of Bombing," was introduced as part of the course on 5 December 1941.³⁰

A number of problems growing out of the rapid increase in the size of the Air Corps began to bother the Lowry officials in the autumn of 1941. It was observed that the majority of men matriculating in the course were recent graduates of the current course. In earlier years there would have been no objection to this; indeed it would have been desired. But with the demand for trained technicians becoming increasingly acute, such a practice concerned a waste of manpower, since few men were now being assigned to duty or

²⁹. Ibid.

³⁰. History, Army Air Dept., Lowry Field, Vol. 2, p. 144.

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both arrangers and bombardier mechanics.³¹ The school recommended steps to end the practice, but there is no record of any having been taken.³²

Yet another manifestation of the Air Corps' growing pains was the increasing numbers of men being sent to Leary without previous experience in being at work in tactical units. Recognizing that their course was too short and limited in scope to turn a novice into an expert, Major G. G. Forrey, the Director of the Armament Department gave an order that thereafter the fact that the man was not fully qualified was to be entered on the certification card of all graduates.³³

As the pace of expansion quickened, more and more tactical units were sent on maneuvers, making it impossible for them to spare their men for training. Soon they began to allow their quotas to go unbroken, and the prospect of a serious shortage of students at Leary loomed as a likely possibility. Captain O. B. Gleason, Supervisor of Instruction at the school, proposed that students be drawn directly from the basic training centers, but this change was resisted by the higher authorities.³⁴ For the time being the school managed to continue close to capacity by allowing

31. Ibid., 147.
32. Ibid., 144.
33. Ibid., 145.
34. Ibid., 145, 143.

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recent graduates of a variety of technical courses--airplane mechanics, electricians, instrument men--to enter on the same basis as aviator graduates.³⁵

Training Officers at Lowry

The technical school at Lowry for a number of years had been training officers in bomb-sight maintenance as part of its course for aviator officers.³⁶ On 23 February 1939, while the Air Corps was setting up its Aviator Program, the Chief of the Air Corps issued an order cancelling all future classes for officers so that the personnel and facilities of the technical schools might be devoted to training much greater numbers of enlisted personnel.³⁷ Lowry Field records indicate that eight officers were graduated from a bomb-sight maintenance course in September 1939 and three the following December.³⁸

Training Aviation Cadets at Lowry

After the issuance of orders to discontinue training of aviator officers, a new problem became increasingly pressing: Where was the Air Corps to obtain the great number of aviator officers required by its expansion program? The view that each bombardment

35. CG, AOTTC to C/AC, 17 Sept. 1941, with 1 to Ind., CCAC to C7, AOTTC, 23 Sept. 1941, in AAG 23.9-1A, Bomb Sight Training.
36. See above, Chro. I.
37. C/AC to AS, 23 Feb. 1939, in Lt. Col. Army, Aviator Program, Lowry Field, Vol. 2, p. 93.
38. Ibid., 271.

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squadron should have an armament officer assigned to it was gaining general acceptance.³⁹ It was undesirable to reverse the order of the Chief of the Air Corps because the demand for officers was now so great that none could be spared for further training. There were considerable numbers of men, however, who had been eliminated from flying schools who, it was believed, could be profitably trained to become armament officers and commissioned second lieutenants. The Chief of Training and Operations of the Office of the Chief of the Air Corps directed the Lowry school authorities to submit an outline for a course of training for such cadets.

In complying with this order in November 1940, Major Lawrence A. Lawson was faced with the question whether to include instruction in bombsight maintenance. It seemed clear that cadets destined for service with bombardment groups ought to receive such instruction, but whether all armament officers should be so trained was debatable. Major Lawson suggested two possible programs. One called for a basic 14-week course, containing no work on bombsights; 25 per cent of the graduates of this course--the men expected to be assigned to bombardment squadrons--would then be given an additional 16 to 19 weeks' training in bombsight maintenance. The second plan proposed that

39. RAR, TMO to Inspector, 18 June 1941, in ibid.

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39

50 per cent of the eliminated credits arriving at Lowry be given a course devoted entirely to bonfire maintenance; no instruction in general aircraft work would be given them.⁴⁰

The first of the programs was adopted. Beginning with a class entering 3 March 1941 and every 4 weeks thereafter, 32 (13 on and after 23 June) aviation cadets began a 14-week course in aircraft; upon completion of it, 8 of the cadets entered on a bonfire maintenance course lasting 13 weeks. In the absence of a syllabus, it is reasonable to assume that the Lowry officials carried out their original intention of using a curriculum for the course that was almost identical with the enlisted men's course, with core added features are the discontinued officers' course.⁴¹

Training by the Norden and Sperry Companies

Soon after the initiation of the Aviation Program, the Office of the Chief of the Air Corps, to supplement the work of its technical school at Lowry, began to make use of the training services of the Norden and Sperry companies. The number of men so trained was not large; but this type of instruction was of great significance because it was offered in every echelon of bonfire maintenance.

40. Asst. Comdt., Lowry Field to Lt. Col. Brock, 20 Nov. 1940, in AAG 333.9A, Denver, Miscellaneous Training; History, Aircraft Dept., Lowry Field, Vol. 2, pp. 95, 96.

41. Comdt., Chanute Field to C/AG, 1 Dec. 1940, in AAG 333.9A, Denver, Miscellaneous Training.

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The two manufacturing companies had long made it a practice to give instruction in the maintenance and repair of their products to the employees of firms buying them. Occasionally, they sent field representatives to their customers' factories; from time to time they invited the customers to send their employees to courses held in their own factories. Nominally, at least, there was no charge for such services.

When the armed services contracted for large quantities of Norden and Sperry products, the two firms began extending these services to the Army and Navy. This development became especially marked after the inauguration of the extension program. When the Sperry company introduced its O-1 bomb sight in 1939, it sent a representative to Langley Field to give instruction in its design, construction, operation, and maintenance to the personnel of the school there.⁴² In the spring of 1940 a Norden representative paid visits to Wright, Langley, and Eggenfeldt fields.⁴³ During his five-day stay at Eggenfeldt, the Norden representative held classes as follows:

- Monday--8 hours on A.F.C.S. for maintenance men and bombardiers
- Tuesday--8 hours on A.F.C.S. for maintenance men and bombardiers
- Wednesday--8 hours on bombights and A.F.C.S. for officers
- Thursday--8 hours show-up on bombights for mechanics
- Friday--8 hours show-up on bombights for mechanics

42. 3rd Ind., Chief, Material Division, Wright Field, to C/AG, 11 Aug. 1939, in AGC 513.9-1A, Bombight Training.

43. Carl L. Norden, Inc., to Chief, Material Division, 27 May 1940, in *ibid.* It was his visit to Eggenfeldt, it will be recalled, that evoked the storm of discussion about the merits of the Langley bombight course.

44. *Ibid.*

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41

More extensive and regular use was made of the factory courses offered by the bombsight firms. Late in 1939 the Materiel Division asked the Sperry Company to offer a course for Air Corps personnel at its Brooklyn plant. It suggested four weeks as a desirable length. On 8 January 1940 the Sperry people not only indicated their willingness, but proposed a number of details. The course should be opened to three types of personnel: (a) civil foremen of depot repair units; (b) military personnel from an air base or shop; and (c) instructors from Air Corps technical schools who were teaching or would be willing to teach bombsight maintenance. This instruction ought to be conducted on two levels: (1) for depot men and air base personnel, the practical aspects of construction, assembly, and overhaul--roughly third and fourth echelon maintenance--should be covered; (2) for instructors, the operation and inspection of the bombsight, field maintenance, and trouble-shooting--roughly first and second echelon maintenance--should be stressed. The Sperry officials were prepared to begin the course the following 15 April. They insisted that four weeks was much too short for such a course; six weeks was an absolute minimum.⁴⁵

The firm's proposals met the approval of the Office of the Chief of the Air Corps. On 19 January it informed the GHO Air Force, Langley Field, and the Commanding Officer, Lowry Field,

45. Sperry Gyroscope Co. to Materiel Division, 8 Jan. 1940, in ibid.

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that they should recommend students to attend a six-week course at the Sperry factory beginning 15 April. Lowry was to provide military personnel from air bases and shops, and Lowry was to assign instructors from his bombight maintenance course.⁴⁶ As initiator of the plan, the Materiel Division was authorized to send civilian personnel from depot repair units.

About the same time, the Air Corps was negotiating with the Norden company for a third and fourth echelon maintenance course at its factory. Here the problem was complicated by the fact that, like the Norden bombight itself, arrangements for instruction in its maintenance had to be handled through the Army Bureau of Ordnance. When approached by the Materiel Division through this devious channel, the Norden people showed themselves an eager to cooperate as the Sperry company. Carl L. Norden, head of the firm, "personally stressed" the "urgent necessity" of training both civilian and military personnel in the maintenance of the bombight manufactured by his company. His recommendations corresponded closely with those offered by the Sperry officials: a course for civilian depot mechanics, enlisted air base personnel, and technical school instructors.⁴⁷ Accordingly, the Office of the Chief of Air Corps arranged with the Lowry for thirteen officers and enlisted men to attend a Norden factory

46. C/AG to CG, GECAP, Langley Field, and to CG, Lowry Field, 19 Jan. 1940, in ibid.
 47. Chief, Field Service Section, Materiel Division, to Chief, Materiel Division, 16 Jan. 1940, in ibid.

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course beginning early in June. This time was selected so that the course might be attended by many of the same men who were to attend the April course at Sperry, since it was felt that Air Corps personnel should be equally familiar with both types of equipment.⁴⁸

The course at the Sperry factory began, as scheduled, on 15 April. In attendance were twenty students--the maximum number the Sperry people felt they could accommodate in the class. These included six civilians (four from combat repair units, one from Wright Field, one from Hawaii); ten enlisted men from Hawaiian air bases; one enlisted instructor from the school at Lowry Field.⁴⁹ On the whole, this class made a creditable record--an average grade of 85. As a group, the fourteen enlisted men did somewhat better than the six civilians, making an average grade of 89.17.⁵⁰ At the conclusion of the course five of the enlisted men were ordered to report to the course starting at the Norden factory a few days later.⁵¹

More difficulty was encountered in the administration of the Norden course. The trouble grew out of the failure of the Air Corps, the Navy, and the company officials, in making arrangements for it, to reach an understanding about its length. When the Field Service

48. SER, Field Service Section to Chief, Engineering Section, 20 Feb. 1940, in ibid.

49. Administrative Executive, OLAG to Sperry Gyroscopic Co., 6 and 13 March 1940; Sperry Gyroscopic Co. to Materiel Division, 23 March 1940, in ibid.

50. Sperry Gyroscopic Co. to Materiel Division, 4 June 1940, in ibid.

51. Secretary of War to CG, Brooklyn Air Base, 12 May 1940, in ibid.

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Section of the Materiel Division had [redacted] [redacted] the idea of a course to the London people, they had mentioned six weeks as the desirable duration. The company officials protested that this was not long enough, that a course so short would only prepare mechanics to destroy the bomb that they were supposed to maintain. Four or five months, they insisted, was an absolute minimum, with nine months the desirable length. The Navy's course consisted of three months at the Gordon Factory, followed by a month of work at the Naval Proving Ground, Dahlgren, Virginia. They suggested that the Air Corps follow a like procedure, with a fourth month spent at an Army school.⁵²

To emphasize the necessity existing in the Air Corps for thorough training, the London company forwarded a report made by one of its field representatives who had recently returned from a visit to Langley Field. "The equipment of the Second Bombardment Group," he reported, "was in very good condition, and the Group had well trained, capable men. The Bombardment Group which was recently transferred to Florida for station had their equipment in a deplorable condition." The condition of the equipment of the other bombardment group at Langley was "fair."⁵³ It was just a few days before this

52. Chief, Navy Bureau of Ordnance to C/AC, 29 April 1940; Ward B. Marvelle of Carl L. Gordon, Inc., to Lt. D. W. Kilpatrick, Arsenal Branch, Wright Field, 21 May 1940, in ibid.
53. Quoted in memo for Chief, Materiel Division by Chief, Experimental Station, Materiel Division, 31 May 1940, in ibid.

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that the same Norden representative reported that "words would not describe the conditions" he found at Parksdale Field.⁵⁴

In spite of this appeal, the Air Corps made no move to lengthen the Norden factory course. The result was that soon after the course began on 5 June a crisis developed. The situation was well described by Technical Sergeant Mack E. Hobbs, on detached service from Barksdale Field, in a report to his superior officer. When the Norden officials learned that the Air Corps was planning to insist on the six-week length, he wrote, "they give up, and now refuse to give us any sort of retine[?] on the grounds that it will be impossible to make bombsight mechanics in that length of time." Sergeant Hobbs himself had become convinced of the correctness of the Norden people's position.

I don't believe I can learn all I'd like to know about bombsights in six weeks [he went on]. Everyone . . . think[?] the same. In fact, the general superintendent told us that about all he hoped to get over in that time was to "leave them alone." Incidentally, they seem to think that our overhaul depots and the school at Lowry are pretty bad, and after seeing the setup here, I'm inclined to agree with them.⁵⁵

This letter apparently stirred the Office of the Chief of the Air Corps to action. A conference was held with representatives of the Navy Department, at

54. Report, Carl L. Norden, Inc. to Chief, Materiel Division, 27 May 1940, in ibid.

55. T/Sgt. M. E. Hobbs to Captain [F. C.] Eurlin, 8 June 1940, in ibid.

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which a decision was reached to lengthen the course to four months. After that, instruction at the Gordon factory followed a more even tenor.⁵³

From this time forward, training at the Gordon factory, like training at the Jersey plant, became a regular feature of the Air Corps technical training program. However, difficulties continued to be encountered in making arrangements. Even while the idea of the Air Corps sending its own men to the Gordon factory was first being discussed, the Navy had indicated that it was willing that the Army establish a continuing program, with alternate classes for the two services.⁵⁷ But it was not until the first Gordon course was three-quarters finished that the Air Corps gave serious consideration to the question of whether there should be separate ones. On 15 September 1940 the Chief of the Air Corps wrote to the Chief of the Navy Bureau of Ordnance requesting that the Air Corps be permitted to send its students to the next Gordon class-- 5 from air units, 3 from tactical units, and one from the school at Torry. He expressed the hope that the class would start "as early as possible."⁵⁸ The Navy, however, was willing to allow the Air Corps an allotment of only ten.⁵⁹ Two officers from tactical units

53. 2nd Ind., C/AC to CS, GHOAF, Los Angeles Field, 9 July 1940, in *ibid.*
57. Chief, Navy Bureau of Ordnance to C/AC, 29 April 1940, in AAS 253.C-1B, Training, General.
58. C/AC to Chief, Navy Bureau of Ordnance, 4 Sept. 1940, in AAS 253.C-1A, General Training.
59. Chief, Navy Bureau of Ordnance to C/AC, 27 Sept. 1940, in *ibid.*

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and eight from air devote were assigned to the class that began on 1 November 1940.⁶⁰

The Sperry school had been in use by the Air Corps only a few months when it became the subject of several complaints and investigations. The first of these came in July 1940 as the result of the visit of Major Edgar T. Selzer, air base training officer at Selfridge Field, to a class in instruments given at the Sperry factory.

