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THE DEVELOPMENT OF MILITARY NIGHT AVIATION TO 1919

by

WILLIAM EDWARD FISCHER, JR.

A.A.S., Community College of the Air Force, 1981

B.S., The Ohio State University, 1984

B.A., College of Great Falls, 1989

A Thesis Submitted to the Graduate Faculty

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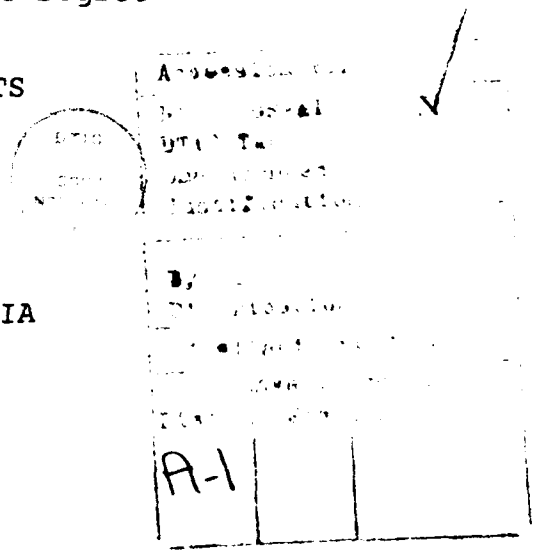

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THE DEVELOPMENT OF MILITARY NIGHT AVIATION TO 1919

by

WILLIAM EDWARD FISCHER, JR.

Approved:

Major Professor Date July 1, 1991

Chairman, Reading Committee Date July 1, 1991

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Graduate Dean

Date July 3, 1991

For

Henry, Molly, and Nicholas

who endured this project with love and forgiveness,

but most of all for

Margaret

whose love, encouragement, and commitment

made this thesis possible

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

AUL - Air University Library, Maxwell Air Force Base, Alabama

HRC - United States Air Force Historical Research Center, Maxwell Air Force Base, Alabama

LC - Library of Congress, Washington, D.C.

NA - National Archives, Washington, D.C.

NASM - National Air and Space Museum Library, Washington, D.C.

SHAA - *Service Historique de l'Armée de l'Air*, Vincennes, France

IS-AD OCSO - Information Section - Air Division, Office of the Chief Signal Officer

2dS GS - Second Section, General Staff, G.H.Q.A.E.F.

PREFACE

This study examines the development of military night aviation from its origins through the First World War. Emphasis is on the evolution of night flying in those countries which fought on the Western Front, namely France, Germany, Great Britain, and the United States. While night flying occurred in other theaters the most intense air effort was clearly in the west. There belligerents pressed aviation technology and tactics to the limits; the skies of northern France and Flanders offered the only opportunity for movement across the stagnated front. Another important consideration was the availability of a rich documentation concerning night aerial activity in the theater.

A striking disparity quickly became evident during preliminary investigations of the topic. Surprisingly no single book-length study was uncovered which was dedicated exclusively to night flying along the Western Front. This thesis seeks to reduce the existing gap in scholarly knowledge.

To appreciate the rapid development of night military aviation during the Great War one first needs to understand the state of night flying prior to August 1914. Numerous

aeronautical journals of the period offer articles exploring the technical problems associated with night flight. Additionally the *New York Times* provides a useful but more general day-to-day account of the evolution of flying during darkness. Source material for the war period is quite extensive.

Aviators' memoirs provide a personal glimpse into the trials and tribulations of night flying under hostile conditions. Contemporary journals contain numerous articles dealing with developments in the field. Yet archival materials offer the most wide ranging information on the evolution of military night aviation.

The National Archives has an extensive assortment of World War I era United States Air Service documents embodied in Record Groups (RG) 18 and 120. However finding night aviation materials among the holdings is a rather time-consuming proposition. Within RG 120 is a collection of documents known as *Gorrell's History of the American Expeditionary Forces Air Service, 1917-1919*. Colonel Edgar S. Gorrell directed the assembling of data on all aspects of Air Service experience during the First World War. Yet only a small portion of the 282 volumes of material was ever published due of military budget reductions in the 1920s.

The United States Air Force maintains its archives at the Historical Research Center, Maxwell Air Force Base, Alabama. While World War I night aviation information is limited it is nonetheless accessible. Similarly the French

Service Historique de l'Armée de l'Air maintains numerous documents dealing with *aviation de nuit* during the Great War. The official French air service correspondence is especially useful for understanding the difficulties of early night aerial combat operations and training.

As with any undertaking of such proportion and consequence, this thesis is the result of input, assistance, and direction by a host of people. Professors Roger P. Snow and William H. Furdell of the College of Great Falls (Montana) supported my goal of a graduate degree in history through instruction at the undergraduate level. Colonel Carl R. Reddel, Major Mark Clodfelter, and the staff at the United States Air Force Academy Department of History believed in me and provided sponsorship to attend graduate school. Hopefully this study will not disappoint them.

The support provided on numerous visits to the United States Air Force Historical Research Center was most appreciated; a special thanks to Colonel Elliot V. Converse III, commander, and Dr. Richard Morse for their assistance. *Général* Lucien Robineau, director of the *Service Historique de l'Armée de l'Air*, kindly provided French archival material which greatly broadened the scope of this thesis.

At the University of Georgia Professor John H. Morrow, Jr. and Professor Emeritus James Colvert graciously took time from their busy schedules to review and comment on the thesis as part of my reading committee. Most of all I owe a great debt to Professor Lee Kennett for agreeing to be my

major professor. His direction and guidance sustained me through the many travails of research and writing. Unfortunately all I can offer in return for the many hours spent on this project is a most heartfelt thanks.

CHAPTER 1

NIGHT AERONAUTICS TO AUGUST 1914

Certainly the earliest aeronauts to venture into the darkened sky did so by means of balloons. While quite possibly not the first documented case of a free balloon aloft at night, the ascent from London of Charles Green, Monck Mason, and Robert Holland in the balloon *Royal Vauxhall*, on 7 November 1836, is nevertheless epic. Boldly crossing the English Channel in fading twilight, the aeronauts were soon welcomed by the lights of Calais. Liège was easily recognized by the flames from its many furnaces. But for most of the night Mason commented that "we could scarcely avoid the impression that we were cleaving our way through a mass of black marble." After sailing through the moonless night the balloon finally descended near Nassau, Germany after traveling 500 miles.[1]

That free ballooning distance record stood for nearly a generation, until John Wise and three other aeronauts embarked from St. Louis, Missouri on 1 July 1859. Their

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[1]Monck Mason, *Aeronautica* (London: Westley, 1848), quoted in Leonard Cottrell, *Up In a Balloon* (New York: Phillips, 1970), 90. A drawing by Mason showing the balloon over Liège is found in Erik Norgaard, *The Book of Balloons*, trans. Erik Hildesheim (New York: Crown, 1971), 63.

ascent in the balloon *Atlantic* was in anticipation of a future transatlantic voyage. The flight ended the following day in Henderson Township, Jefferson County, New York, an incredible 800 miles distant. Though coming dangerously close to ditching in Lake Erie, Wise and John La Mountain, who also took part in the epic journey, remained riveted to the goal of crossing the Atlantic by balloon. Both men would continue to experiment with endurance ascensions. Wise would finally meet his end in Lake Michigan during the night of 28/29 September 1879; it was his 463d ascent.[2]

Also in 1859, Thaddeus S. C. Lowe, a rival of Wise and La Mountain, built the *City of New York* specifically for a transatlantic voyage. Unfortunately the balloon, rechristened *Great Western,* burst on 8 September 1860. While Lowe's transatlantic ambitions never came to fruition, he nevertheless achieved notable success with balloons during the American Civil War.[3]

Lowe apparently made history in August and September 1861 by making the earliest recorded captive balloon night ascensions for military purposes; his mission was to count Confederate campfires. La Mountain made numerous free

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[2]William Hyde, "The Aeronautic Expedition," *New York Times*, 11 July 1859, p. 2; Tom D. Crouch, *The Eagle Aloft: Two Centuries of the Balloon in America* (Washington, D.C.: Smithsonian Institution Press, 1983), 247-255, 449-450.