I found about twenty men undergoing instruction [as reported]. I was more or less struck with the appearance of lack of interest of those undergoing instruction. I inquired from various students as to what they were at out of the course. Their answers brought out that the instruction was poor, no assistance or advice was given them, and as far as they were concerned, they were just wasting time. . . . I felt certain that those interviewed were competent to express an opinion on the course that they were taking. . . . This was the fifth week of the school, and the men . . . were not getting very far with repair and adjustment procedure due to lack of instruction. The men themselves had a desire to learn, but things seemed to be kept from them, and naturally they were discouraged. . . . As a whole, the school did not impress me at all. The scope of instruction was not in accordance with the Air Corps plan for the school. I feel that the Sperry Company could do better. It sort of gave me an idea that they were just making something out that it was merely 'eye-work.' I could not help but get the impression that the school was for appearances sake. . . .⁶¹

The enlisted men were housed at the Brooklyne Air Base, and according to Major Selzer the conditions there were far from satisfactory

60. IAR, Materiel Division to Personnel, 12 Oct. 1940, in *ibid.*

61. Maj. Edgar T. Selzer to CG, Selfridge Field, 20 July 1940, in *ibid.*

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to them. "The Brooklyn Base, as we know, is a very busy place," he went on; "hence not much attention can be given these men. Nevertheless this does not leave these men in a very good frame of mind."⁸²

The classes which Major Selzer observed, it should be emphasized, dealt with aircraft instruments; there was no course in bombight maintenance in session at the Sperry plant at the time. Nevertheless, it is reasonable to assume that approximately the same conditions prevailed during both the instruments and bombight maintenance courses. At any rate, such a view appears to have been shared by the Office of the Chief of the Air Corps, to whom the letter was referred through channels. The Chief, on 8 August 1949, directed the Commandant of the Air Corps Technical School at Glenn Field to assume responsibility "for the coordination of instructional matter pertaining to technical training, in cooperation with the Air Corps Factory representative at the Sperry factory." He was also to be responsible "for the coordination of instructional matter pertaining to technical training, in cooperation with the Factory Inspector, Bureau of Guidance, Army Department, at the C. L. Brown Factory, and the supervision of Air Corps personnel

82. Ibid.

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outlined to pursue course of instruction at the Women Bombardier School. . . ." The Commandant was ordered to make a report on conditions at each of the schools.⁶³ By this act the Office of the Chief of the Air Corps placed responsibility for the factory schools in the hands of the same officer who administered the bombardier course at Lowry--the Commandant of Chanute Field.

That the criticisms Major Selzer made of the Sperry school were well taken was shown in his report the Chanute Field Commandant made to the Chief of the Air Corps on 23 September 1940. Some of the conditions prevalent at the time of the major's visit, it declared, appeared to have been corrected. Classrooms and laboratories were "adequate." But no schedules of programs of instruction similar to those used in the Air Corps technical schools were followed. The teaching method employed was criticized with particular severity, for it

places the responsibility of success more on the student than on the instructor. . . . [After a 15-minute lecture,] the student was given a text and a place to work and told to proceed. . . . Occasional lectures were given to determine the progress of the student. This type of instruction . . . [places] the responsibility of initiative and thinking on the students . . . is the opposite to that used by the Air Corps technical schools.

Moreover, the teaching staff was inadequate, only one instructor being on full-time duty. The report repeated Major Selzer's charge that the arrangements for quarters and mess were "unsatisfactory."

63. C/AC to Comdt., Chanute Field, 2 Aug. 1940, in ibid.

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The Glanville Commandant's recommendations were fourfold: (1) There ought to be two full-time instructors on duty at Storry. (2) Storry instructors ought to visit Glanville Field to learn the teaching methods practiced by Air Corps Technical Schools. (3) Air Corps technical school methods should be employed at the Storry school. (4) After "completion of the present project," instruction in the subject ought to be given by the Air Corps technical schools.⁶⁴

The report on the Norden school, which the Glanville Commandant submitted at the same time, was enthusiastically favorable. "The class is divided into groups and receives instruction in the factory where parts are being made and various units assembled," this stated. "An instructor is placed with each group during its progress through each phase of instruction. . . . Instruction appears to be of the highest type and invaluable to the Air Corps." The enlisted men taking the course had a "high regard" for the instruction they were receiving. There was high praise, too, in this statement: "The authorities of the C. L. Norden, Inc., and the Factory Inspector, Bureau of Contract, Navy Department . . . cooperate with the students to the fullest extent possible and relations are most ideal."

⁶⁴ Cf. Col. Lt., Glanville Field to C/AG, 28 Sept. 1949, in ibid.

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As far as the housing and messing of enlisted men attending the Forden school were concerned, the report was generally approving. All men were on construction of ration and quarters status, which had proved "very satisfactory." Arrangement might be even better if the men were placed on detached service from their organization while attending the course, and mail be checked directly to them in care of the Factory Inspector of the Navy Bureau of Ordnance stationed at the plant.

A number of the recommendations that the Commandant had underscored his approval of the Forden school: (1) Lieutenant William L. Travis of the Armament Department at Lowry Field should be detailed to attend the next course at Forden. (2) Enlisted instructors in the bomb light maintenance course at Lowry should "be given priority for attendance at the Forden school." (3) "Every effort [should] be made to continue this school until such time as the Air Corps can send sufficient bomb light maintenance personnel."⁶⁵

Further commendation of the Forden course came from Captain Travis a few months later when, in accordance with the Commandant's recommendation, he was detailed to the next class at the school. In writing to the Chief of the Training and Operations Division he declared that, because of the small student capacity of the school and its advanced level of instruction--third and fourth echelon

65. Ibid.

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SECURITY INFORMATION

maintained—greater care should be exercised in the selection of students to go to Mac and the school's willingness to the Air Corps. Only the following types of men, Captain Ervick thought, ought to be detailed to Norden: (1) rated mechanic concerned with bomb overhaul; (2) students who had had previous experience with bombing instruments and A.T.G.S.; (3) experienced officers in charge of the bomb overhaul of bombing instruments and related equipment; and (4) officers in charge and senior enlisted instructors in the Air Corps' bomb-aim maintenance school.⁶⁶ There was, of course, nothing radical in this proposal. Most of its provisions were supposed to be in effect already. Captain Ervick's re-statement of the necessity for it, however, may have tightened its enforcement.

The Sperry and Norden schools were not much help in meeting the demands of the 120,000-man program. During most of the period it was in effect, the Sperry concern was preoccupied with getting its new J-1 bomb-aim and A-5 pilot into production. A number of conversations were held between company officials and Air Corps authorities leading toward the inauguration of a new course starting about July 1941; but as pilots and pilots were not available, plans were scuttled.⁶⁷ During the same period, only a few of Air Corps men received training at the Norden factory. One class

66. Capt. J. E. Ervick to Chief, SAC, 4 Dec. 1940, in ibid.
 67. G/AC to Col. St., Omaha Field, 11 Dec. 1940, 14 Jan. 1941 and 13 April 1941, in ibid.

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to be there on 7 July 1941, a record the following 3 November. World economy officials indicated they would be willing to arrange classes for a group of fifty enlisted men at a time. Training and Operations, however, showed no enthusiasm for the idea, holding that the instruction offered at Iowa was adequate for routine Air Corps needs.⁸⁸ Eventually, the Air Corps contracted itself with an agency with the Navy for half of the costs of each class, or ten men, during 1941. The bulk of the planes were again filled by civilian mechanics from the depots of the Maintenance Command and enlisted personnel from the Air Force Company Command, the successor to the 61st Air Force; as instructors were Air Corps technical schools attended.⁸⁹

88. IIR, Chief, Inspection Division to C/AC, through IIO, 2 July 1941; IIR, IIO, 9 July 1942, in WHD files.

89. Army Bureau of Ordnance to C/AC, 10 April 1941; IIR, IIO to Materiel, 27 Sept. 1941; IIR, Materiel Division to IIO, 13 Oct. 1941, in AID 223.3-1A, Request for Training.

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Chapter III

THE TRAINING PROGRAM DURING THE WAR

When it was set up in September 1940, the 136,000-Man Program was expected to operate until April 1942. But in the early months of 1941 the course of the war in Europe and the continued aggressiveness of Japan in Asia made it increasingly clear that the United States could not escape open participation in the war. To meet the anticipated needs, great new training programs for air crews and ground crews were adopted to go into effect on 3 November 1941. The ground crew program called for the training of technicians at the rate of 100,000 men a year, or twice as many as under the preceding program. The Acceleration of Training Program, as this was called, provided that one per cent of the technicians, or 1,000 a year, should be bombsight mechanics.¹

The schools had barely readjusted their facilities to these requirements when war was forced on the United States on 7 December 1941. Almost overnight the training programs had to be sharply increased again. During 1942, it was planned, 300,000 technicians were to be produced, of whom 1.16 per cent, or 3,480, were to be bombsight mechanics.² This meant nearly 300 graduates

1. History, Amusement Dept., Lowry Field, Vol. 2, p. 16; RSR, AFRTT to Chief, AAF, 1 Dec. 1941, in AAG 353.9-02, Training, General.
 2. C/AC to CG, AAFTTC, 30 Dec. 1941, in ibid.

RESTRICTED 54
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a month—a tremendous goal which the technical schools were not able to meet until November 1942. Even before this goal was attained, supplemental directives raised the production rate

--to 4,160 a year, or an average of almost 350 a month.³

Throughout 1942 the record was one of steady increases until July when an all-time high of 829 men were graduated.⁴

The personnel trained in bombsight maintenance following American entry into the war was of every type—enlisted men, aviation cadets training to be armament officers, armament officers, Navy officers, and civilian employees, women as well as men. More schools were used and a greater variety of training was offered than ever before. At Lowry Field great numbers were trained in first and second echelon maintenance of sights and pilots. A course in the first and second echelon maintenance of the Honeywell C-1 pilot was taught at a school in Minneapolis conducted by the Minneapolis-Honeywell Regulator Co., subsequently in Indianapolis at the Armament Training Center, and later in Denver at Lowry Field. Aviation cadets were taught to supervise first and second echelon maintenance of sights and automatic pilots at Lowry and later at Yale University. Third and fourth

3. CG, AAF to CG, AAFTC, 8 Aug. 1942, in AAG 353.9 D2, Training, General; Report to Inspector General by Technical Training Liaison Section, AFRTT, 1 Oct. 1942, in AFTHD files.

4. Monthly reports on "Training Status of Army Air Forces Personnel: Technical Training," issued by Statistical Control Division, Office of Management Control.

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56

echelon maintenance of sights and pilots was taught at the Armament Training Center, at the factories of the Sperry and Norden companies, and at Lorry. And as in earlier periods, considerable "on-the-job" training was conducted in tactical units by military personnel and by representatives of the manufacturing companies.

In this period, training was probably conducted more efficaciously than before. Now that the country was at war, school officials were able to evaluate more accurately the efficiency of their teaching through the pragmatic test of how well their graduates performed in theaters of combat. Unfortunately the reports reaching the schools were not always consistent. In March 1943, Colonel John B. McGorsick, just back from an inspection trip to Northwest Africa, reported that he found the men there needed "further instruction in field maintenance" of bombsights.⁵ Barely a month later a study based on interviews with officers returning from a number of combat theaters indicated that the maintenance of bombsights was not proving to be as much of a problem in war zones as it was in the training schools, and this in spite of the rougher handling the instruments received overseas.⁶ Late in August, Colonel

5. CG, AAF to CG, AAFTEG, 30 March 1943, in AAG 253 C, Miscellaneous Training.

6. CG, AAF to CG, AAFTEG, 5 May 1943, in AAG 452.26, Bomb Sights.

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Travis, returning from an inspection trip to the Southwest Pacific theater, reported conditions which fall between the two extremes. Maintenance of equipment he found "fairly satisfactory," although the omission of preflight inspection often seriously affected the accuracy of bombing.⁷

First and Second Echelon Maintenance Training for Enlisted Men at Lowry

In less than a week after Pearl Harbor the Lowry school authorities had revised their first and second echelon course for enlisted men to meet the greatly increased demands imposed by the war. This was accomplished by putting the school on a six-day week, two-shift basis, with a new course starting every three weeks. The normal class was increased to 110 members. The length of the course remained twelve weeks.⁸ During 1942 the course was modified further in order to meet the desire of Headquarters, AAF that an average of at least 300 mechanics be trained each month. In August 1942, 459 men entered the school; and every month thereafter with few exceptions, well over 300 men matriculated.⁹

No important changes were made in the curriculum until the summer of 1942. At that time production on the new Sperry S-1 sight and the A-5 automatic pilot was well under way; plans were

7. Memo for AC/AS, Training by Col. W. L. Travis, 27 Aug. 1943, in files of AC/AS, Training.

8. CG, AGTC to Comdt., Lowry Field, 10 Dec. 1941, in AAG 333.11, Lowry.

9. Monthly reports on "Training Status of AAF Personnel: Technical Training."

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ultimately to install them on 50 per cent of all new bombardment planes. To be forewarned for the expected demand, a new twelve-week course covering the Sperry instruments was inaugurated on 20 July.¹⁰ Men reporting to Lowry were divided between the two courses so that in September the ratio of Norden graduates to Sperry was 8 to 2, in December, 7 to 3, in February 1943, 6 to 4, and in March and thereafter, 5 to 5.¹¹

The prospect of wide use of the Sperry sight and the belief that bombardment maintenance schools were now geared at such a high production rate that there might be a surplus by the end of the year caused Headquarters, AAF to make a drastic reversal of policy in the spring of 1943.¹² To avoid "over-specialization," it directed the Technical and Training Command to train every maintenance man to service both types of sights. This could be accomplished if the practical work to be done by the students were greatly increased.¹³

In putting this directive into practice, however, the
and
Training Command/the Lowry officials notified it so that they could provide training for both first and second echelon maintenance men and depot overhaul men. Under this plan, half of

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10. CG, AAFTC to CG, AAF, 25 July 1942, in AAG 353, 11, Lowry Field.
11. CG, AAF (by Col. E. S. Smith, AFRIT) to CG, AAFTC, 2 Sept. 1942, and 1st Ind., Re., AAFTC to CG, AAF, 19 Sept. 1942, in files of AC/AS, Training.
12. RFR, Nos. 1-3 between Military Personnel and AFRIT, 17 Feb. 1943, 27 Feb. 1943, 4 March 1943, in AAG 221, Mechanics, Miscellaneous.
13. CG, AAF to CG, AAFTC, 11 May 1943, in AAG 353, Mechanics.