[3]"A New Aerial Ship," *New York Times*, 10 September 1859, p. 4; Thaddeus S. C. Lowe, letter to the editor, *ibid.*, 19 November 1859, p. 8; Crouch, *Eagle Aloft*, p. 273-276. The Atlantic Ocean would not be successfully crossed by balloon until August 1978.

balloon flights over enemy lines for the Union Army but the honor of the first military free balloon night flight appears to belong to Captain John R. Bryan, C.S.A., serving under General Johnston in eastern Virginia. In mid-April 1862 Bryan, on his first captive balloon ascension, soon found his cable cut. Drifting back and forth across the lines during the night, the captain was much relieved when he finally landed back on the Confederate side. Unfortunately, American military ballooning ended before termination of the war.[4]

Night ballooning stirred the imagination of those who ascended into the starlit sky. Part of the enjoyment clearly resulted from the stable atmospheric conditions often encountered at night. Such stability made the aeronaut's job easy, as Eugène Godard demonstrated on a night ascension when he "passed from one point of Paris and its environs to another, picking up his passengers." Later, during the Franco-Prussian War, a besieged Paris kept in contact with the outside world by means of free balloons. In all sixty-six ships left Paris between 23 September 1870 and the armistice four months later. The hazards of passing over enemy troops during daylight soon resulted in numerous night ascensions from the city. Carried in the balloons

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[4]The French made the first daylight military captive balloon ascension on 2 June 1794, at Maubeuge. Crouch, *Eagle Aloft*, 355; John R. Bryan, "Balloon Used for Scout Duty," *Southern Historical Society Papers*, vol. 33 (1905), 33, quoted in *ibid.*, 383.

were 1.5 million letters -- the first overnight airmail service.[5]

European military balloon experimentation increased greatly after the Franco-Prussian War, with the British, French, and German armies all evaluating balloon use by the mid-1880s. The United States Army lagged behind, obtaining its first balloon in 1893. These military balloon branches were clearly the forerunners of twentieth-century military aviation.[6]

A great revival in free ballooning occurred in the United States after the record-setting ascension of Count de la Vaux during the Paris International Exposition of 1900. Cheered during departure by a crowd estimated at one million strong, the Count remained airborne for over 35 hours, finally coming to earth near Kiev. The flight covered a distance of 1,193 miles, surpassing Wise's 1859 journey.[7]

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[5]"Balloon Excursion by Moonlight," *Scientific American*, 29 November 1851, 80; Charles Christienne and Pierre Lissarague, A *History of French Military Aviation*, trans. Francis Kianka (Washington, D.C.: Smithsonian Institution Press, 1986), 17. An illustration of a night mail balloon being readied in Paris is found in Norgaard, *Balloons*, 68.

[6]An illustration of late-nineteenth century vintage shows a French balloon on night military maneuvers in Norgaard, *Balloons*, 50. Christienne and Lissarague, *French Military Aviation*, 18; Peter Mead, *The Eye in the Air: History of Air Observation and Reconnaissance for the Army, 1785-1945* (London: Her Majesty's Stationery Office, 1983), 19; Alex Imrie, *Pictorial History of the German Army Air Service, 1914-1918* (Chicago: Henry Regnery, 1973), 11; Crouch, *Eagle Aloft, 520*.

[7]"Race of 16 Balloons is Started at Paris," *New York Times*, 1 October 1906, p. 1; Cortland F. Bishop, "Importance of St. Louis Balloon Race," *ibid.*, 20 October 1907, part 5,

Aeronautics clubs and contests grew rapidly in the first decade of the new century; the Aero Club of America, the first in the United States, was founded in 1905, being modeled after European organizations. Immeasurably safer and more accessible than heavier-than-air flying machines, and less costly and more easily maintained than dirigible balloons, the free spherical balloon proved to be for many people a satisfying airborne medium. Their experiences furthered support for military aeronautical developments.[8]

The first international balloon race, for the *James Gordon Bennett Coupe Internationale des Aéronautes*, was held in Paris under the auspices of the *Fédération Aéronautique Internationale* (*FAI*) on 1 October 1906. The balloon achieving the furthest distance from ascension point would be declared the winner. With much foresight, the *FAI* had selected for the competition a day whose night would be brightly lit with moonlight and was known through meteorological records to routinely have prevailing westerly winds. Such conditions were supposed to assist the aeronauts in making long flights, but ultimately they failed to hold true. Lieutenant Frank P. Lahm of the U. S. Army Signal Corps won the competition with a flight of barely 400 miles.

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p. 5; Crouch, *Eagle Aloft*, 533.

[8]Crouch, *Eagle Aloft*, 533-542.

Unfavorable winds forced Lahm to cross the English Channel, then land before being swept out over the North Sea.[9]

With the amazing growth of aeronautics clubs, the concern for safety likewise increased. By 1909, the *FAI* established criteria for the award of a spherical balloon pilot license, one night ascension being part of the requirements. While licensing was not enforceable, earning one gave the aeronaut public credibility.[10]

The broad appeal of these early organizations can be seen in the composition of America's third club, the Philadelphia Aeronautical Recreation Society (PARS). Organized in the latter half of 1906, the PARS prohibited "professionals" from membership, yet eagerly welcomed women, who made up roughly one third of the organization by mid-1908. Therefore, it is not surprising that two Society dames were the first women in the United States to make a night flight by balloon.[11]

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[9]"Race of 16 Balloons," *New York Times*, 1 October 1906, p. 1; "Great Balloon Race Won By An American," *ibid.*, 2 October 1906, p. 4; Bishop, "St. Louis Balloon Race," *ibid.*, 20 October 1907, part 5, p. 5; Crouch, *Eagle Aloft*, 546-547. See appendix 1 for additional pre-war Bennett Cup winners.

[10]See appendix 2 for complete requirements.

[11]"Women In Balloon Fall 3,000 Feet," *New York Times*, 28 June 1908, part 2, p. 3; there were sixty-six women on the roles in 1909 according to Crouch, *Eagle Aloft*, 540; "Moonlight Balloon Party," *New York Times*, 16 August 1908, part 2, p. 1; "Women Enjoy Trip In Balloon At Night," *ibid.*, 17 August 1908, p. 2; Leon Cottrell, *Up in Balloon*, 79-83, notes that Madame Blanchard, wife of Pierre Blanchard, made many night free balloon ascensions throughout Europe between 1809 and 1819.

What good all this ballooning was for the development of military night aviation remains to be answered. Obviously, "free balloons . . . [were] of little practical use in the service." However, as very few people the world over had flown an airplane by the end of 1907, ballooning provided the military with an outlet for expanding aeronautical experience among its men.[12]

Plausibly most basic to the importance of free ballooning was that it enabled an aviator candidate to "acquire familiarity with dangling his toes in space." Lieutenant J. N. Fletcher of the Royal Flying Corps (RFC), believed that airplane pilots and observers who had first plied the skies in a balloon would have greater confidence in their ability to learn heavier-than-air skills. Additionally, he contended that if Great Britain's balloonists were better organized, and had a central registry to collect meteorological information obtained during balloon ascents, night flying by airplanes would in five years time be as safe as navigating on the sea. As for airships, Fletcher expressed the opinion held in British military circles as early as 1909 concerning their vulnerability in combat and the need for operating under cover of darkness. However the lieutenant had his own

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[12]"German Aeronauts Win Balloon Race," *New York Times*, 24 October 1907, p. 5; Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917* (Washington, D.C.: Government Printing Office, 1958), 200, note 14.

unique idea for training pilots. "If night flying is to be a principal rôle of airships," Fletcher insisted that:

> the pilot must be trained first in night ballooning. When real flying, away from illuminated aerodromes, becomes a possibility for aeroplanes, some regulation should be adopted to make each pilot do at least two night balloon runs before he attempts to cross unknown country by night.[13]

Apparently free balloons had been used, even after the Airship Company of the Air Battalion (formed in April 1911 to consolidate British military aviation) had become No. 1 Squadron, RFC in 1912, for "reconnaissance training of aeroplane pilots when aeroplanes were in short supply." In fact barely a month after the war started, a Royal Naval Air Service (RNAS) pilot trainee wrote home about a night ascension in a free balloon from Hendon; never had he expected that flight training "should come down to an old (1902) gas bag."[14]

Undoubtedly once war production geared up and airplanes became more numerous, free balloon training of airplane pilot candidates declined. However, both the British and German armies did instruct captive balloon observers in the art of free ballooning. Such training

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[13]Griffith Brewer and J. N. Fletcher, "The Value of Ballooning as a Training for Flying," *The Aeronautical Journal* 18, no. 71 (July 1914), 232, 237-239; "Looking Forward to Warfare in the Air," *New York Times*, 21 March 1909, part 5, p. 9.