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every group entering the bombsight school took a Norden first and second echelon course, the other half a Sperry first and second echelon course. At the end of ten weeks the students in both groups were screened. The half of the Norden group which demonstrated particular aptitude was then given eight additional weeks of Norden third and fourth echelon training, becoming qualified Norden depot overhaul men. The half of the Sperry group with unusual aptitude was given eight weeks of advanced Sperry training to qualify them as Sperry depot overhaul men. The remaining half of the Norden group was then given ten weeks of Sperry first and second echelon maintenance training; the remaining half of the Sperry group was given Norden first and second echelon maintenance training, thus producing men qualified in the maintenance of both sights.¹⁴

A scarcely less important modification in the education given Lowry first and second echelon maintenance men was the inauguration of an "on-the-job" training program following their graduation from the course. The need for practical experience before assignment to tactical units had become apparent as early as Nov 1941, when recruits were first admitted to the bombsight maintenance course.¹⁵ For a time, however, the situation did not become serious, as sufficient numbers of experienced personnel

14. CG, AMSTFC to CG, IV ^{Dist} AMSTFC, 31 July 1943, in files of AG/AS, Training.

15. See above, p. 10.

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60

were available to act in supervisory capacities in tactical organizations. But with the shipment of many organizations overseas and the activation of many additional ones, the shortage grew steadily worse.

Early in June 1942 the Directorate of Bombardment in Headquarters, AAF submitted two plans designed to correct the situation. One proposed that the Lowry course be extended four weeks to allow students to work in the bombsight maintenance sections of bombardier schools. Not until the men had ~~time~~ thus proved their ability to perform all the duties normally performed by bombsight maintenance personnel would they be assigned to tactical units. Although the bombardier schools were under the jurisdiction of the Flying Training Command, the men would remain under the supervision of the Technical Training Command until their assignment. The alternate plan looked to the same objectives, but with a different arrangement for supervision of the students during the period of "on-the-job" training. Upon graduation from the course at Lowry, according to this proposal, the men were to be assigned to tactical units. But before assuming duties at their permanent posts, they were to be sent on four weeks' detached service at bombardier schools, during which period they were to be supervised by the Flying Training Command.¹⁶

16. RAR, AFDB to AFRT, 8 June 1942, in AIG 303.9-1A, Bombsight Training.

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The difficulty of deciding who should supervise the students during the "on-the-job" training period and the belief that the shortage of mechanics was not yet acute enough to warrant lengthening of the course consequently deterred Headquarters, AAF from taking any step at the time.¹⁷

As the time went on, the need for "on-the-job" training grew ever greater. This was asserted repeatedly during the next year by responsible AAF authorities. In August 1942, for example, a Board of Officers assembled to review and reorient the technical training program recommended the principle of such an innovation on the ground that "a period of training of one month at such schools will furnish . . . graduates with more practical experience in combinations of equipment than they would ordinarily obtain in six months at the average operational training unit."¹⁸ Again in June 1943 the Assistant Chief of Air Staff, Training submitted a plan to the Technical Training Command calling for a period of eight weeks' "on-the-job" training in bombardier schools. This called for adoption of the plan gradually, over an eighteen-month period, so as to lessen the problem of administration for the Flying Training Command. The Flying Training Command was to supervise the training of the men while

17. RAE, AIRIE to AAFTR, 12 June 1942; AAFTR to AIRIT, 29 June 1942, in ibid.
18. RAE, AIRIE to AAFTR through AAFTR, 25 Sept. 1942, in files of AS/AS, Training.

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62

SECURITY INFORMATION

they were at the bombardier schools.¹⁹

Realization of the long-discussed change was undoubtedly facilitated by the consolidation of the Flying Training Command and the Technical Training Command into the Training Command in July 1943. Beginning early in September 1943 bombardier mechanics, upon their graduation from the Lowry course, were assigned to one of three bombardier schools for eight weeks' practical experience. Upon the satisfactory completion of this period, they were assigned to an air force for detail to a tactical unit.²⁰

First and Second Echelon Maintenance Training for Aviation Cadets and Officers at Lowry and Yale

Under the stress of war the lowbight maintenance course for aviation cadets at Lowry was greatly accelerated. The work previously given in sixteen weeks was given in twelve after 6 January 1941. A new class was entered every four weeks, as previously, but the size was raised from eight to fifteen. As a result, all students were drawn from recent graduates of the present course for aviation cadets.²¹ Early in January 1943, when all technical courses for aviation cadets were moved to Yale University, cadet and instructor personnel were moved from

19. Rough draft of letter, AG/AS, Training to CG, AAFTRC, 7 June 1943, in 1346.
 20. CG, AAF (referred in AG/AS, Training) to CG, AAFTRC, 28 Aug. 1943, in 1357.
 21. CG, AAFTRC to Comdt., Lowry Field, 10 Dec. 1941, in AAG 357.11, Lowry; 1st Ind., M., Lowry Field to CG, AAF, 7 June 1942, in files of AG/AS, Training.

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Denver to New Haven, Connecticut. No important changes in the course of instruction were made at that time.

During the spring of 1943, however, Headquarters, AAF concluded that to facilitate assignment of officers and to conform to recent tables of organization, the category of bombardment maintenance officer should be eliminated. Hereafter, bombardment officers, in addition to their present duties, should be made responsible for both air maintenance as well as maintenance of cover turrets.²² On 31 May Headquarters, AAF ordered the Technical Training Command to lengthen the bombardment course for cadets to include whereas on bombardment maintenance, within the transition as quickly as possible, but, preferably enough to produce an even flow of graduates.²³ Thus the AAF reverted to the policy it had followed before the start of the expansion program of giving its bombardment officers training in all phases of bombardment.

Under the new consolidated program the number of weeks devoted to bombardment maintenance was reduced from six to five. In 160 hours--six hours a day, six days a week--the course covered

Principles of operation and use of the bombardment in conjunction with the automatic pilot and its relationship to flight and operation of the airplane. Maintenance and aerial adjustment of the automatic pilot.

²² Memo for AG/AS, Training by Brig. Gen. P. W. Warner, 31 May 1943, in ibid.
²³ CG, AAF to CG, AAFMG, 31 May 1943, in AAG 303, Bombardment Training.

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Performance of the workload, daily, fifteen-hour, fifteen-day and thirty-hour inspection and maintenance on Morson, Honeywell and Sturry equipment. Security, handling and storage of technical data.⁷⁴

Broken down into sheets, the first sheet was devoted to the theory of "binomial"; the second sheet to Morson workload at V-8; the third sheet to Sturry S-1 workload; the fourth sheet to Honeywell C-1 automatic pilot; and the fifth sheet to Sturry A-1 automatic pilot.⁷⁵

That there was considerable delay in working out the details for the revised course was indicated by Colonel Travis, then of Headquarters, AAF, who visited Yale early in October 1943. He found that project sheets for students and instructors were still in the formative stage. His five-day inspection convinced him, however, that the effectiveness of the teaching in the course was "truly first rate," teaching methods were "unusually excellent," and the students' enthusiasm was "quite high." He noted the usual shortage of supplies.⁷⁶

As new devices and techniques in bombing were developed, the AAF found it necessary to depart more and more frequently from the dicta laid down by the Office of the Chief of the Air Corps in February 1939 that officers no longer be trained in bomb-sight

74. Program of instruction, ES, Yale University, AAFLES, 13 Oct. 1943, in files of AG/AS, Training.
75. Memo for AG/AS, Training by Col. W. L. Travis, 5 Oct. 1943, in ibid.
76. Ibid.

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maintenance at technical schools. As Yale's facilities were devoted exclusively to the training of officers and aviation cadets, it was possible to establish short special courses for officers there on the occasion of... In the summer of 1943, for example, a series of four-week courses was conducted to teach maintenance methods of the Sterry light to officers familiar with Jordan equipment. The officers attending were drawn primarily from the Flying Training Command and the Second Air Force.²⁷

First and Second Echelon Maintenance on A-10's at Minneapolis-Roseville and Army Air Corps Training Center

Instruction on first and second echelon maintenance of the C-1 automatic pilot, can only be referred to as A.F.C.M., and on... nature of the course in Jordan instruments at Lowry Field. But during the period of rapid expansion following Pearl Harbor, the service of many men was required--enlisted personnel and civilians--who could maintain flight control equipment although not necessarily the conception to flight. To meet this need, the AAF made arrangements with the Minneapolis-Roseville Regulator Company, manufacturers of C-1 pilot, to give a course in their maintenance at first and second echelon levels.

The course at Minneapolis-Roseville was established through a letter contract on 27 May 1943, and an Army Air Corps Training

27. CG, AMTTC to HQ, AF, AG/AS, Training (teletype), 6 June 1943; memo for AG/AS, Training by Lt. Col. W. L. Travis, 12 June 1943, in 1510.

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Detachment was organized the following 27 June. Under this and subsequent contracts the company agreed to teach approximately one hundred men at a time up to 30 June 1943 for \$118,000. Consistent instructor personnel, materials, tools, fixtures, and supplies were to be furnished by the company. Students were housed in a dormitory of the University of Minnesota, and instruction was given at the University and the Cold-Chamberlain Airport, Minneapolis.²⁴

The course lasted twenty-eight days and, as of today, consisted of lectures, laboratory work, and observation of equipment during flight. (See Appendix 3 for syllabus followed.) Although the enrollment at Minneapolis-Honeywell was never large--it averaged somewhat less than 100--the student body was considerably more varied in character than that at most technical schools. Army officers and enlisted men, Navy officers, and civilians studied side by side. Considerable numbers of officer instructors and enlisted men from the bombardier schools of the Flight Training Command and first tactical units of the Second and Fourth Air Forces attended under quotas allotted by Headquarters, AAF.²⁵

24. History of AMTCO, Minneapolis-Honeywell Regulator Co., 9, 10, 16.
 25. CG, AAF to CG, AMTCO, 9 May 1943, in AIG 273.9 D, Factory Training; PFR, AMTCO to AFDOP, 10 May 1943, in AAG 270.01 B, Factory Training; PFR, AMTCO to AMTCO, 10 June 1943, in AAG 273.9, Factory Training; CG, AAF to CG, 2nd AF, 10 July 1943, in AAG 270.01 C, Factory Training; CG, II DLT to AMTCO to CG, AMTCO (tele no.), 23 July 1943, in AIG 273.9 I, Factory Training; CG, AAF to CG, AMTCO, 7 Sept. 1943, in AAG 270.01 C, Factory Training; PFR, AMTCO to AMTCO, 30 Sept. 1943, in AIG 273.9 I, Factory Training; CG, AAF to CG, 10 Oct. 30 Sept. 1943; CG, AAF to CG, 2nd AF, 23 Sept. 1943, in AAG 270.01 C, Factory Training.

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The course at Kingsport-Kingswell had been in one way
out a lot better than a number of criticisms on the way it was
being conducted were submitted by Lieutenant Clerk A. Proctor and
Technical Sergeant Bradley J. Bennett, students in the course.
The course, these men complained, was too theoretical; the in-
structors were too few and inexperienced; there was a lamentable
lack of cooperation between the teaching staff and the factory
superiority. The instruction suffered from insufficient teaching
aids; only one oscilloscope and one welder were available to the school.
Sergeant Bennett declared that the course was of "little practical
value." For a long time this man was instructor.³⁰

From the evidence now available, it is clear that these
criticisms were just in most respects, although the fault was
not always the company's. The official syllabus of the course
indicates that a considerable amount of time was spent on theo-
retical matter. The first part of the course was taught by the
lecture system, with one instructor in charge of as many as 25 or
30 men; during the laboratory parts of the course the ratio of
instructors to students varied between 1 to 5 1/2 and 1 to 7.
It was the responsibility of the AF to furnish aircraft to the

30. Comments of Sgt Lt. Clerk A. Proctor and T/Sgt. Bradley
Bennett, attached, attached to 1st Ind., CG, AAFHS to CG,
AFM, 6 Oct. 1957, in AAC 318.9 I, Factory Training.

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school, but no more than three were available at any time, and the condition of these was so poor that they could not always be used.⁸¹

The tension between the Minneapolis-Honeywell people and the AA was increased by the order of the Technical Training Command, issued in October 1947, directing the elimination of all lectures and "theoretical material," extension of the use of laboratory work, and the setting up of a ratio of one instructor to eight students.⁸² The company officials protested the application of this directive to their school, but to no avail. Methods of instruction were modified to conform in most respects.⁸³

Another source of friction between the school authorities and Headquarters, AATC, was the manner in which students were assigned to the courses. After conversations with the company officials, Captain Kenneth E. Moore, commanding officer of the detachment at Minneapolis, submitted a list of striking cases of misassignment. "In 98% of the cases," he summarized, "the men had no electrical experience in civil life. In many cases, too, men who had received extensive technical training in fields not related

81. History of AATC, Minneapolis-Honeywell Regulator Co., 13, 81, 82.
82. For a fuller discussion of this order and its effects on technical maintenance training, see below, p. 92.
83. History of AATC, Minneapolis-Honeywell Regulator Co., 13, 80.

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to A.F.C.S. were assigned to the course.²⁴ Headquarters, Technical Training Command, in a letter to Headquarters, AAF, admitted that this constituted "a waste of technical training."²⁵

In view of the difficulties with the company, Lowry School officials and Headquarters of the Technical Training Command urged Headquarters, AAF to move the A.F.C.S. course to Lowry field and conduct it in conjunction with its London based course. Lowry pointed out that it has been severely handicapped in its instruction on A.F.C.S. by the lack of adequate equipment. If sixteen sets of A.F.C.S. were transferred from Minneapolis-Honeywell to Lowry, this situation could be remedied.²⁶

When the company officials were apprised of the projected transfer, they registered a vigorous protest against what they claim a was an improper wedding between A.F.C.S. equipment and the Norden bomb sight. According to Dr. Ronald Bursten, director of the aeronautical division, the G-1 automatic pilot "has a direct connection with the bomb sight assembly, but it is no more proper to attach it to the Norden equipment than it would be to the Sperry S-1." A.F.C.S. involved electronics, while the bomb sight fell in another category. "Our experience has also shown that

24. Report on Qualification of Selected Minneapolis-Honeywell-Lowry School, by Capt. Kenneth R. Woods, 11 Sept. 1948, in AAG 323.9 I, Factory Training.
25. 1st Ind., CG, AAFTRC to CG, AAF, 19 Sept. 1948, in ibid.
26. 1st Ind., CG, AAFTRC to CG, AAF, 6 Oct. 1948, in ibid.

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The mechanics who repair Norden bombsights are often poor students in electronics. Some of the men trained in Norden equipment who attended our school have failed to do their job in the school work.³⁷ Apparently Dr. Bursten's comment discouraged AAF officials from taking any immediate action.

The question of transferring the school to the Army in December 1944 when officers of the Army Training Command submitted a report criticizing the Minneapolis-Monmouth Company for giving insufficient attention to mechanical maintenance and none at all to bombsights and stabilizers. When informed of the charges, George E. Weston, director of the school, replied that the course had been reorganized so that at least 75 per cent of it dealt with mechanical maintenance. Furthermore, it had been impossible for the school to teach anything about the bombsight and stabilizer because until recently these instruments had been classified as "confidential," and consequently, Minneapolis-Monmouth officials were not supposed to know anything about them. Inasmuch as the classification on these instruments had been lowered to "restricted," it would now be possible to offer some instruction on them. The school had no stabilizers, but felt that drawings and other teaching equipment would serve as a

37. Portland Bursten, Minneapolis-Monmouth Corporation Co., to Col. L. S. Smith, AFHQ, 18 Oct. 1942, in ibid.

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fairly satisfactory substitute. Benton stated that on a recent visit to Lowry Field he had learned that the instruction on the C-1 pilot being given there almost paralleled that which Minneapolis-Moneyball was giving, although Lowry lacked certain instructional materials that the company possessed.³⁸ In spite of the protests of the company officials, Headquarters, AAF accepted the advice of the Technical Training Command and ordered the course transferred from Minneapolis-Moneyball to the Army Air Training Center, Indianapolis, on 5 March 1943.³⁹

During the summer and autumn of 1943 the AAF availed itself of the Minneapolis-Moneyball Company's offer to give a one-week "refresher" course on the C-1 pilot to instructors from AAF schools. The purpose of this was to present information on recent mechanical improvements developed at the plant. Normally, ten men were assigned to a class.⁴⁰

The Army Air Training Center had been conducting A.F.C.I. training on the third and fourth echelon maintenance level for some months under the auspices of the Air Service Command.⁴¹ When

38. George L. Benton, Minneapolis-Moneyball Plant for Co., to Capt. R. E. Guisard, AAFHQ, 11 Feb. 1943, in AAG 222.9, Factory Training.
39. AAFHQ to CG, AAF, 23 March 1943, in ibid.
40. CG, AAFHQ to CG, AAFHQ, 27 Apr. 1943, in AAG 222.9, Factory Training; Technical Training Command Daily Diary, 2 July 1943, in AAFHQ files.
41. See below, Chap. III, Third and Fourth Echelon Maintenance at Army Air Training Center.

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the course was moved to Indianapolis on 3 March, the Technical Training Command assumed control and the course was lowered to the first and second echelon level. The course was six weeks in length, a new class starting every two weeks. Each class had 23 officers--50 enlisted men, graduates of a Technical Training Command airplane mechanics' course, and 8 civilian Air Service Command employees. Occasionally, as at Indianapolis-Knoxville, Army personnel were admitted.⁴² (See Appendix C for course of instruction.)

Third and Fourth Echelon Maintenance at Army Air Training Center and Army

A hybrid school, teaching all levels of maintenance to civilian personnel and enlisted men, and operated at various times under the Air Service Command and the Technical Training Command, was the Army Air Training Center at Indianapolis. This school was established in June 1949 by the Air Service Command to meet its operational needs for trained civilian and military personnel to work in its depots.⁴³ A corner of a World War II, located in the State Fair grounds in Indianapolis, was converted into classrooms, the latest type of ceiling installed, and the assistance

42. 1st Ind., AFASG to Bureau of Aeronautics, 20 May 1948, in AAG 250.23, Technical Schools, Miscellaneous.
 43. Lt. Col. Dallas M. Speer, AFASG to CG, Army Storage Depot, 17 June 1947, in AFED 1100.

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73

of representatives of the Sperry, Norden, and other companies obtained in drawing up courses.⁴⁴ Key men from Air Service Command's depots in all sections of the country were brought in on temporary duty to get the school started and to teach civilians and enlisted men earmarked to be instructors.⁴⁵

When the Training Center was established, it was understood that the Technical Training Command would eventually assume responsibility for its operation. The Air Service Command kept putting off the transfer on the grounds that it desired to put the school in a "smooth-running" condition" first.⁴⁶ One factor in its reluctance to give up control undoubtedly was its desire to continue to send its civilian air depot personnel to the school; according to established policy the Technical Training Command trained only military personnel. The unfavorable comments on the quality of the training at the Center, made by representatives of the Sperry and Norden companies late in 1942, reinforced the claims of the Technical Training Command.⁴⁷ Finally, representatives of the two commands reach^{ed} an agreement that the Technical Training Command's policy would be modified to permit Air Service Command civilian employees to attend courses at the school.

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44. Memo for Col. Davasher by Capt. R. H. Glissmeyer, 5 Dec. 1942, in files of AC/AS, Training; memo for AC/AS, Training by Col. L. O. Ryan, 19 May 1943, in ibid.
45. Chief, Field Services Section, AAFASC to CG, AAFTEC, 15 June 1942, in A7ED files.
46. Ibid.
47. Memos for Col. Davasher by Capt. R. H. Glissmeyer, 5 and 19 Dec. 1942, in files of AC/AS, Training.

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and arrangements were made for the transfer to take place
1 February 1946. Ultimately, it was decided, the training
facilities of the Center were to be moved to another station
of the Technical Training Command so that the Air Service Command
might have additional space for storage and repair work at
Indianapolis.⁴⁵

Three courses in subjects relating to bomb-light were
offered at the Aircraft Training Center: a course in A.T.C.M.
maintenance, for both civilian personnel and enlisted men; a
course in Jerry 8-1 bomb-light maintenance for enlisted men; and
a course in Martin M-series bomb-light maintenance for enlisted
men. All were on third and fourth echelon level, although the
course in A.T.C.M. was subsequently reduced to first and second
echelon level.

The A.T.C.M. course was begun first in August 1946. At the
outset there was a great deal of variation in the size of the
classes and the length of the course of instruction. Some
classes lasted 2 weeks, others 7; some classes had as few as 11
members, others as many as 53; some classes were made up of both
civilian and military personnel, others civilians alone. After

⁴⁵ Memo for Col. Bawchar by Capt. Robert F. Ellis, opm, 19
Dec. 1946; CG, AM to CG, AACTC, 20 Jan. 1947; memo for
Brig. Gen. L. S. Smith by Lt. Col. Paul C. Hutchins,
27 Jan. 1947, in Files of AG/AS, Training.

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the Technical Training Command assumed responsibility for the school, the course was reduced to first and second echelon maintenance level.⁴⁹

The four-year Sperry S-1 aircraft course was inaugurated on 8 March 1943 and a new class was begun every two weeks thereafter. The twelve students in each class were furnished by the Technical Training Command from the graduates of the first or second echelon course at Lowry. (See Appendix B for the course of instruction.)

A four-year course in Norden M-series aircraft was begun on 10 March and every two weeks thereafter. Each class was composed of twelve enlisted men, graduates of the first and second echelon course at Lowry, who were provided by the Technical Training Command. (See Appendix C for the course of instruction.)

The quality of the instruction offered at the Advanced Training Center, an inspector of the office of the Assistant Chief of Air Staff, Irvine reported, was "adequate." Instructors at the school echoed the complaint of their brethren at other technical schools that the students being sent them were not sufficiently well grounded in "fundamentals" to take full advantage of the material being offered them.⁵⁰

49. See above, Chas.III, First and Second Echelon Maintenance on A.T.C.L. at Wrightsville-Honeywell and Advanced Training Center.

50. Memo for AG/AS, Training by Col. L. O. Brown, 19 May 1943, in files of AG/AS, Training.

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The Training Center had been under control of the Technical Training Command for barely six months when plans to discontinue it were drawn up. This was a result of the dissatisfaction of both the Air Service Command and the Technical Training Command with the somewhat hybrid nature of the school. The Air Service Command felt that field maintenance methods peculiar to its needs ought to be stressed in the instruction. The Technical Training Command found it difficult to cope with the confusion over such matters as courses, schedules, and transportation arising from the interest of two commands in the school.⁵¹ To the satisfaction of both the Technical Training Command and the Air Service Command training at the Training Center was discontinued on 1 February 1943, precisely a year after responsibility for the school was assumed by the Technical Training Command. The last group of students was sent to Indianapolis at the end of October 1942; thereafter students requiring instruction in third and fourth echelon maintenance in land, air and pilots were sent to Lowry to attend a newly established course.⁵²

51. CG, ALCASO to CG, AAF, 28 Aug. 1942, in ibid.
 52. CG, AMLIO to CG, AAF, 15 Oct. 1942, in AAF 500, Arrangement
 Admin. Schools; Daily Diary, Technical Training Division,
 19 Oct. 1942, in AAFED files. For
 information about the new course at Lowry, see above,
 Chap. III, First and Second Echelon Maintenance Training;
 for details of it at Lowry.

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Third and Fourth Machine Maintenance at Storry and Gordon Factories

After Pearl Harbor the factory schools of the Storry and Gordon companies taught third and fourth machine maintenance to larger numbers of men than ever before, but responsibility for their administration became divided and correspondingly confused. In May 1942 the Technical Training Command was given jurisdiction over both;⁷³ the following September military personnel attending the two schools were made charges of the AAF Technical Training Detachment located at the Storry factory.⁷⁴ As before, Headquarters, AAF allotted the quotas for both schools.

When the United States formally entered the war, the Storry S-1 aircraft and the A-5 aircraft were just coming into general use. The Air Service Command was anxious that the civilians working at its depots receive training in the overhaul of the new instruments. To meet its demands, Headquarters, AAF arranged with the Storry Company to start two courses at its factory, one in S-1 overhaul, the other in A-5 overhaul. The length of the courses and the size of the classes varied. Some ran as long as 12

73. CG, AAF to CG, AAFHQ, 23 May 1942, in AAG 805.9, Factory Schools.
74. CG, AAF to CG, AAFHQ, 10 Sept. 1942, in AAG 805-200, Miscellaneous.

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...others for as short a period as 8. Some had as many as
...others as few as 5. Most were composed exclusively
of civilians. Occasionally, however, small number of enlisted
...on from the First and Third Air Forces and in-
structors from Lowry Field and the bombardier schools were
....

In November 1945 the Sperry Company inaugurated a new course
exclusively for military personnel. This was a twelve-week course
covering both the 3-1 night and day pilot and intended to prepare
officers to serve as instructors in bombardier schools. About
fifteen were included in each class. Strictly speaking, this
was not on third or fourth echelon maintenance level, although
it was more advanced than the course given at Lowry and, indeed,
was open only to graduates of that course.⁵³

Nevertheless, AAF had some difficulty in administering the
courses at the Gordon Factory. When the United States entered
the war the Gordon course was being conducted in cooperation with

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- 53. CG, AAF to Dean Kelley, Sperry Gyroscope Co., 3 Jan. 1946, in
AAG 352.9, Factory Training; CG, AAF to CG, AAFHQ, 3 May
1946, in AAG 352.9 9, Factory Training; MR, AFIT to AAF HQ,
13 May 1946, in AAG 350.36 3, Statistics; CG, AAFHQ to
CG, AAF, 25 July 1946, in AAG 352.11, Lowry; CG,
AAG to AAF HQ, 12 Sept. 1946, in AAG 352.9 11, Factory
Training; CG, AAF to CG, 5th AF, 1 Oct. 1946, in AAG 357.9 1,
Factory Training.
 - 54. Dean P. Kelley, Sperry Gyroscope Co., to AFIT, 19 Aug. 1945,
in AAG 352.9 4, Factory Training; Col. L. S. Smith to Dean
P. Kelley, Sperry Gyroscope Co., 3 Oct. 1945, in AAG 352.9 1,
Factory Training; CG, AAF to Sperry Co., 3 Nov. 1945, in
AAG 352.9, Factory Training.