[14]Mead, *Eye in the Air*, 42; Harold Rosher, *In the Royal Naval Air Service: Being the War Letters of the late Harold Rosher to his Family* (London: Chatto and Windus, 1916), 20-21.

prepared the observer to safely land a runaway captive balloon -- witness Captain Bryan's Civil War experience. The British also used such vessels for reconnaissance and bombing training during the last decade of the nineteenth-century. In the United States Army, free balloons were used for training airship pilots well into the postwar years, presumably with requisite night ascensions.[15]

Yet there is little doubt that the steady improvements in airship and airplane performance in the decade prior to 1914 rapidly redirected military emphasis away from ballooning. The French army disbanded its captive balloon companies by 1911 in favor of dirigibles, while at the same time in Britain "the spherical balloon was drifting into obsolescence without anything comparable replacing it."[16]

The United States Army recognized the military operational value of free balloons as being "of little use" for anything but conveying information from a besieged position -- apparently the lessons of 1870 Paris were not completely lost. Only Germany continued to actively experiment with balloons, having earlier developed the captive *Drachen*, often referred to as a "sausage" because of

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[15]Imrie, *German Air Service*, 11; Mead, *Eye in the Air*, 20; Crouch, *Eagle Aloft*, 527.

[16]Christienne and Lissarague, *French Military Aviation*, 25-26; Mead, *Eye in the Air*, 39.

its shape, which could remain aloft in high wind conditions.[17]

During the first decade of the twentieth century, airship development quickly caught the attention of the military. Whether non-rigid, semi-rigid, or rigid, the airship seemed destined for success. Its capacity for better stability than nascent airplanes, great lifting power, facility to remain aloft for lengthy periods, and simply the awe-inspiring sight of the massive vessels aloft, made the airship a likely candidate for military consideration.

The non-rigid *La France*, built by Captain Charles Renard and Lieutenant Arthur Krebs, became the archetype for the new class of air vessel. First flown on 9 August 1884, *La France* made seven demonstration flights in all, creating much sensation. These French exhibitions convinced one man of the military possibilities for such a vehicle. Fueled by patriotic fervor, Count Ferdinand von Zeppelin worked with an undivided devotion on rigid airship development. Sixteen years after the *La France*, the *LZ1* (*Luftschiff Zeppelin 1*) made its maiden voyage on Lake Constance. While not an

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[17]War Department, Field Service Regulations, United States Army, 1914, Corrected to July 31, 1918 (Changes Nos. 1 to 11) (Washington, 1918), extracts in Maurer Maurer, *The U.S. Air Service in World War I*, vol. 2 (Washington, D.C.: The Office of Air Force History, 1978), 23; Christienne and Lissarague, *French Military Aviation*, 26. The United States Army Signal Corps added a Siegsfeld *drachen* balloon to its roster in 1899, Crouch, *Eagle Aloft*, 527.

unqualified success, the *LZ1* ushered in a new era in military aeronautics.[18]

However, the French Army would be the first to incorporate a dirigible, nicknamed *Le Jaune*, into its inventory in 1905. The German Army added their first airships, of semi-rigid design, in 1906-1907, and commissioned a non-rigid in August 1908. Since the German military regarded the airship in the same light as an observation balloon, for basically tactical operations, it is not surprising that they had no interest in rigid airships until the *LZ3* made an eight-hour flight in 1907. The army then agreed to buy one from Zeppelin, provided it could fly continuously for twenty-four hours and demonstrate its ability to navigate the air. Rather than give up against such outrageous demands, the Count continued his difficult work.[19]

Because of the early experimentation with dirigible airships on the Continent, the British Committee on Military Ballooning recommended that their Balloon Factory begin immediate research. The *Nulli Secundus*, of semi-rigid design, became operational in 1907. Across the ocean, the

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[18]Christienne and Lissarague, *French Military Aviation*, 20-21; Douglas H. Robinson, *The Zeppelin in Combat: A History of the German Naval Airship Division, 1912-1918*, 3d ed. (London: Foulis, 1971; Seattle: University of Washington Press, 1980), 12. The first flight of the *LZ1* occurred on 2 July 1900.

[19]Christienne and Lissarague, *French Military Aviation*, 23; Imrie, *German Air Service*, 12; Robinson, *Zeppelin in Combat*, 14.

exhibitions of Thomas Baldwin, America's most famous prewar airship pilot, caught the attention of the U.S. Army, whose Signal Corps Dirigible No. 1 would be supplied by Baldwin in 1908. Within a decade of *LZ1*'s first flight, a military commitment to dirigibles had been established in Europe and the United States. Expectations varied widely among the nations, but one thing seemed certain; the myth of British Home Isle impregnability lay shattered by the remarkable flights of Zeppelin's rigid airships.[20]

Volatile hydrogen and fragile envelopes made dirigibles an inviting target. The need for airships to develop operational night capabilities to overcome such vulnerabilities was clearly evident. Therefore, when a dirigible ascended from Tegel, where German military ballooning headquarters was located, on the evening of 17 August 1908 rumors abounded that the trip was simulating anticipated wartime conditions. A month later, Major Gross, the commander of the *Luftschiffer Bataillon*, made a thirteen-hour flight in a semi-rigid airship, most likely *Militärluftschiff 1 (M1)*. Winds aloft increased well above twenty-five miles an hour, bringing the ship to "a stand-still for two hours over the village of Rathenow." It was also during this period that German naval officials first began to express confidence in the ability of airships to

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[20]Mead, *Eye in the Air*, 30; Robin Higham, *The British Rigid Airship, 1908-1931: A Study in Weapons Policy* (London: Foulis, 1961; repr., Westport, Connecticut: Greenwood Press, 1975), 13; Crouch, *Eagle Aloft*, 528.

carry out strategic reconnaissance at sea. The fear of blockade was already apparent.[21]

Colonel J. E. Capper, Superintendent of the [British] Balloon Factory believed that two categories of airships were suitable for military use. One class would be made up of "comparatively harmless" dirigibles of 70,000 to 100,000 cubic feet capacity, useful mainly for scouting, but also tactical bombardment activities to include night attacks on enemy bivouac areas. He posited that only during darkness might a dirigible "descend with safety to within a few hundred feet of the ground . . . Even on a bright moonlight night it is difficult to see a balloon at 500 feet." Such an idea might well have been feasible in 1908, when there were no airplane or heavy antiaircraft defenses, but such a low flying target at the outbreak of the war would have brought new meaning to the words "sitting duck."[22]

Capper's second class of airships were large, between 500,000 and 1,000,000 cubic feet capacity, and in his opinion, "may revolutionize the strategy of war." Their targets were to be strategic in nature: dockyards, arsenals, storehouses, railway centers, and more. Again descending under cover of darkness, the airships could bomb their

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[21]"Secret Night Trial Of German Airship," *New York Times*, 18 August 1908, p. 5; "Dirigible Up Five Hours," *ibid.*, 19 August 1908, p. 14; "Major Gross Flies 13 Hours," *ibid.*, 13 September 1908, part 2, p. 3; Robinson, *Zeppelin in Combat*, 19-20.