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the Navy; ordinarily, only half of the places in a class of ten could be filled with officers and enlisted men of the AAF. Soon after Pearl Harbor, AAF officials approached Navy and Marine officials with proposals that they shorten their course, offer a greater variety of instruction, and allow greater numbers of both military and civilian personnel to attend. The Air Service Command was particularly anxious that additional training become available, as a severe shortage of maintenance men was being felt in its depots.⁵⁷ The Navy officials frowned upon the notion of starting any additional courses, but agreed that beginning with the next class--the one starting 7 March 1942--the course should be reduced to three weeks and the allotment created for the AAF should be doubled to twenty men per class.⁵⁸

Although in theory the Technical Training Command became responsible for the administration of the Florida course about this time,⁵⁹ Headquarters, AAF supervised the allotment of the twenty places in each class. For the class beginning 1 September 1942, for example, allotments were made as follows: 2 instructors

57. C/AS to Chief, Navy Bureau of Ordnance, 7 Feb. 1942, in AAG 233.9 DL, Training General.

58. Memo for C/AS by Chief, Navy Bureau of Ordnance, 18 Feb. 1942, in AAG 233.9 1A, Bombight Training.

59. CG, AAF to CG, AAFSTG, 23 Nov 1942, in AAG 233.9, Factory Schools.

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Area Lowry Field; 4 enlisted men from the First Border Command; 14 enlisted men and civilians from the Air Service Command.⁶⁰ The Alpine Training Command was also awarded visible quotas in the Gordon classes for prospective borderland instructors throughout 1942. Apparently, difficulties were occasionally experienced by the various commands in filling the quotas allotted them, for there was no wide shortage of personnel and the requirement that only graduates of the Lowry first and second echelon courses were eligible was adhered to in almost all instances.⁶¹

Late in 1942, the AAF was averse to disrupting the Lowry to increase the training facilities at the Gordon factory. This time it was stated specifically that a four- to eight-week advanced course for maintenance men and instructors be established, with twenty to thirty men in each class. All students would be graduates of the elementary course at Lowry, and most of them would be used to satisfy the growing needs of the borderland schools for instructors.⁶² But the Bureau of Ordnance of the Army was in no mood to grant such a request. Its inspector at the Gordon plant was complaining that at a time when both the

60. PAR, AFRIT to AAFIC, 19 Apr. 1942, in CHID files; Arnold to Chief, Signal Services Section (Telegraph), AAFIC, 14 May 1942, in ibid.
61. CG, AAFIC to AFRIT, 24 April 1942, in AAF 123.2 G, Factory Training; CG, AAF to CG, AAFIC, 9 May 1942, in ibid.;
PAR, AFRIT to AAFIC, 12 May 1942, in AAF 123.2 G B, Factory.
62. Memo for Chief, Army Bureau of Ordnance by Lieut. Gen. L. S. Smith, AFRIT, 12 Nov. 1942, in CHID files.

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Army and Navy were crying for more instructors, and use of skilled personnel and factory space for instructional purposes, was unwarranted. The difference in the type of training required by the Army and the Navy, the inspector added, imposed a further penalty. The Navy warned the AAF that it shortly intended to close down the Norden school completely.⁸³

The AAF protested that such a move would have a "detrimental effect" upon its personnel, especially the civilians of the Air Service Command, who were in great need of training. The situation was even more undesirable, an arrangement had recently been made for the AAF to receive the major part of Norden production.⁸⁴ When it became clear that the Navy was not likely to alter its position, the AAF proposed that it be permitted to restrict a course of its own at the Norden factory, "subject to the general supervision of the Naval Representative at the Norden factory."⁸⁵ The Navy voiced the objection on the ground that to adopt such an arrangement would continue the interference with Norden production, and insisted that training at the factory must cease about

83. Chief, Navy Bureau of Ordnance to Chief, Field Services Section, NAFASO, 1 Dec. 1942, in AIED files; Chief, Navy Bureau of Ordnance to CG, AAF, 18 Jan. 1943, in AAO 330.9, Factory Training.
84. CG, AAF to Chief, Navy Bureau of Ordnance, 3 Dec. 1942, in ibid.
85. CG, AAF to Chief, Navy Bureau of Ordnance, 16 Jan. 1943, in ibid.

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1 March 1943.⁶⁶ Before arranging for a course to replace that at the Norden factory, Headquarters, AAF, canvassed the commands and air forces to learn the need for this type of training. The Air Service Command declared that sixty of its civilian employees needed such training.⁶⁷ The Flying Training Command indicated that it did not feel that third and fourth echelon maintenance training was necessary for its maintenance men, although it hoped it would continue to be available for civilian personnel working at sub-depots.⁶⁸ Ultimately, the problem was solved by the establishment, early in the spring of 1943, of a Norden third and fourth echelon phase in the course at Lowry.⁶⁹

Bombsight Maintenance Training in 1943

During the calendar year 1943 production of bombsight maintenance mechanics declined sharply. An all-time high was reached during the month of July, when 822 men were graduated in all categories of bombsight maintenance training; during December only 297 were produced.⁷⁰ The reason for this was that the AAF had about attained

66. Chief, Navy Bureau of Ordnance to CG, AAF, 13 Jan. 1943, in ibid.
 67. CG, AAF, to Chief, Navy Bureau of Ordnance, 16 Jan. 1943, in ibid.
 68. 3rd Ind., CG, AAFSTC to CG, AAF, 8 Jan. 1943, in ibid.
 69. See above, Chap. III., First and Second Echelon Maintenance Training for Enlisted Men at Lowry.
 70. Monthly reports on "Training Status of Army Air Forces Personnel: Technical Training."

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23

the limits of its expansion. By and large, only replacements were required. The casualty rate of ground crew personnel such as bombight maintenance men was trifling.

Nevertheless, the training of bombight maintenance men continued to be a problem for the AAF. For one thing, plans drawn up in early 1944 called for the installation of Norden bombsights on all light and medium as well as heavy bombardment aircraft as soon as possible, creating employment for far greater numbers of maintenance men than ever before.⁷¹ For another, as the war progressed, new bombight equipment and methods for its use were developed, requiring major modifications in the courses of instruction. Two of these which had secured considerable importance by the beginning of 1944 were the adoption of the "Slide Bomb" as the standard of the Scarry sight and pilot as standard equipment.

The "Slide Bomb" was an ingenious device used in connection with the Norden sight to control the flight of the bomb after it had left the plane. Following its adoption late in the autumn of 1943, Headquarters, AAF directed the Training Command to incorporate instruction on this equipment in courses for both officers and enlisted men beginning in November.⁷² This necessitated

71. Daily Activity Report, AG/AS, Operations, Commitments, and Escort Units, 14 Feb. 1944, in AITSD files.

72. Daily Diary, Technical Training Division, AG/AS, Training, 12 Nov. 1943, in AITSD files.

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The extension of the first and second echelon courses at Lowry by one year, the third and fourth echelon courses by two years.⁷³ The present course for aviation cadets at Yale was lengthened by one year.⁷⁶

Probably none of the developments of 1943 affected training more profoundly than the recommendation of a board of officers that use of the Sperry sight and pilot be discontinued by the AAF.⁷⁵ It required several months after this for the recommendation to be approved by AAF authorities, and even longer for the effects of the decision to be felt in the training program. In the latter part of 1943, 50 per cent of the enlisted men receiving instruction in basic and intermediate were being taught the Sperry sight.⁷⁶ Orders were issued on 18 January 1944 that the entire class entering Lowry the following day were to receive Gordon training. The course in first and second echelon maintenance was to last sixteen weeks; one-third of the graduates were to continue in a third and fourth echelon maintenance course of

73. Daily Diary, AAFHQ, 21 Dec. 1943, in AFHQ files.
74. Daily Diary, AAFHQ, 31 Dec. 1943, in AFHQ files.
75. Report of an Advisory Board of Officers, initiated by CG, AAF to consider once again basic and their associated automatic pilot, 15 Dec. 1943, in files of Assistant Section, AG/AS, AFHQ.
76. CG, AAFHQ to AG/AS, Training, 20 Dec. 1943, in AAF HQ, Bombardier Training (Subcommittee).

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of instruction. The course for armament officers at Yale
was to be altered less radically: the course was to be
"familiarized" with Sturtevant aircraft and pilots because those in-
struments would continue to be used by core AAF units for a
while. The time saved by reducing the thoroughness of Sturtevant
training was to be added to the period for London instruction.⁷⁷

77. 1st Ind., CG, AAF to CG, AAFHQ, 18 Jan. 1944, in ibid.

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Chapter IV

ADMINISTRATIVE PROBLEMS

Quantitatively, the strides the AAF made in the three and three-quarters years following the inauguration of the expansion programs were tremendous. It was estimated at the start of the expansion period that there were no more than seventy-five qualified bombsight mechanics in the Air Corps.¹ By 31 December 1943 between 7,000 and 7,500 non-enlisted men, officers, and civilian employees of the Air Service Command had received training and were presumably qualified to maintain bombsights.²

Types of Schools and Their Problems

Most of these men were trained in courses run by the Technical Training Command, later the Training Command. The officers, either as aviation cadets or commissioned officers, underwent instruction at the school at Lowry Field and after January 1943, at Yale University; a very few took the courses conducted at the factories of the Sperry and Norden companies. The enlisted men attended courses at Lowry, and in a few cases the manufacturers' factory schools, the Armament Training Center, Indianapolis, and the school of the Minneapolis-Honeywell Regulator Company, Minneapolis. Most of the civilians were trained by their employer, the Air Service Command, at the Armament Training Center. In addition, considerable numbers of enlisted men were given

1. See above, Chap. II.

2. This figure is based upon a letter from Capt. R. H. Spencer to Chief Clerk, Technical Training Division, 14 Aug. 1943, in files of AO/AS, Training, together with monthly reports on "Training Status of Army Air Forces Personnel: Technical Training," for July-December 1943.

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training in less formal ways, with the result that records of their training are largely fugitive. In this group are men who were given "on-the-job" training at the bombsight vaults of the Air Service Command, at the bombardier schools of the old Flying Training Command, and in the tactical units of the various air forces.

Except during the period of greatest expansion, from 1940 through 1942, the general policy of the AAF was to concentrate all bombsight and pilot maintenance training at Lowry Field, under the direction of the Technical Training Command ^{its successor,} and the Training Command. Courses were started at other centers during the three-year period principally because the facilities at Lowry were so overtaxed that they could not accommodate instruction on third and fourth echelon maintenance, for which great demand had appeared. As the production pace slackened, the advanced courses at other centers were moved to Lowry.

The record of the experience of AAF training suggests that this policy of concentration was probably well taken. Instruction at Lowry has always been maintained at a fairly high and uniform standard, while that at other schools varied from excellent to very poor. The brief course of the Armament Training Center was a chaotic one because responsibility for its operation was divided between the Technical Training Command and the Air Service Command. The school conducted by the Minneapolis-Honeywell Regulator Company was admitted to be less than a success by both company and AAF officials; responsibility for this failure appears to lie principally with the AAF, which established the

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school as a temporary expedient and never gave the company all the cooperation it owed it. The schools at the Sperry and Gordon factories were more successful, especially the latter, which achieved a notably fine record. Undoubtedly the AAF could have employed these schools even more profitably if it had adopted a continuing program for their use rather than arranged for only one class at a time. The circumstance that arrangements for classes at the Gordon school had to be made through the Navy was a serious handicap. The AAF did miss an opportunity to avoid much of this when it rejected overtures from the Gordon company to arrange a continuous schedule of classes for the Army's exclusive use in 1941. The fact that neither the Sperry nor Gordon companies accepted payment for the training they gave reduced to some degree the control which the AAF could exert over the subject matter and the way in which it was presented, although officials of both companies apparently went out of their way to cooperate completely. The schools at the factories presented peculiar problems of military administration in respect to rationing, housing, and giving military training to enlisted personnel. The training detachment at the Minneapolis-Honeywell school appears to have operated with better than average efficiency; ^{detach-}ments took care of the needs of the students at both

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89

Sperry and Norden were at best makeshift affairs, with the inevitable indifferent results.

Procurement and Employment of Instructors

In conducting training in bombsight maintenance, as in all technical training, the AAF had to cope with a perennial problem in procuring competent instructors and making the most advantageous use of them. The problem was most pressing in the AAF's own technical schools. The experience of the Lowry school was characteristic. Soon after the inauguration of the expansion program, a shortage in qualified instructors resulted. Instructors were required to teach long hours, and were denied such privileges as passes and furloughs. By May 1940 their morale had slumped so low that Lieutenant Travis, in charge of the course, recommended that they all be given the rating of staff sergeant.³ Apparently no action was taken on his request. The morale situation was gradually improved as the most proficient men passing through the school were retained to augment the instructor corps.

After America's entrance into the war, the instructor problem became increasingly acute. Ever greater numbers of instructors were called into tactical units and sent to combat areas. Between 1 July 1942 and 12 January 1943, for example, eighty-three Lowry instructors left for assignments overseas to attend

3. Armament Dept. Memo, 15 May 1940, in History, Armament Dept., Lowry Field, Vol. 2, pp. 132, 133.

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90

officer candidate and technical officers schools. During this same period the student body increased almost 300 per cent, the ratio of instructors to students was raised to one to five, and material on the new Sperry sight was added to the course.

To meet the instructor shortage, Lowry authorities had to depend for the most part upon limited-service men and men over forty--recent recruits from civilian life. Although these men were intelligent and eager, virtually none had any practical experience in the maintenance of bombsights. Moreover, in spite of a liberal use of these only partially satisfactory men, the growing student body created a shortage of fifty instructors by the middle of January 1943. It was estimated that the school could use an additional twenty-five every month to the end of 1943. The authorities were especially eager to obtain as replacements men who through service overseas had been rendered unfit for any but limited service. Headquarters, AAF declined to grant blanket authority for the retention of large groups of students as instructors, but granted the school's request for specific numbers each month. The idea of using limited-service personnel returning from overseas harmonized with established Headquarters policy, but in practice very few men of this type were made available to the school.⁴

4. 1st Ind., En., AAFTCO to CG, AAF, 19 Sept. 1942, in files of AC/AS, Training; CO, Lowry Field to CG, IV District, AAFTCO, 12 Jan. 1943, with ind. in AAG 220.31, Lowry Field; CG, IV District, AAFTCO to CG, AAFTCO, 23 Jan. 1943, with ind. in AAG 220.63, Technical Schools, Miscellaneous; memo for AC/AS, Program Planning by Brig. Gen. L. S. Smith, 4 March 1943, in files of AC/AS, Training.

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Like other schools of the Technical Training Command, Lowry made an effort to use civilian instructors during late 1942 and early 1943. A few of the sixty-six engaged by the Lowry Armament Department were assigned to teach bombsight maintenance. The school authorities did not consider them a great success, pointing out to the higher authorities that the comparatively low wages offered and the transportation difficulties involved in reaching the school discouraged the most suitable type of civilians from applying for teaching positions.⁵

As time went on, the tendency to replace the more experienced enlisted instructors with graduates of the school produced a serious problem at a school like Lowry. Men were teaching first to fourth echelon maintenance who had never had any practical experience in tactical units; there was no longer a single instructor who was a qualified bombardier. In August 1943 the school authorities asked the Headquarters of the Training Command whether some sort of "on-the-job" training, similar to that being given to their graduates at the bombardier schools, might not be made available to their teaching staff. Apparently approval was never granted by Headquarters, AAF.⁶

5. CG, IV District, AAFTC to CG, AAFTC, 23 Jan. 1943, in AAG 290.63, Technical Schools, Miscellaneous.
 6. 2nd Ind., Det. Hq., AAFTC, Knollwood Field, to CG, AAFTC, 3 Aug. 1943, in files of AC/AS, Training.

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Like all other types of training conducted by the Technical Training Command, that in bombsight maintenance was seriously affected by the instructional methods prescribed by Major General Walter R. Weaver, Commanding General of the Technical Training Command, in the autumn of 1942. A series of inspections of the technical schools convinced General Weaver that too much time was being spent on theory, lectures, and written examinations. Late in October he issued a directive ordering that lectures and written examinations be abolished; that the practice of having students sketch parts of the equipment being studied be discontinued; and that emphasis be placed on laboratory work, with the students becoming familiar with the equipment through handling it.⁷

Evidence of the effect of this directive on bombsight training is neither complete nor convincing. The most elaborate protest came from the Minneapolis-Honeywell Regulator Company which was giving instruction on A.F.C.F. at the time. George B. Benton, director of the school, argued that certain fundamental theoretical material--which had to be given to the ill-prepared students being sent to the school--could be just as effectively presented to groups of 25 or 30 men as to the groups of 6 to 8 ordered by the October directive.⁸ "Resentment among the civilian

7. History of AASTD, Minneapolis-Honeywell Regulator Co., 18.

8. George B. Benton to Capt. Kenneth R. Moses, 13 Nov. 1942, cited in ibid., 19, 20.

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93

instructors" at the Indianapolis Armament Training Center against the new teaching principles was reported by Colonel L. O. Ryan of Headquarters, AAF after an inspection trip in May 1943.⁹ Colonel Travis of Headquarters, AAF found that the "proficiency of the training was very low" on a visit to Lowry the following September.¹⁰ There is reason to believe that the new teaching methods met similar opposition at Lowry, Yale, and other AAF bombsight maintenance schools. At any rate, when the Technical Training Command was absorbed into the new Training Command in July 1943, all pretense of enforcing them was abandoned. But as Colonel Travis' comment indicates, the effects of the October order lingered on for some time afterwards.

Teaching Equipment

Bombsight maintenance training was handicapped by the inadequate number of instruments available to the schools. The records are sparse, but the pattern they suggest is a familiar one. In the autumn of 1939 the commanding officer of Lowry was complaining that although the Sperry O-1 sight was the standard, his school was having to give instruction on the older H-1 for want of any of the latest type sights.¹¹ Early in 1941 the course had to be "modified" for six weeks because of

9. Memo for AC/AS, Training, by Col. L. O. Ryan, 19 May 1943, in files of AC/AS, Training.

10. Memo for AC/AS, Training by Col. W. L. Travis, 9 Sept. 1943, in *ibid.*

11. 3rd Wrapper Ind., CO, Lowry Field to CO, Chanute Field, 5 Sept. 1939, in AAG 353.9-1A, Bombsight Training.

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94

the lack of bombsights and other instructional equipment.¹² Again, late in 1942, conflict arose between the authorities at the factory school and at Lowry over a supply of Minneapolis-Honeywell automatic pilots.¹³ Apparently the shortage of bombsights handicapped the bombardier schools even more than it did the technical schools, for a number of the former complained during 1943 that they were having to curtail the "on-the-job" training they were accustomed to give their maintenance men.¹⁴

The scarcity of other teaching tools was a scarcely less troublesome handicap. This was the result of the circumstances that bombing instruments and all information about them were classified, and that the AAF had to obtain its Norden sights through the Navy. For a number of years the Army issued brief guides to the operation of the Sperry sight, but published none on the Norden, contenting itself with a cautious distribution of the Navy's Ordnance pamphlets Numbers 611 and 630. Ordinarily students were given access to these pamphlets only while in the classroom. Check lists and charts were issued in small quantities and were scarce around technical schools.¹⁵

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12. 1st Ind., School Eq., Lowry Field to Materiel Division, Wright Field, 15 Jan. 1941, in AAG 353.9 A, Denver, Miscellaneous Training.
13. CG, AAFTRC to CG, AAF, 17 Nov. 1942, in AAG 452.19, Auto Pilots.
14. CO, AAF Bombardier School, Midland, Texas, to CG, AAFASC, 7 May 1943, in AAG 452.26, Bomb Sights; RFR, AC/AS, ITRD to AC/AS Training, 9 July 1943, in *ibid*; Report on Inspection of AAFTRC Schools by Col. T. S. Power, Air Inspector, 19 July 1943, in AFIND files.
15. History of Armament Dept., Lowry Field, Vol. 2, p. 125; RFR, Materiel Division to T&O, 1 April 1941, in AFIND files.

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Complaints against this situation were raised by the Inspector General of the AAF on a visit to Lowry during March 1941. He felt that the "confidential" label put on A.F.C.E. had been used by the school as an excuse to avoid instruction on flight and adjustment. The only manual being used on the subject was Ordnance Pamphlet No. 350, nearly four years old, which was "outdated and inadequate." The Lowry officials acknowledged the justice of some of these criticisms, but protested they were doing their best to correct them.¹⁶ To correct some of the shortcomings, they suggested that a graduate of the course be permitted to take the notebook he kept as a student back with him to his home organization. If a student knew during the course that he would be permitted to retain his notebook, they argued, he would give more attention to its compilation, thus increasing the amount of benefit he derived from the instruction. Under existing conditions, a bombardier maintenance graduate had nothing to which he could refer for figures as to desired tolerances, spring tensions, and other necessary adjustments. Unwilling to rely on his memory, he hesitated to make the necessary changes in the equipment. Such

16. C/AG to CG, ACTEC, 31 March 1941, and indorsements in AAG 353.9-1A, Bombardier Training.

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96

conduct led officers of tactical units to charge that the schools were giving their students inadequate training.¹⁷ The proposal was vetoed by the Office of the Chief of the Air Corps on the ground that literature on the sights was in preparation and would eventually be given adequate distribution.¹⁸ The situation did improve somewhat toward the end of 1941 and throughout 1942 as the literature was gradually made available. The training film, "Theory of Bombing," was added to the Lowry course just before Pearl Harbor, and subsequently became available to the other schools. Only inferentially was there any consideration of the work of bombsights; in its nineteen minutes' running time it described the theory of falling bodies and its application to practical bombing. The velocity of closing on moving targets, the effects of head, cross, and tail winds, and the establishment of collision courses were analyzed and explained.¹⁹

It was not until December 1943 that any training films on the bombsights themselves were issued. At this time a series of ten well-produced films--five on the operation of the Norden sight, five on the Sperry sight--were made available by the Army Air Forces Training Film Laboratory at Wright Field. These were designed primarily for the training of bombardiers, with emphasis

17. Lt. Col. Farly W. Duncan, Asst. Comdt., Lowry Field, to C/AC, 11 March 1941, in AFTHD files.

18. R.R. Heberich Division to E.O., 1 April 1941, in AFTHD files.

19. Air Service Command, Army Air Forces Training Film and Film Strip Catalog, Feb. 1943, p. 5.

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placed upon the operation, rather than the maintenance of the sight. Nevertheless, as was true in flying experience, the information presented gave the bombsight maintenance man a better understanding of the nature and significance of his work. ²⁰ Beginning early in 1943 the technical schools made extensive and effective use of such pedagogical devices as "mock-ups" and "breadboards." The introduction of these into the classroom increased the laboratory nature of the teaching.

Training in Automatic Pilots

Training in the maintenance of automatic pilots became a peculiar administrative problem around 1940 and 1941. It grew out of two facts: (1) The Sperry A-1, A-2, A-3, and A-4 pilots, which were not connected with a bombsight, had been regarded by the Air Corps as aircraft instruments and their maintenance attended to by instrument mechanics. The Sperry A-5 pilot and the Minneapolis-Honeywell C-1 pilot, on the other hand, were

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- 20. The films are as follows: TF 1-871, Norden Bombsight Principles; TF 1-872, Norden Operation; TF 1-873, Norden Preflight Inspection; TF 1-874, Norden: Conduct of a Mission; TF 1-875, Norden Levelling System; TF 1-832, Theory of S-1 Bombsight; TF 1-833, S-1 Azimuth; TF 1-834, S-1 Operation; TF 1-835, S-1 Preflight Inspection; TF 1-836, S-1 Conduct of a Mission.

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98

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customarily--although not necessarily--used in connection with a bombight. (2) The construction of the pilot was extremely delicate. These facts posed two questions for the Air Corps: Should the pilots be maintained by instrument or bombight maintenance men? Should training in these subjects be given in instrument schools or in a bombight maintenance course?

At the outset, a compromise arrangement was effected. In squadrons which used the A-5 pilot without bombights, responsibility for the maintenance of the pilot was to rest upon instrument mechanics. In squadrons where the pilots were used with bombights, they were to be tended by armorers, or more ideally, bombight maintenance men. Therefore, training in pilots was to be offered both as part of the instrument course at Chanute Field and as part of the bombight maintenance course at Lowry Field.²¹

As the C-1 pilot came into general use throughout the Air Corps, instruction on it was offered at Lowry, Yale, and the Army Air Training Center and for a time at the Minneapolis-Honeywell School. A suggestion made by the Technical Training Command in April 1943 that Chanute set up a four-week course in this pilot for graduates of its instrument course was vetoed by Headquarters, AAF on the grounds that the C-1 was too intimately

21. Comdt., Chanute Field to C/AC, 23 Dec. 1940, and indorsements, in AAG 333,9-11, Bombight Training.

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connected with the bombight to be a concern of instrument mechanics.²² A minority opinion of a sort was offered by the the Office of the Material Division of/Assistant Chief of Air Staff, Material, Maintenance, and Distribution, which insisted a few months later that the mechanics of the pilots and bombights were considerably different and "experience has indicated that a good pilot mechanic does not necessarily do a good job on a bombight mechanic."²³ The situation was muddled further by a directive that the Assistant Chief of Air Staff, Training sent to the Training Command in October 1943 authorizing organizations using C-1 and A-5 pilots without bombights to send instrument mechanics to "the bombight mechanics course covering the automatic pilot."²⁴

The diversity of opinion prevailing at Headquarters, AAF produced confusion in the air forces and commands. In the Flying Training Command and the Second Air Force, graduates of Chanute's airplane and engine mechanics' course and the

22. CG, AAFMTC to AC/AS, Training, 29 April 1943, with indorsements in AAG 452.19, Auto Pilots.
 23. ROR, No. 2, AC/AS, MWD to AC/AS, Training, 25 May 1943, in AAG 452.23, Bomb Sights.
 24. Daily Diary, Technical Training Division, 27 Oct. 1943, in AFMWD files.

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Advanced Training Center's C-1 pilot course were classified as bombsight maintenance men during the summer of 1943 until the situation was brought to the attention of Headquarters, AAF and directives to correct it were issued.²⁵

Bombsights as a Classified Subject

The fact that bombsights were long a classified subject provided Air Corps officials with an extremely difficult administrative problem. In order to check on the loyalty of every prospective student in bombsight maintenance, a rule in effect in 1939 provided that he must "be a citizen of the United States of unquestioned loyalty, trustworthiness and reliability" who had served in the Army for at least three years. The statement of the commanding officer of the post at which the soldier was stationed that he fulfilled this requirement was deemed sufficient proof.²⁶

The revelation in July 1941 that a cadet bombsight instructor had a felonious record so disturbed the Air Corps' Legal Division that it demanded immediate stiffening of the requirements.²⁷ The Chief of the Air Corps responded with a new AAF Regulation No. 35-13 specifying that no person would be trained as a bombardier or bombsight maintenance man until his application, together with a set of his fingerprints, had been submitted to

25. CG, AAF to CG, AAFHQ, 29 July 1943, in AAG 352, Mechanics; CG, AAF to CG, 2nd AF, 10 Aug. 1943, in AAG 221, Mechanics, Miscellaneous.