[22]"Big War Balloons For Offensive Work," *ibid.*, 2 August 1908, part 2, p. 10.

targets, then escape the blast by using extended-delay fuses. Finally, he regarded the possibility of enemy invasion of Great Britain by airships to be "chimerical"; on the contrary, Capper opined that a strong home fleet of airships was essential to prevent any seaborne incursions from succeeding. While he undoubtedly bore a lot of grief from the Royal Navy for his remark, copies of Colonel Capper's address were eagerly acquired by the U. S. Signal Corps.[23]

It should not be surprising, therefore, that several months later Major George Squier, in an address before the American Society of Mechanical Engineers, defined the role of airships in a very similar manner. Having only recently acquired Signal Corps Dirigible No. 1, Squire readily incorporated the ideas of someone more experienced in airship strategy.[24]

Problems continued to mount for Count von Zeppelin, with weather, engine trouble, and accidents preventing his rigid airships from successfully flying for twenty-four continuous hours. Obviously, such endurance attempts required night flying during some portion of the test. Notably in one instance, during a planned long-distance journey from Friedrichshafen to Munich, several cities and towns along the route were "brilliantly lighted with

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[23]*Ibid.*

[24]"Air Warship Near, Says Major Squier," *ibid.*, 3 December 1908, p. 8.

electricity" during darkness to serve as navigational aids for the airship.[25]

Finally on 29 May 1909, when Zeppelin lifted off from Friedrichshafen on what was to be his first successful attempt to best the twenty-four hour mark, local residents thought little of the unannounced ascension, having already become "accustomed to night flights." The expedition ended thirty-seven hours and 700 miles later.[26]

No doubt caught up in the emotion of Zeppelin's success, General James N. Allen, the U.S. Chief Signal Officer, insisted that he favored the rigid airship over the airplane for army purposes, although the Signal Corps had but one dirigible in its inventory. Immediately, the War Department requested plans for the aerial defense of the east coast of the United States. One incredible proposal divided the coast into a string of 250 mile long ellipses, with an airship station housing two to three dirigibles to be located in its center. Included was a searchlight network for night patrol navigational aids. With greater perception than exhibited by the United States military, the *New York Times* called Zeppelin's journey a great feat, but nevertheless one that "will not convince those persons who have most closely studied modern aeronautics that the

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[25]"Disabled Airship Drifts For Hours," *ibid.*, 2 April 1909, p. 4; Robinson, *Zeppelin in Combat*, 14.

[26]"Zeppelin Flies Over 24 Hours," *New York Times*, 31 May 1909, p. 1.

dirigible balloon is to be the flying machine of the future."[27]

During these endurance trials, a most incredible situation developed in Great Britain. As early as March 1909, many English citizens, living mainly in the eastern counties, had begun to hear "phantom" airships at night. Ostensibly, the increasingly aggressive posture of Germany, in concert with Zeppelin's endurance records, Blériot's crossing of the Channel in an airplane, and the inability of the British naval and military forces to offer protection against aerial invasion, brought many British citizens to the realization that their island fortress was no longer impregnable. Combining that fear with the image of destruction wrought against New York City, and elsewhere by a mass German air armada in H. G. Wells' *The War in the Air*, led to a sort of Zeppelin hysteria during the spring of 1909. Wells called forth a vision of warfare where old methods of limiting destruction were ineffective and resulted in social disorganization. Little wonder why so many people were hearing a new bogeyman in the night.[28]

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[27]"Zeppelin Craft Badly Wrecked," *ibid.*, 1 June 1909, p. 2;"Airship Patrol For Our Coast," *ibid.*, 3 June 1909, p. 1; "Zeppelin's Long Voyage," *ibid.*, 1 June 1909, p. 8.

[28]Malcolm Cooper, *The Birth of Independent Air Power* (London: Allen & Unwin, 1986), 1; Alfred Gollin,*The Impact of Air Power on the British People and their Government, 1909-14* (Stanford: Stanford University Press, 1989), 49-63; H. G. Wells, *The War in the Air* (London: Bell, 1907; repr., New York: Dover, 1963), 157-159.

With regard to fiction, a more tranquil account of airship development was offered by Rudyard Kipling, his book coming out during the year of the phantoms. Set in the year 2000 A. D., *With The Night Mail* envisioned a worldwide system of postal packet airships, plying the night skies along designated air routes. Other commerce carriers similarly dotted the skies, while large freighter submarines hauled cargo through the ocean depths. Perhaps Kipling's vision of peaceful employment of the new warfaring technology manifest in airships and submarines helped settle the British hysteria of 1909. For better or worse, such writings undoubtedly kept the public interested in aeronautical developments.

Airships were nevertheless soon involved in night military operations and training. On 3 November 1909, three German airships; the *M2*, *P2*, and *Z2* (formerly *LZ5*), departed Cologne under cover of darkness to execute mock attacks against the garrison at Coblenz and the fortress of Ehrenbreitstein. Londoners truly did hear an airship in the early morning hours of 3 June 1910. The *Beta* flew a seventy-mile round trip from the Balloon Factory at Aldershot, circling St Paul's Cathedral from 1,000 feet. French airships and airplanes both participated for the first time during the 1910 army maneuvers; in the process a

Clément-Bayard dirigible successfully reconnoitered the positions of bivouacked armies at night.[29]

Once again, rumors of German airships overflying England were sounded. According to the *New York Times*, a dirigible was "plainly observed" by members of the RFC over Scheerness, a garrison town and naval seaport, on the night of 14 October 1912. The new German naval airship, *L1* had indeed left Friedrichshafen the previous day on an endurance flight which would last for thirty hours and cover 900 miles, but the Germans steadfastly denied such an intrusion. Certainly this disavowal met with skepticism, but in the end the importance of the "scare" was that "Germans were capable of such a foray and there was nothing the British could do about it."[30]

Night airship experimentation had increased as airship capabilities improved. The British made at least one attempt with the *Beta* in 1913 for night artillery spotting. In the last days of peace, Germany's *L3* made a twenty-two hour endurance flight during which experiments in radio-direction finding were presumably conducted. Convinced that

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[29]"Airships Surprise Fortress," *New York Times*, 4 November 1909, p. 1; Mead, *Eye in the Air*, 36; "Army Airship Over London," *New York Times*, 5 June 1910, part 2, p. 2; "Night Flight Without Lights," *ibid.*, 17 September 1910, p. 9; Christienne and Lissarague, *French Military Aviation*, 38-39.

[30]"A Strange Airship Seen In England," *New York Times*, 17 November 1912, part 3, p. 4; "Sure Zeppelin Ship Sailed Over England," *ibid.*, 18 November 1912, p. 1; Robinson, *Zeppelin in Combat*, 21-22; Gollin, *Impact of Air Power*, 223-225.

airplane development remained in an immature state, German war planners recognized the utility of night operations but insisted that their airship fleet was intended for mainly daylight operations. Night airship flights had indeed become almost routine for the British, French, and Germans on the eve of Sarajevo.[31]

As hostilities opened in August 1914, the combatants were clearly unequal in airship strength and ability. The Germans had twelve airships available; ten rigid and one each non- and semi-rigid. France could muster only six dirigibles, many having previously become obsolete. Their first rigid ship was unavailable, needing further modifications. In Britain all army airship assets had previously been transferred to the navy. Seven non- and semi-rigid were all that was available. In fact the first rigid designed ship was not even begun by this time; "those valuable years from July, 1908 had been frittered away."[32]

Understandably, the development of night flying by airplanes was a slow process. Unable to fly in the slightest bad weather, fragile early craft could scarcely be expected to venture into the nighttime sky with any degree of safety. The first recorded night flight occurred on 22 October 1909 at College Park, Maryland, though others may

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[31]Higham, *British Rigid Airship*, 15; Robinson, *Zeppelin in Combat*, 31; Imrie, *German Air Service*, 19.