26. Memo for AC/S, G-3 by C/AC, 29 Dec. 1939, in AAG 363.9-1A, Bombsight Training.

27. AAF Form 1, 10 Dec. 1941, in AAG 363.9-1A, Bombsight Training.

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his office and approved. It was understood that the Chief of the Air Corps would have Military Intelligence check the candidate's record and fingerprints with the Federal Bureau of Investigation before granting this approval.²⁸ Civilian personnel sent to schools had to be cleared by the Federal Bureau of Investigation.²⁹

In practice, this investigation of loyalty qualifications took a long time--so long that it became customary to wink at the letter of the regulation and allow students to start the course while their records were still under investigation. It was a common occurrence at the Lowry school for men to be permitted to reach the last two weeks of the course before being cleared. In one instance a student was removed when an unfavorable report was received the day before his graduation.³⁰

Various offices of Headquarters, AAF had suggestions as to how this situation might be remedied. The Assistant Chief of Air Staff, A-1 suggested in February 1942 that AAF Regulation No. 35-13 be rewritten to prescribe an "adequate period" for investigation of the prospective student's loyalty qualifications, while "experienced soldiers" should be excused from the investigation.³¹ The latter part of this proposal evoked

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28. Memo for AG by Chief of Air Staff (written at the direction of the Secretary of War), 21 July 1941; Acting AC/S, G-2 to Chief, AAF, 1 Aug. 1941, in *ibid.* (telegram).
29. Arnold to Chief, Field Services Section, AAFASC/ 14 May 1942, in AFHD files.
30. Statement of Lt. Col. Charles E. Listner of IV District, AAFHQ, in Minutes of the District Commander's Conference at Ft., AAFHQ, 5-6 Aug. 1942, in files of AC/AS, Training.
31. FAR, AC/AS, A-1 to AC/AS, A-3, 24 Feb. 1942, in files of AC/AS, Training.

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expressions of hearty dissent from the Assistant Chief of Air Staff, A-3 and from the Director of Bombardment.

Colonel L. S. Smith, Director of Individual Training, had an even more radical suggestion. Because of our losses of heavy bombardment aircraft, he believed it was reasonable to assume that some bombsights had fallen into enemy hands. Thus, he thought, there was no longer any more need for investigating the loyalty of men who maintained and operated bombsights than there was for investigating the loyalty of men who maintained and operated the planes. He believed that the regulations should be rewritten so that "no delay whatever will ensue due to investigation of loyalty, that investigation proceed and that individuals suspected of disloyalty as the result of investigation be relieved of all duties concerned with maintenance of equipment wherever sabotage could affect the war effort."³²

AAF authorities were not yet ready to accept a suggestion so novel as Colonel Smith's. The revision of AAF Regulation No. 25-13 issued in April 1942 continued to require that an investigation be made into a prospective student's loyalty, but prescribed a procedure designed to eliminate some of the delay caused by the existing manner of investigations. "A request for

32. RFR, L.S.S. [Col. L. S. Smith, AFFIT] to APPDB, 17 March 1942, in files of AC/AS, Training.

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103

fingerprint investigation of an individual . . . will be submitted by his organization commander direct to the Federal Bureau of Investigation at least four weeks prior to the opening of the course of training to be pursued," this regulation stated. "A request for investigation will be accompanied by a completely executed copy of the candidate's fingerprint impressions on a standard United States Army Personal Identification fingerprint card together with the organization commander's certificate that the candidate" possessed other loyalty and eligibility qualifications.

The Federal Bureau of Investigation will notify the organization commander direct concerning the candidate's fingerprint investigation. Notation thereof will be entered on the candidate's service record under 'Remarks Administrative,' and the notification will be filed with the service record. An individual suspected of disloyalty as a result of investigation will immediately be relieved of all duties wherein subversive activity could offset the war effort.³³

A few more months of struggle to administer this regulation convinced the War Department of the validity of the point of view expressed by Colonel Smith. Increasing numbers of bombsights were falling into the hands of the enemy, it was realized; meanwhile the attempt to enforce the loyalty requirements was interfering more and more with the administration of the training program. Finally, on 13 November 1942 the Secretary of War directed that the commanding generals of the various air forces and commands would immediately cease to forward the prospective students' fingerprints to the Commanding General, AAF.³⁴ Early in 1943 the classification of

33. AAF Reg. No. 35-13, April 1942.

34. Secretary of War to CG's, Defense Commands, Depots, and Service Commands, in files of AC/AS, Training.

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bombsights and literature relating to them was lowered to "restricted."³⁵
In June all references to a fingerprint investigation were removed
from AAF Regulation No. 35-13.³⁶

Navy Control over the Norden Sight

The circumstance that the Navy had had the foresight years before to obtain exclusive control over the production of the Norden bombsight created a number of administrative problems. Some of these have already been mentioned: The sights used in AAF schools were obtained only after long negotiation with the Bureau of Ordnance of the Navy. Almost all literature about these instruments originated with the Navy. The valuable training offered at the Norden factory school was granted the AAF by the Navy on a quota basis.

Yet in an even more serious way the Navy's control of the Norden sight affected the conduct of training. To avoid dependence upon the Navy, the AAF persisted in using the Sperry S-1 sight long after its mechanical inferiority had become apparent. This in turn led the AAF, between 1939 and the start of 1944, to waste approximately one-half of its training in teaching personnel the maintenance of a type of sight which had virtually no combat use during World War II.

35. CG, AAF to CG, AAFASG, 3 June 1943, in AAG 45-26, Bomb Sights.
36. AAF Reg. No. 35-13, 20 June 1943.

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In administering the training of bombsight maintenance men during World War II, the Army Air Forces encountered a host of problems made none the less difficult because the instrument it dealt with was a novel one in the history of warfare. The problems common to all technical training were handled in pretty much the same fashion with pretty much the same degree of success that prevailed in other fields of technical training. The problems peculiar to the bombsight itself were met as they arose rather than through the employment of planning and foresight. Judged by the numbers of men trained and their performance in combat, however, the program was successful even beyond the hopes of most AF optimists.

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- Air Force Combat Command Memorandum No. 65-5, 13 October 1941

Headquarters, Air Service Command:

- Army Air Forces Training Film and Film Strip Catalog, February 1943

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| 220.63 | Technical Schools, Miscellaneous |
| 220.66 B | Factories |
| 220.66 C | Factories |
| 221 | Mechanics, Miscellaneous |
| 352.11 | Lowry Field |
| 353. | Armament Training |
| 353 | Bombardier Training (Bombardment) |
| 353 | Mechanics |
| 353.01 F | Training Programs |
| 353 C | Miscellaneous Training |
| 353.9 | Factory Schools |
| 353.9 | Factory Training |
| 353.9-1A | Bombardier Training |
| 353.9-1B | Training General |
| 353.9 A | Denver, Miscellaneous Training |
| 353.9 G2 | Training, General |
| 353.9 D | Factory Training |

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353.9 D1	Training, General
353.9 G	Factory Training
353.9 E	Factory Training
353.9 I	Factory Training
353.11	Lovry Field
452.19	Auto Pilots
452.26	Bomb Sights

These Army Air Forces Central Files books were the most valuable materials for this study. The 353 files--particularly those dealing with Bomb Sight Training and Factory Schools--were especially rich.

Command and Office Files

Office of the Assistant Chief of Air Staff, Materiel, Maintenance, and Distribution:

Armament Section, Materiel Division Files

Office of the Assistant Chief of Air Staff, Intelligence:

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Special Studies:

Individual Training of Bombardiers. In Archives of AC/AS Intelligence, Historical Division.

"History of Armament Department, Lovry Field." In Archives of AC/AS, Intelligence, Historical Division. As the bulk of bombsight maintenance training was conducted at Lovry, the record given here, while lacking definitiveness and being uncritical in many respects, is very valuable.

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"History of Army Air Forces Training Detachment, Minneapolis-Honeywell Regulator Co." In Archives of AC/AS, Intelligence, Historical Division. A good, although incomplete, account of exoerience at this important factory school.

Training Films:

- TF 1-832 Theory of S-1 Bombsight
- TF 1-833 S-1 Azimuth
- TF 1-834 S-1 Operation
- TF 1-835 Preflight Operation
- TF 1-836 Conduct of a Mission
- TF 1-871 Norden Bombsight Principles
- TF 1-872 Norden Operation
- TF 1-873 Norden Preflight Inspection
- TF 1-874 Norden: Conduct of a Mission
- TF 1-875 Norden Levelling System

These films were intended primarily for the instruction of bombardiers. However, they are shown to students in bombsight maintenance to give them an appreciation of the problems involved in the work for which they are being trained.

Interviews and conversations with:

- Colonel V. L. Travis, formerly of the Armament and Photography Training Branch, Technical Training Division, AC/AS, Training.
- Major W. S. Blalock, Bombardment Branch, Requirements Division, AC/AS, Operations, Commitments, and Requirements.
- I. G. Boehm, Armament Section, Materiel Division, Assistant Chief of Air Staff, Materiel, Maintenance, and Distribution.
- Major H. O. McTague, Aircrew Training Division, Assistant Chief of Air Staff, Training.

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~~SECURITY INFORMATION~~

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~~SECURITY INFORMATION~~

Appendix 1

COURSE OF INSTRUCTION AT LOWRY FIELD
AFTER 30 NOVEMBER 1949

<u>1st Week</u>			
Theory		40	hours
<u>2nd Week</u>			
Course Outline		8	"
Electricity		16	"
Grounding		16	"
<u>3rd Week</u>			
Partial disassembly of M-1 light		16	"
Printer clock or 1 trainer wiring		8	"
Clock maintenance		8	"
<u>4th Week</u>			
Complete disassembly of M-1 by instructor		16	"
Complete disassembly by students		16	"
<u>5th Week</u>			
Printer operation		40	"
<u>6th and 7th weeks</u>			
A.P.C.B. maintenance		80	"
<u>8th Week</u>			
M-3 maintenance		8	"
M-3 calibration by instructor		16	"
M-3 calibration by students		16	"
<u>9th Week</u>			
M-3 calibration by students		16	"
M-3 maintenance		8	"
M-3 calibration		16	"
<u>10th week</u>			
M-3 calibration		16	"
M-3 maintenance		8	"
M-3 calibration by students		16	"
<u>11th week</u>			
M-3 calibration by students		16	"
M-3 calibration		8	"
M-3 calibration by students		16	"
<u>12th week</u>			
M-3 calibration by students		16	"
Low altitude and computers		8	"
Magnetic troubleshooting		16	hours

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Source: 1st Ind., Co Lt., Orlando Field to Chief of the Air

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110
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Appendix 2

A.F.C.M. INSTRUCTION AT LOWRY FIELD,
JANUARY 1941

Sixth Week

16 hours--Classroom work to obtain general picture of purpose and operation of A.F.C.M. equipment. Map-work is used.

8 hours--Detailed study of the flight gyro and the erection system.

8 hours--Detailed study of the operation and purpose of the servo unit.

8 hours--Detailed study of the vector wheel, connection with the stabilizer unit, and the purpose and operation of the precision motor.

Seventh Week

8 hours--Detailed study of the heading motor, its purpose and operation.

8 hours--Classroom study of the relationship between the various units and the part each plays in controlling the airplane in flight. Map-work used.

8 hours--Classroom study of routine cleaning and maintenance of the equipment.

8 hours--Ground instruction, routine maintenance and adjustment of equipment installed in an airplane.

Eighth Week

8 hours--Flying, adjustment and operation of the equipment in flight.

16 hours--Ground instruction. Removal of units, cleaning, reconditioning and maintenance (16 hour inspection), reinstallation and adjustment.

16 hours--Classroom work. Map-work used to clarify adjustments. Examination.

Ninth Week

8 hours--Flying, adjustment and operation of the equipment in flight.

12 hours--Flying, operation of flight and A.F.C.M. during dry run (bombing exercises without bombs).

16 hours--Troubleshooting.

8 hours--Review and operation.

Note.- Troubleshooting extends throughout the entire course, but 16 hours are devoted to this subject at the end of the course because of its importance.

Source: School Ho., Lowry Field to Comdt., Chanute Field,
2 Jan. 1941, in A13 373.2-1A, Boston Mt Training.

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Appendix B

SYLLABUS OF A.F.C.M. MAINTENANCE COURSE
AT MINNEAPOLIS-20 LYNNEL AIRPORT CALIF. 7

1st Week (conducted in the classrooms and classrooms of the
University of Minnesota-25 hours)

Orientation test, instructions regarding the use of confidential notebooks. Theory of flight. C.A.A. films, Kit 2, Film 10, Kit 1, Film 1, Kit 1, Film 3, Kit 2, Film 1-4, produced by Jet Propulsion Organization. Lecture on aircraft instruments, definition of basic electricity terms, symbols, color codes, etc. Study of Ohm law, A.C. and D.C., transformers, coils, condensers, bridge circuits, potentiometers, A.C. and D.C. bridges, bridges in series, Minneapolis-Horngren bridge circuits. Shop work on harness, soldering, tin, A.V. connectors, P.C.L. wiring, sector panel wiring, etc. Written test at end of week.

2nd Week (conducted in the classrooms and classrooms of the
University of Minnesota-25 hours)

Demonstrations of vacuum, rectification and observations, study of flight gyro, stabilizer, sector panels, turn controls, study of servo motor, amplifier, pilot's control box, and converter. Fundamentals of electronic theory, diodes, filter bridges, and tube, and Minneapolis-Horngren amplifier. Shop work on flight gyro, servo motor and amplifier. Review and written test.

3rd Week (class conducted at Wold-Chamberlain Airport-25 hours)

Ground instruction on electric, behavior ground planes, craft, vacuum, actual flights, and instruction of flight check procedure. Practice study of approach, rudder trim, return series stops, velocity, signal, servo cables, ground check procedure and practice on vacuum for detection of mal-functions. Continued flights throughout week. Review on Saturday.

4th Week (class conducted at Wold-Chamberlain Airport-25 hours)

Work on vacuums, checking instruments, circuits, ohmmeters, voltmeters, mal-functions, starts, recalls, open circuits, bridge interaction, diagrams, field problems. Visit to plant of Minneapolis-Horngren to study actual construction of A.C.T. Continued flight throughout week. Review. Final examination.