[32]Imrie, *German Air Service*, 21; Christienne and Lissarague, *French Military Aviation*, 25; Higham, *British Rigid Airship*, 72-73.

have taken place earlier. Wilbur Wright and his student, Lieutenant Frederic E. Humphries, a Signal Corps aviator trainee, flew for forty-two minutes "under a bright moonlight." Wright then flew a two-minute night solo ten days later. The only other recorded Wright Brothers night flight took place at Hempstead, Long Island, New York on 7 August 1911, with Orville flying a Model R. Unfortunately, the Wrights failed to record their impressions or reasons for flying after darkness.[33]

Airplane night flying manifested itself for the first time in Europe on 28 April 1910, during *The Daily Mail's* London to Manchester race. Only five days earlier Claude Grahame-White abandoned his first attempt at the $50,000 prize, "recognizing the danger of approaching Manchester in the darkness." Grahame-White soon had competition for the purse when Louis Paulhan took off from London. Paulhan landed in the dark near the village of Lichfield, having run out of fuel after covering 117 miles. Well behind Paulhan, Grahame-White descended near the village of Roade (in the vicinity of Northampton) since "the light was getting too bad."[34]

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[33]"Wright Flies Py Moonlight," *New York Times*, 23 October 1909, p. 1; "Makes Night Flight," *Dayton Journal*, 23 October 1909, p. 1; Arthur G. Renstrom, *Wilbur and Orville Wright: A Chronology Commemorating the Hundredth Anniversary of the Birth of Orville Wright August 19, 1871* (Washington, D.C.: Library of Congress, 1975), 205-206.

[34]"Flies 113 Miles, But Loses Big Prize," *New York Times*, 24 April 1910, p. 13; "Paulhan Wins $50,000 Race," *ibid.*, 28 April 1910, p. 1.

In an unsuccessful bid to overtake his rival, Grahame-White decided to leave the ground in the early morning hours, but *not* until the moon had come above the horizon. The fear of losing the $50,000 prize no doubt influenced his decision to fly in the dark. Commenting on his harrowing experience the following day Grahame-White recalled that,

> I felt -- well, I scarcely know how I felt. I did not know whether I should lose myself flying through the night. My start was a confused jumble of scattered lights, which swept away swiftly below me. I could not judge my run along the ground, but I rose as speedily as possible. Directly I was in the air, the lights of the railway station showed clearly below me, and I headed for them. I could see absolutely nothing of the ground below me; it was all a black smudge . . . Great difficulty presented itself in knowing in the darkness whether I was ascending or not. I had done no night flying before.[35]

The British, while giving Paulhan credit for winning the race, lauded the night flying of Grahame-White even more. One journalist who witnessed the event "saw him pass overhead like a great black bat." Apparently the loss of a second coveted air record to a Frenchman, the first being Blériot's Channel crossing in 1909, injured the pride of many British. Hence they extolled Grahame-White's accomplishments at the expense of Paulhan's victory. Being a bit more objective, the *New York Times* cautiously noted that night flying "will have to receive much consideration

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[35]"Mr. Grahame-White's Attempt," *Times*, 29 April 1910, p. 9; Claude Grahame-White, *Story of Night Flight*, in "Aviators Tell Of Great Race," *ibid.*, 29 April 1910, p. 3.

from the navigators of the future, and the problems they will have to solve are many."[36]

Nonetheless, sailing through the night sky caught the imagination of many pioneer heavier-than-air aviators, just as it had with balloon and airship aeronauts. Exhibition pilots began to add night flights to their repertoire before the end of 1910. Charles K. Hamilton, one of America's premiere stunt pilots, amused himself by chasing a bat during one night flight. Ralph Johnstone and Walter Brookins flew by moonlight for over an hour. Arch Hoxsey went so far as to cover his aircraft with aluminum (metallic) paint; ascending into the nocturnal sky, "it became as bright under the silver of the moonbeams as if it had been phosphorescent."[37]

However, such folly had its consequences. Accidents were commonplace for exhibition pilots during the day, and the night only compounded the dangers involved in stunt flying. At a meet in New Jersey, several Wright exhibition team members ascended into the darkness, equipped with port and starboard lights, as well as automobile horns to "honk each other out of the way." By 1912, so many of these

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[36]Philip Gibbs, "Watching the Early Travelers in the Air," *U. S. Air Service* 8, no. 11 (November 1923), 23; "Aviators Lose Their Way," *New York Times*, 30 April 1910, p. 8.

[37]"Hamilton Chased Bats In Night Flight," *ibid.*, 28 June 1910, p. 5; "Schriever In A Long Moonlight Flight," *ibid.*, 19 September 1910, p. 1; "Airmen Play Tag With Moonbeams," *ibid.*, 20 August 1910, p. 16.

pilots had been killed or injured in "trick" flying that Walter Brookins, a well-known daredevil, formed the "Safe and Sane Club," in which pilots pledged not to stunt. Howard Gill, who had been seriously injured while attempting a night landing, joined the club. However, as the American public's demand for such stunt flying remained insatiable, it was not very surprising when Gill was killed in a twilight mid-air collision during an exhibition in Chicago, five months later.[38]

Around this time occurred the first organized night flying exhibition in Great Britain. Grahame-White and Louis Noel flew as part of a pyrotechnic display at Hendon, their airplanes being equipped with multi-colored electric light bulbs. Léon Morane made night flights in a Blériot monoplane from Etampes aviation camp in France in August 1910, though he probably did so even earlier. Other French pilots soon followed his example.[39]

Probably most important about these early night flights through roughly 1912, was that almost always, the London to Manchester race being the greatest exception, the

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[38]"Night Ascension For Aeroplanes," *ibid.*, 18 August 1910, p. 2; "Aviators Form Club To End Air Follies," *ibid.*, 6 April 1912, p. 5; "Gill Badly Hurt At Night," *Aero* 3, no. 18 (3 February 1912), 355; "Aviator Killed In Midair Collision," *New York Times*, 15 September 1912, p. 1.

[39]Mahgni-Eltten, "Night Flying - Ancient and Modern," *Aeronautics* (London) 10, no. 138 n.s. (7 June 1916), 367; "Gary Is Charmed With Night Flight," *New York Times.*, 28 August 1910, part 3, p. 3; "Makes Night Flight," *ibid.*, 10 September 1910, p. 3; "Night Flight Over Paris," *ibid.*, 12 February 1911, part 3, p. 2.

flying remained limited to the immediate confines of the aerodrome and at low altitudes. Such restrictions, besides the obvious need to stay within range of the paying multitudes at flying exhibitions, appear to have been dictated by the unreliability of aircraft engines. While such flying was sure to please a crowd, one author felt assured that "in reality they were easy and hardly dangerous." Whether or not he had flown at night during this period is unknown! In the United States exhibition flying became bolder, with night loop-the-loops the crowd pleaser of 1916 (see figure 1).[40]

With improvements in aircraft capabilities, more and more pilots began attempting long-distance and endurance flights. The Frenchmen Ernest F. Gaillaux and Maurice Gaillaux both made long-distance flights from Biarritz during 1913. But it was the exploits of two German pilots, Bruno Langer and Karl Ingold, early the following year that remain phenomenal accomplishments even today.[41]

On 3 February 1914, Langer flew an incredible fourteen hours and seven minutes nonstop, in the process setting a

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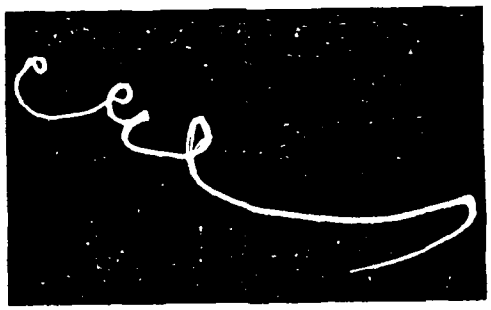
[40]"Les Vols de Nuit Avant la Guerre," Conférences sur les vols de nuit Escadrille F 25, *janvier* 1917, 1, box A164, *Service Historique de l'Armée de l'Air (SHAA); Capitiane* Personne, "Vols et bombardements de nuit," 31 *decembre* 1917, 1-2, box A89, *SHAA*; "Aero Club of Pennsylvania," *Flying* 5, no. 7 (August 1916), 302. The cover of the May 1916 issue of *Flying* (5, no. 4) featured a photograph of a night looping exhibition.

[41]Aviation and Sports, "Noteworthy Events In The World's Progress In 1913," *New York Times*, 31 December 1913, p. 10.



Miss Katherine Stinson writing the abbreviation "Cal" in a series of eight loops at Los Angeles

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Fig. 1. Flying school advertisement from 1916 showing night looping exhibition.

new duration record. Not to be outdone, Ingold departed Mulhouse, in Alsace, four days later for a long-distance flight. Flying near the Allgau mountains in the dark, he "perceived on the horizon a light which drew him like a moth" -- Munich. Ingold landed his *Aviatik* biplane there after sixteen hours and twenty minutes of flying, in the process covering 1,700 kilometers. Langer quickly reciprocated with another attempt on 11 February, leaving Johannistal aerodrome in a Roland biplane loaded with 655 liters of gas and 60 liters of oil. On landing at Kreuz, near Posen, Bruno fell but twenty minutes short of tying the record.[42]

The journal *l'Aérophile* argued that the robust nature of German aircraft, with their water-cooled engines, inspired "absolute confidence" in their pilots. Many German fliers therefore became determined to "systematically practice night flights" in the hopes of winning the large prizes offered by the *National Flugspende* (National Aviation Fund). Without the excessive fear of mechanical failure, and with the innovations in airborne and ground lighting systems, which will be discussed later, the Germans led in the attack for the conquest of the night.[43]

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[42]"Vols de Nuit: Les records de distance et de durée et la signalisation nocturne des Aérodromes en Allemagne," *l'Aérophile* 22, no. 5 (*1er mars 1914*), 109.

[43]*Ibid.*

Organized military night flying was slow to germinate in the prewar period. Simply stated, the operational usefulness of such flights was not foreseen. In fact, the RFC specifically prohibited night flying in its original standing orders of April 1912, as did various French regulations as late as 1913. Even so, the boldness of many early aviators dictated night experimentation. *Major* Wilhelm Siegert established German military night flying experimentation at Metz in the winter and spring of 1913. He would remain a driving force for German night activity during the First World War.[44]

The first RFC Military Wing night flight occurred on 16 April 1913, when Lieutenant Cholmondeley flew a round trip from Larkhill to Upavon. No. 3 Squadron made further pilgrimages into the night, but any organized, meaningful night training prior to August 1914 was resisted by higher authority - the only mission of the Military Wing remained daylight reconnaissance. Speaking at a meeting of the Aeronautical Society of Great Britain in February 1913, Major Frederick H. Sykes, Commandant of the Military Wing, RFC, argued against too much reliance on airplanes, in part due to their inability to work at night. Yet he foresaw an increasing likelihood that ground armies would mask their

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[44]Personne, "*Vols et bombardement de nuit*," 2, box A89, *SHAA*; Bill Gunston, *Night Fighters: A Development and Combat History* (New York: Scribner, 1976), 13; "Vols de Nuit," *l'Aerophile*, 110; *Major* Georg P. Neumann, *The German Air Force in the Great War*, trans. J. E. Gurdon (London: Hodder and Stoughton, [1920]), 176.

movements in darkness, owing to the daylight presence of observation aircraft. He believed that night reconnaissance might become "one of the most important duties of airships."[45]

Sykes spoke again to the Aeronautical Society the following year. While progress was being made, he declared:

> To sum up the question of observation, although a very solid all-round advance has been made in day work, night work, in so far as the aeroplane is concerned, has shown no tangible results. Night work at present lies in the scope for the aeroplane which can, for certain, fly for 14 hours with two engines and fuel for this endurance.[46]

Motors remained unreliable, while insufficiently strong undercarriages (to withstand hard landings) and inadequate lighting further hampered night operations.

As already mentioned, a U.S. Army Signal Corps officer accompanied Wilbur Wright on the first night flight in 1909. Apparently, nearly two years transpired before night flying reappeared at the aviation field at College Park, Maryland. Lieutenants Thomas DeW. Milling and R. C. Kirtland landed by signal fires after a short flight from Chevy Chase on 21 August 1911. Similarly, Captain Charles DeF. Chandler, the field commander, returned from the Naval Academy one summer

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[45]Christopher Cole and E. F. Cheesman, *The Air Defence of Britain 1914-1918* (London: Putnam, 1984), 5; Bill Gunston, *Night Fighters*, 13; F. H. Sykes, "Military Aviation," *The Aeronautical Journal* 17, no. 67 (July 1913), 131-133.

[46]F. H. Sykes, "Further Developments of Military Aviation," *The Aeronautical Journal* 18, no. 70 (April 1914), 90-91.

night in 1912 to land by beacon fire. He had followed the signal lights along the Baltimore and Ohio Railway line to College Park. Night scouting was attempted at the field using two airplanes equipped with acetylene searchlights in November 1911. Lieutenant Henry "Hap" Arnold flew on one of these experimental aircraft, yet two years later declared that "the use of aeroplanes at night need not be considered at the present time, even if there are fanciful pictures of aeroplanes fitted with searchlights."[47]

Interestingly, an article appeared in the Austrian journal *Fachzeitung für Flugtechnik* immediately after the U.S. night scouting experiments of 1911, extolling such efforts at night flying with airplanes. Trials of airplane-mounted spotlights, while not completely successful, nevertheless had shown that night reconnaissance might become an important future function of airplanes. With remarkable insight, the author of the article even posited the idea of night photographic reconnaissance. If airmen utilized sensitive cameras in conjunction with airborne searchlights, the darkness would no longer hide enemy activity. During the French army maneuvers of 1912, a squadron of fifteen airplanes had been equipped with

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[47]"Army Airmen Land at Night," New York Times, 22 August 1911, p. 2; "Breaks Army Altitude Flight," *ibid.*, 2 June 1912, part 2, p. 1; Charles deF. Chandler and Frank P. Lahm, *How Our Army Grew Wings: Airmen and Aircraft Before 1914* (New York: Ronald Press, 1943), 225-227; "Fly At Night With Lights," *New York Times*, 19 November 1911, part 2, p. 13; Henry H. Arnold, "Arnold Shows Use Of Air Craft In War," *ibid.*, 8 September 1913, p. 5.

searchlights, presumably for night observation activities. Yet few aviators were convinced of the value of night airplane reconnaissance in the prewar era. Such a scheme would not find useful implementation until the closing months of the First World War.[48]

U.S. Signal Corps night activity remained unorganized until Europe had been at war for quite some time. United States Naval Aviation, established in July 1911, similarly incorporated experimental night flights before the war. The Belgian M. V. De Jonckheere performed a mock night attack on the USS Massachusetts, docked at Philadelphia in 1912. Searchlights attempted to illuminate his plane before it reached the ship. He contended that he "could have blown the warship to atoms." On the opposite coast, naval officers had earlier watched a similar attack as well as a mock bombing of a miniature city by several civilian aviators, including Glenn Martin. Additionally, naval aviators flew night scouting missions at Guantanamo Bay, Cuba, finding the wind conditions more favorable than during the day.[49]

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[48]"Ueber nächtliche Rekognoszierungsflüge," *Fachzeitung für Flugtechnik* 5, no. 50 (10. *Dezember* 1911), 19-20; "Squadron of Aeroplanes," *New York Times*, 17 September 1912, p. 4.

[49]"Aviator Foils Searchlight," *ibid.*, 7 April 1912, part 2, p 1; "Night Flying Successful," *ibid.*, 11 February 1912, part 4, p. 11; "Scouts Fly At Night," ibid., 31 January 1913, p. 5.

By 1914 then, though man had been roaming starlit skies for nearly a century, the conquest of the night had scarcely begun. The Great War would change all that as necessity spurred innovation in flying under the cover of darkness. Indeed, night flying could no longer be ignored.