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~~SECURITY INFORMATION~~

~~SECRET~~ ~~RESTRICTED~~ 112
~~SECURITY INFORMATION~~

Appendix A

COURSE OF INSTRUCTION IN FIRST AND SECOND EMBELON MAINTENANCE
OF A.T.C. IN AIRCRAFT TRAINING CENTER, MARCH 1943

A.T.C. (Type B1-01)

- A. Basic Fundamentals (7 weeks)
 - 1. Elements of flight
 - 2. Flight instruments
 - 3. Gyroscopic principles and operation
 - 4. Electrical fundamentals
 - 5. Electrical devices and test equipment
 - 6. Wire circuits
 - a. rubber-wire-cable
 - 7. Coordinated turns
 - a. turn box
 - b. vector box
 - 8. Amplifier
 - 9. Sensitivity-rod-rod-throttling
 - 10. The wind reading
- B. Flight and ground checks on equipment (1 week)
- C. Maintenance of equipment (2 weeks)
 - 1. Disassembly of equipment
 - a. stabilizer, directional
 - b. flight gyro
 - c. servo motor
 - d. rotary inductor
 - e. turn box
 - f. vector box
 - g. amplifier
 - h. pilot control box
 - 2. Maintenance and cleaning - electrical
 - 3. Reassembly and calibration
- D. Trouble shooting on reconstruction board (1 week)
 - 1. Electrical
 - 2. Mechanical

Source: Training Program at Aircraft Training Center,
Indianapolis, Ind., attached to letter of CG, AAF
to CG, AAFHS, 17 March 1944, in AAF 323.01 3,
Training Program.

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~~SECURITY INFORMATION~~ 113

Appendix B

SPECIAL POLYMER MIL ENGINEER COURSE OF I. DIVISION
RE TRAINING GRANTING CENTER, MARCH 1948

- I. Introduction.
 - 1. Grouping of men—three men to a group.
 - 2. Assignment of tool, benches and units.
 - 3. Log book procedure.
 - a. Log in of work done on an instrument and running time.
 - 4. Soldering technique.
 - a. How to clean and tin a soldering iron—types of fluxes.
 - b. Solder on 13 cold connections.
- II. Disassembly of complete unit into sub-assemblies.
 - 1. Removal of sub-assemblies from unit following given procedure.
- III. Disassembly, cleaning, oiling, adjustments and reassembly of each sub-assembly.
 - 1. This work to be done on each sub-assembly by each man in the group.
 - 2. This is to be a complete overhaul of all sub-assemblies doing all work necessary for correct operation, including replacement of broken or worn parts, cleaning of dirty or rusted parts, covering of exposed parts with rust-inhibiting oil, and reassembly of unit, making all adjustments required.
 - a. Vertical press group.
 - 1. Disassembly following given procedure.
 - 2. Reassembly following given procedure.
 - 3. Static balance following given procedure.
 - 4. Dynamic balance following given procedure.
 - 5. Pendulum balance following given procedure.
 - b. Airbrush type unit.
 - 1. Disassembly, inspection, and reassembly of unit following given procedure.
 - c. Variable speed units.
 - 1. Disassembly of unit.
 - 2. Cleaning of rollers and discs.
 - 3. Oiling of rollers and discs.
 - 4. Reassembly of unit making necessary adjustments on springs and bearing rollers.

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~~RESTRICTED~~ 114
~~SECURITY INFORMATION~~

- d. Main frame.
 - 1. Disassembly, inspection and reassembly of unit following given procedure.
- e. Range computing unit.
 - 1. Disassembly of unit following given procedure.
 - 2. Cleaning and inspection of parts.
 - 3. Reassembly of unit observing all tolerances for correct operation of release contacts and sighting angle cam.
- f. 101 collimator assemblies.
 - 1. Disassembly, inspection and reassembly of: level cam and drift units, range gear unit, low frame, and tube of rail circle.
- IV. Reassembly of complete unit from sub-assemblies.
 - 1. Replacement of sub-assemblies into unit following given procedure.
- V. Floor check.
 - 1. This is to check the operation of the sight prior to calibration.
 - a. Check travel of knob and dial.
 - b. Check location of springs and clutches.
 - c. Check detent position of sighting angle and trail cams.
 - d. Check cross-trail mechanism.
 - e. Check D. C. circuits.
- VI. Calibration.
 - 1. This is a procedure to calibrate the sight to conform according to the known facts.
 - a. Adjustment of sighting angle units.
 - b. Check for: drift, crection, vibration and freedom.
 - c. Check release contacts to make at correct time.
 - d. Check accuracy of sighting angle dial.
 - e. Check alignment of cross-hairs.
 - f. Summary of calibration curve problems to check over-all error of sight.
 - 1. Parallax check.
- VII. Trouble shooting.
 - 1. Field check.
 - a. Easiest and first check to be made on a sight in the field.
 - b. Common causes of trouble with the S-1 and their remedies.

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~~SECURITY INFORMATION~~ 115

Appendix 6

NORDEN PORTSIGHT MAINTENANCE COURSE OF INSTRUCTION
AT GREAT LAKES TRAINING CENTER, MARCH 1943

A. General Practices.

- 1. Purpose of the course.
- 2. Rules and regulations.
- 3. Discussion of pertinent matter pertaining to this equipment.

B. Laboratory work.

- 1. Norden Stabilizer.
 - a. Complete disassembly.
 - (1) Stabilizer.
 - (2) Servo motor.
 - (3) Precession motor.
 - b. Gyro balancing and building.
 - c. Cleaning and maintenance.
 - d. Reassembly.
 - e. Calibration.
- 2. Norden Portsight.
 - a. Complete disassembly.
 - (1) Gyro.
 - (2) Rate end.
 - (3) Synchronous end.
 - (4) Trail and cross trail mechanism.
 - b. Cleaning and maintenance.
 - (1) Rotor balance.
 - (2) Shaping springs.
 - (3) Sight balancing.
 - (4) Auto. otive erective system.
- 3. Pedestal clock.
 - a. Wiring.
 - b. Precession runs.
 - c. Beep and tape.

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GLOSSARY OF ABBREVIATIONS

AAF	Army Air Forces
AAECTTC	Central Technical Training Command
AAFTTC	Flying Training Command
AAFASC	Air Service Command
AAFTTTC	Eastern Technical Training Command
AAFTD	Army Air Forces Training Detachment
AAFTTC	Training Command
AAFTTC	Technical Training Command
AAG	Air Adjutant General
AC	Air Corps
AC/AS	Assistant Chief of Air Staff
AC/S	Assistant Chief of Staff
ACTTC	Technical Training Command
ACACT	Assistant Chief of Air Staff, A-3
AFAMC	Material Command
AFCC	Air Force Combat Command
AFCE	Automatic Flight Control Equipment
AFDOP	Directorate of Personnel
AFIRD	Historical Division, AC/AS, Intelligence
AFRIP	Military Personnel Division, AC/AS, Personnel
AFRDB	Directorate of Bombardment
AFRIT	Directorate of Individual Training
AG	Adjutant General
AR	Army Regulation
C/AC	Chief of the Air Corps
CG	Commanding General
CO	Commanding Officer
Condt.	Commandant
CTI	Classified Technical Instruction
GHCAF	General Headquarters Air Force
Hq.	Headquarters
IMED	Material, Maintenance, and Distribution
OCAC	Office of the Chief of the Air Corps
RR	Routine and Record Sheet
T&O	Training and Operations
TF	Training Film

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~~SECURITY INFORMATION~~

~~RESTRICTED~~
~~SECURITY INFORMATION~~

I N D E X

A

AAF Regulation No. 35-13,
 100-102, 104
 AAF Training Films Laboratory, 96
 Administrative problems, 11,
 14, 29, 35-37, 43, 46, 61,
 83, 86-104
 Air Corps Circular No. 35-7,
 30
 Air Force Combat Command, 53
 Air Service Command, 7, 71-74,
 76-77, 79-82, 86-87. See also
 Schools, Armament Training
 Center.
 Area saturation bombing, defini-
 tion, 1
 Armament officers, 5-8, 11, 15,
 21, 37-38, 63, 85
 Armament Training Center. See
 Schools.
 Army Alpha and Mathematics
 tests, 10
 Assistant Chief of Air Staff,
 A-1, 101. See also Personnel
 Division.
 Assistant Chief of Air Staff,
 A-3, 102
 Assistant Chief of Air Staff,
 Materiel, Maintenance, and
 Distribution, 99
 Assistant Chief of Air Staff,
 Training, 61, 75, 99
 Aviation cadets, 62, 84, 86

B

Barksdale Field, La., 26-28,
 31, 40, 45
 Bennett, T/Sgt. Bradley J., 67
 Benton, George R., 70-71, 92
 Bombardment, Directorate of,
 60, 102
 Brooklyn Air Base, 47-48
 Burstan, Dr. Rowland, 69-70

C

Chanute Field. See Schools.
 Claassen, Capt. C. B., 36
 Color-blindness, 8
 Combat theaters, maintenance of
 bombsight in, 56-57
 Conference on:
 Curriculum change, 45-46
 Discontinuing production of
 Sperry equipment, 3, 84
 Technical training program, 61
 Curriculum changes, 23, 25, 33-35,
 39, 46, 57-59, 63, 75, 83-84, 93

D

Dahlgren Field, Va., 44
 Denver, Colo., 63
 Denver Municipal Airport, 14
 Dixon, L. A., 26-27, 29, 31, 33
 Dunn, Lt. Col. Ray A., 19-20

F, G

Federal Bureau of Investigation,
 101, 103
 First Air Force, 78
 First Bomber Command, 80
 Flying Training Command, 60-62,
 65-66, 80, 82, 87, 99
 Fourth Air Force, 66
 General Headquarters Air Force,
 9, 12, 15, 19, 27-29, 41, 53
 General Classification Test, 10-11
 Glide Bomb, 83

H, I

Hamilton Field, 16
 Hawaiian air bases, 43
 Hobbs, T/Sgt., Mark H., 45
 Huglin, Capt. Harold Q., 9, 27-29,
 33

~~RESTRICTED~~
~~SECURITY INFORMATION~~ 118

Indianapolis, Ind. See Schools,
 Armament Training Center.
 Individual Training, Director of,
 102
 Inspector General, AAF, 95

P

Pearcy, Maj. C. G., 36
 Personnel Division, 20. See also
 Assistant Chief of Air Staff, A-1.
 Plans Division, 20
 Proctor, Lt. Clark A., 67

L

Langley Field, 16, 40-42, 44
 Lawson, Maj. Lawrence A., 38
 Legal Division, 100
 Lowry Field. See Schools.
 Loyalty qualifications and
 investigation, 11, 100-103

Q, R

Qualifications:
 Bombardiers, 19
 Bombsight maintenance men, 8-11,
 27, 29-30, 36, 75
 Rees, Lt. Clifford H., 29-30
 Requirements. See Qualifications.
 Royal Air Force, 1
 Rudolph, Col. Jacob H., 22

M

McCormick, Col. John H., 56
 Maintenance Command, 53
 Marvella, Ward E., 32
 March Field, 16
 Materiel Division, 15, 21, 29,
 31-33, 41-43, 44, 99
 Mechanical aptitude test, 10
 Military Intelligence, 101
 Military Occupational Special-
 ists, No. 683, 7; No. 574, 7
 Minneapolis-Honeywell Regulator Co.
See Schools.
 Minnesota, University of. See
 Schools.
 Mitchel Field, 16
 Moses, Capt. Kenneth R., 68

S

Schools:
 Armament Training Center, 55-56,
 71-76, 86-87, 93, 98, 100
 Chanute Field, 12-13, 15, 25, 48,
 98-99
 Lowry Field, 8, 13-43, 46, 51,
 55-56, 62-63, 65-66, 69, 71,
 75-76, 78, 80, 82, 84, 86-87,
 90-91, 93, 96, 98, 101
 Minneapolis-Honeywell Co., 55,
 65-71, 86-88, 92, 98
 Minnesota, University of, 66
 Norden Co., 19, 33, 39-40, 43-
 48, 50, 77-82, 86, 88-89, 104
 Sperry Gyroscope Co., 19, 33,
 39-40, 43, 46-48, 50, 77-78,
 86, 88-89
 Wright Field, 12, 15, 17, 19, 27,
 40, 43
 Yale University, 55, 62-64, 84-
 86, 93, 98
 Second Air Force, 65-66, 99
 Second Bombardment Group, 44
 Secretary of War, 103
 Selfridge Field, 47
 Selzer, Maj. Edgar T., 47-49

N

National Cash Register Co., 5
 Naval Proving Ground, 44
 Navy Department, 4, 24, 31, 42-46,
 53, 55, 66, 72, 79-81, 88, 104
 Bureau of Ordnance, 3, 14, 42,
 46, 48, 50-51, 80, 104
 Ordnance pamphlets, 94-95
 Non-precision type bombsights, 2, 5
 Norden, Carl L., 42
 Norden Co. See Schools.

~~RESTRICTED~~ 119
~~SECURITY INFORMATION~~

Smith, Col. L. S., 102-103
Sperry Gyroscope Co. See
Schools.
Stabilized Bombing Approach Equip-
ment (S. B. A. E.), 4
State Fairgrounds, Indianapolis,
Ind., 72

Training Detachment. See Schools,
Minneapolis-Moneywell Co.
Training Films, 96
Training Section, 10
Travis, Col. William L., 30-31, 51-
52, 57, 64, 89, 93

V, W, Y

T

Technical Training Command, 58,
60-63, 68-79, 86-87, 91-93, 98
Technical Training Detachment,
77. See also Schools, Sperry
Gyroscope Co.
TF 1-277, 35
Third Air Force, 78
Training, "on-the-job," 56, 59-
61, 87, 91, 94
Training and Operations Division,
20, 38, 51, 53
Training Command, 62, 83, 86-87,
91, 93, 99

Victor Adding Machine Co., 3-4
Weaver, Maj. Gen. Walter R., 92
Wold-Chamberlain Airport, Min-
neapolis, Minn., 66
Wright Field, 32-33, 96. See
also Schools.
Yale University. See Schools.

~~RESTRICTED~~
~~SECURITY INFORMATION~~

~~RESTRICTED~~

~~RESTRICTED~~
~~SECURITY INFORMATION~~

MEMORANDUM FOR THE COMMANDING GENERAL, ARMY AIR FORCES: (Office of the Assistant Chief of Air Staff, Intelligence; Attention: Chief, Historical Division)

Subject: Bombsight Maintenance Training in the AAF

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