CHAPTER 2

THE EMERGENCE OF NIGHT BOMBING, 1914 - 1916

Aerial bombardment was in its infancy as the First World War spread across Europe. Experimentation had taken place in the prewar era, most notably manifest in the Michelin bomb dropping competitions, the *Aéro Cible*, which had begun in France in 1912. Germany had examined the possibility of the use of Zeppelins as bombing platforms, while in Great Britain, the Royal Naval Air Service (RNAS) actively pursued such activity with airplanes. The RFC did *some* experimentation but insisted that reconnaissance remained the primary function of aircraft. The Canadian official historian notes that there was much "visionary writing" about aerial bombardment yet there existed "little connection between theory and reality." By August 1914 however, the very idea of *night* aerial bombardment by airplanes was given little thought.[1]

Pilots began to carry small bombs in their aircraft during daylight scouting missions. The bombs were dropped

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[1]S. F. Wise, *Canadian Airmen and the First World War: The Official History of the Royal Canadian Air Force*, vol. 1 (Toronto: University of Toronto Press, 1981), 9; *"Les Vols de Nuit Avant la Guerre," Conférences Escadrille F 25, janvier* 1917, 1, box A164, *SHAA*.

into the massed troop formations encountered daily during the "war of movement." Though this aerial bombardment made little impact on the advance or retreat of troops, it did cause short-term disruptions as soldiers took cover during the bombings. The primary purpose was to simply harass the ground forces. Nevertheless, aerial bombardment soon found sanction with higher authorities who wanted to strike the enemy by all possible means. Bombardment hence became a second specialized function of the military airplane, though it would remain in a primitive state of development for some time.[2]

The French leadership was so impressed with the possibilities of aerial bombardment that they created *Groupe de Bombardement* (*GB*) 1 after less than two months of combat (27 September 1914). In October *the Grand Quartier Général* (*GQG*) ordered the formation of sixteen bomber *escadrilles*, to be organized under four *GBs*. The advancement of French bombardment aviation had begun. With grand designs of their own, the German Air Service formed the *Brieftauben Abteilung Ostende* (*BAO*) at this time for the bombardment of England from Calais. Yet Russia made the most audacious attempt to acquire a bombardment capability for its air service by

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[2]Lee Kennett, *The First Air War, 1914-1918* (New York: Free Press, 1991), 47-48.

incorporating Igor Sikorsky's giant four-engined Ilya Muromets airplanes into the Squadron of Flying Ships.[3]

With the exception of Sikorsky's large aircraft, early bombardment planes were simply converted observation platforms with little capacity for carrying bombs. Often they were "pusher" type aircraft (with the propeller situated behind the aviators pushing the plane through the air) which afforded excellent forward visibility. Tractor aircraft (propeller in the front), with their more restricted field of vision, were found less useful as early bombers. As one example, the French air service developed the Voisin pusher into its first bomber. With good visibility for the aircrew, the plane apparently was selected because its bomb-lifting capacity exceeded that of any other plane in the French inventory. With engine improvements and use as a night bomber the Voisin remained active throughout the Great War.[4]

Yet prewar theorists of air power had regarded the *airship* with its great lifting capacity as the ideal instrument for aerial bombing. It is not surprising then, that a Zeppelin following quickly on the heels of the German infantry advance into Belgium carried out the first night bombing operation of the First World War. During the night

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[3]Christienne and Lissarague, *French Military Aviation*, 81-82; Neumann, *German Air Force*, 157; Kennett, *First Air War*, 46.

[4]Christienne and Lissarague, *French Military Aviation*, 83.

of 6/7 August 1914, the German Army's *Z6* attacked the fortress of Liège. However, the airship was damaged by gunfire during the assault and subsequently removed from service. In the following weeks three more German Army airships were quickly lost during low-level daylight operations.[5]

The long-feared German airship blitz had proven to be merely myth. Soon after these stunning losses, German military authorities restricted the remaining dirigibles of prewar construction to night use. Nevertheless in night operations against Antwerp and Ostend during September, the airship confirmed its usefulness. Experience in night employment began to show that flights under bright moonlight proved exceedingly hazardous for the slow-moving dirigibles. By November 1914 the German craft were restricted to operating only on the dark nights associated with the new moon. Such a policy limited airship operations to a maximum of about fourteen nights per month.[6]

The French fared little better with their airships in the early months of the war. While carrying out night missions the French dirigibles *Conté* and *Dupuy de Lôme* suffered heavy damage from friendly fire. Influenced by

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[5]Imrie, *German Air Service*, 23-24.

[6]*Ibid.*, 24; Ernst W. von Höppner, *Germany's War In The Air: A retrospective on the development and the work of our military aviation forces in the World War*, trans. J. Hawley Larned (Leipzig: Köhler, 1921), bound typewritten translation in the Air University Library (AUL)., 40.

pre-existing fears of the German dirigibles, French troops saw in every airship the spectre of the "Zeppelin." Unable to stop their troops from indiscriminate firing, French authorities were forced to discontinue airship operations; they would not be resumed until April 1915. Once missions recommenced however, the French military found their airships increasingly vulnerable during night operations. By autumn, missions were carried out only on the darkest nights -- a lesson the Germans had learned nearly a year earlier. Disregarding the risks, the airship *Alsace* continued to fly at low altitudes, even on moonlit nights, in the hope of improved bombing accuracy. Such daring turned to tragedy on 2 October 1915 as the dirigible was destroyed during a night operation.[7]

During this time the first bombing planes had begun to penetrate the nighttime sky; with several aviators claiming to be the first to undertake such a mission. *Sous-Lieutenant* Almonacid, commander of *Escadrille* MF 29 at the end of 1915, declared that he had made a trial night flight (bombardment?) in September 1914. For this he was punished by higher authorities. Ignoring his superiors, Almonacid made another night flight after which he "obtained authority to make raids and bombing on the North Sea coast."

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[7]Christienne and Lissarague, *French Military Aviation*, 62-64.

Unfortunately, no other source has corroborated his assertions, though they may well be fact.[8]

Another aviator who claimed the first night bombardment of the war was Wing Commander Charles Samson, commander of No. 3 Naval (N) Squadron, RNAS at Dunkirk. Having done some night flying while in command at the naval aviation training school at Eastchurch, Samson was confident of his ability to cope with a night combat mission. Using a Maurice Farman pusher loaded with eighteen sixteen-pound bombs, the pilot departed around 2200 hours on 21 December 1914 to hunt German submarines at Ostend. From an altitude of 6,000 feet Samson throttled back and soared in over the sea toward his objective. Having descended to 1,000 feet without locating any submarines, he powered up the engine and turned to bomb the artillery batteries south of town. Samson recalled: "As soon as the noise of my engine was heard pandemonium started." Dropping his bombs, Samson headed back out to sea, avoiding the numerous searchlight beams which had quickly appeared. Soon afterwards he landed safely on the sands near Dunkirk.[9]

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[8][*Sous-Lieutenant*] Almonacid, "Etudes Relatives A l'Aviation de Bombardement," [Studies Relative to Aviation Bombing], Translation no. 107, n.d. [late-1917?], 1, RG 120, Entry 806, National Archives (NA).

[9]C. F. Snowden Gamble, *The Air Weapon: Being Some Account of the Growth of British Military Aeronautics From the Beginnings in the Year 1783 Until the End of the Year 1929*, vol. 1 (London: Oxford University Press, 1931), 238; Air-Commodore Charles R. Samson, *Fights and Flights* (London: Ernest Benn, [1930]), 177-179.

Samson relates that while he was heading to the aerodrome on the night of 27 January 1915 for his next night bombing mission, an unseen German machine bombed the airfield. *Major* Wilhelm Siegert, the organizer of *BAO*, insists rather that the bombardment occurred the following evening. For this *BAO* operation fourteen mixed-type aircraft, including at least one Otto pusher -- an "antediluvian machine" -- departed one after the other from Ghistelles airfield. Siegert noted later that "every once in a while we saw below us or to our side the fiery exhaust gases of other airplanes." Amazingly there were no mid-air collisions during the mission and all aircraft returned home safely. Later, to reduce the possibility of collision, night bombers were individually dispatched into the night at intervals of roughly five minutes.[10]

The *BAO* found itself stranded at Ghistelles airfield when the German offensive ground to a halt in northern France. Without Calais, the unit could not carry out a protracted bombing campaign against England with existing

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[10]Samson, *Fights and Flights*, 188; Neumann, *German Air Force*, 176-177; Wilhelm Siegert, "First German Bomber Squadron Attack on Dunkerque," trans. Ursula E. Wolff, *Cross and Cockade Journal* (U.S.) 13, no. 4 (Winter 1972), 322-324; "The Necessity for a Profound Study of the Bombing Section of Aviation with a View to determining Rules for Employment," n.d. [19 January 1918 on folder in pencil], 14, 248.222-60, United States Air Force Historical Research Center (HRC). One author found that German air units did sporadic night bombing as early as December 1914, see Kennett, *First Air War*, 52-53. A photograph of an *Otto* pusher is found in John H. Morrow, Jr., *Building German Airpower, 1909-1914* (Knoxville, University of Tennessee Press, 1976), 98.

aircraft. The *BAO* was sent to the Eastern Front for a time, only to return to Ghistelles airfield in early 1916.[11]

Within a month of Siegert's night bombardment mission against Dunkirk, a Friedrichshafen FF 29 floatplane assigned to the German Navy's *Seeflieger Abteilung* (*Sfa*) 1 at Zeebrugge, made an unopposed night penetration twenty-five miles into England. After dropping three bombs which caused no effect, the plane made a forced landing in the Channel. The crew was later rescued and interned by the British.[12]

Yet this had not been Germany's first night incursion over British soil. Several days earlier, on 19 January 1915, Navy Zeppelins *L3* and *L4* set off from Hamburg-Fuhlsbüttel, carrying their maximum loads of sixteen men, eight 110-pound explosive bombs and ten or eleven twenty-five pound incendiaries, to attack targets along the Humber River. Unable to reach their objective the airships bombed targets of opportunity before turning for home. The mission demonstrated to German authorities the need for a more advanced base of operations before London could be attacked.[13]

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[11]C. M. White, *The Gotha Summer: The German daylight air raids on England, May to August 1917* (London: Hale, 1986), 33-34.

[12]Cole and Cheesman, *Air Defence of Britain*, 28-29.

[13]Zeppelin *L6* started on the mission but was forced to turn back due to engine problems. Cole and Cheesman, *Air Defence of Britain*, 24-25; Robinson, *Zeppelin in Combat*, 58-60. Forward basing was soon established at Brussels, Maubeuge, and Gontrode, see Imrie, *German Air Service*, 29-30.

Such was not a prerequisite for attacking Paris. The capital was assaulted on the night of 20 March 1915 by two German airships flying at 7,000 feet. Heavy anti-aircraft fire crippled one dirigible as it passed over the city. Another raiding airship was damaged while attacking the French army headquarters at Compiegne. Though *General* Ernst von Höppner, later the *Kommandierender General der Luftstreitkräfte*, remembered the operation as a success, further similar "successes" would have decimated the German airship fleet. Additional night raids occurred in the first half of 1915 against Dunkirk, Nancy, and Calais.[14]

Over Calais on the night of 17 March 1915, the Germans tried a novel method for navigating airship *Z12*. Due to poor visibility the crew had been unable to locate their objective. Therefore a singly-manned observation car was lowered from the airship's bomb compartment by means of a thick steel cable. Steering blindly by directions telephoned to the control car from the observer 1,000 feet below, *Z12* was able to complete its bombing mission.[15]

Naval zeppelins carried out two more night attacks against England before the first appearance of a German army airship over the British Isles. The army's four-engined,

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[14]Höppner, *Germany's War*, 40.

[15]Ernest Dudley, *Monsters of the Purple Twilight: The True Story of the Life and Death of the Zeppelins, First Menace from the Skies* (London: George G. Harrap & Co., 1960), 36-37. A photograph of an observation car is on page 32.

one million cubic-foot capacity *LZ38* attacked East Anglia on the night of 29 April 1915. Little more than a month later, this same airship made the first night raid on London. Airship *LZ38* flew five more missions over England before being destroyed on the ground by RNAS bombing.[16]

Airships had easily adapted to a night bombardment role during the first year of fighting; such was not the case for existing limited-capability airplanes. Converted observation aircraft would simply no longer suffice for aerial bombardment; specialized aircraft specifically designed for such a role had become a necessity. One author believed 1915 the "Year of Decision" for German aviation, and certainly it was a fitting motto for the other air services as well.[17]

The need for greater aircraft range was immediately evident with the failure of the *BAO* to implement cross-Channel bombing from Ghistelles airfield. Another related problem was the lifting capacity of aircraft. The Maurice Farman (MF) 7 "longhorn" and MF 11 "shorthorn" are prime examples; either type could carry no more than 300 pounds of bombs. The answer to these challenges appeared in the development of multi-engine bombers.[18]

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[16]Cole and Cheesman, *Air Defence of Britain*, 51-53; Robinson, *Zeppelin in Combat*, 74.

[17]John H. Morrow, Jr., *German Air Power in World War I* (Lincoln: University of Nebraska Press, 1983), 36.

[18]J. M. Bruce, *The Aeroplanes of the Royal Flying Corps (Military Wing)* (London: Putnam, 1982), 238-246.

Sikorsky had already demonstrated such a capability with his four-engined Ilya Muromets airplanes. Additionally, Giovanni Caproni's trimotor prototype was flying before the end of 1914. The belligerents pushed for multi-engined development, two of the boldest schemes being the *Riesenflugzeug* (R-plane) and the British Handley Page 0/100 programs. Progress was slow as immense difficulties had to be overcome before prototypes became operational. Neither plane would play a role in Western Front aerial bombardment until late in the war.[19]

Ventures less ambitious than the Handley Page and R-plane programs were undertaken as short-term solutions for bombardment. One example were the German C-planes, armed single-engined biplanes which, though devised for observation, became useful bombers in 1915. These aircraft continued to be used as bombing platforms through much of the war. *Grossflugzeuge* (G-planes) were an outgrowth of the German failure the capture Calais. They were the first twin-engined aircraft of World War I, and quite possibly the first aircraft specifically designed for bombardment to gain large-scale production. However they remained in insufficient numbers until 1917.[20]

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[19]Kennett, *First Air War*, 45-46; G. W. Haddow and Peter M. Grosz, *The German Giants: The Story of the R-planes, 1914-1919* (London: Putnam, 1962), 1; Bruce, *Aeroplanes of the RFC*, 261-268.

[20]White, *Gotha Summer*, 34-35; Morrow, *German Air Power*, 74-75.

Another critical challenge to the development of bomber aircraft in 1915, the "Year of Decision," came from increasingly effective air and ground defenses. Antiaircraft artillery (AAA) had been practically nonexistent at the start of World War I; by the spring of 1915 Germany had 138 such weapons. Furthermore, the entry into the daytime skies of tractor monoplanes with fixed forward-firing machine guns spelled trouble for bombardment aviation. Bombers no longer had comparatively free passage to their objectives. Burdened by added weight the bombers had little chance to outmaneuver the smaller faster-flying, quicker-climbing "fighters."[21]

The Morane-Saulnier Type N gave the Allies a great offensive advantage in the sky. Metal deflectors were attached to the propeller for protection against its forward-firing machine gun. Yet the first airplane specifically designed for aerial fighting was the Fokker *Eindekker* used by the Germans. It had the distinction of being the earliest airplane with a synchronizing gear to prevent bullets from striking the propeller. Most vulnerable to attack by these airplanes were pushers like the Voisin, which had no defense against attacks from the rear. Hence by the end of 1915 daylight bombardment aviation was sustaining heavy losses due to the combination of pursuit aircraft and antiaircraft artillery; the only

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[21]Kennett, *First Air War*, 52.

immediate solution was to fly under the cover of darkness.[22]

In the increasingly high threat aerial environment of 1916, night flying provided bombers with freedom of action on the Western Front. The fighter menace faded into the gathering darkness -- few pursuit pilots were willing to fly their inherently unstable machines in such conditions. Had they succeeded, the opportunity for intercepting bombers at night appeared insignificant. AAA was much more inaccurate at night than during the day. Unless a plane was caught in a searchlight beam, AAA could offer only feeble resistance to the unseen night fliers; ranging remained difficult even when searchlights illuminated aircraft for short periods.

Another advantage was lower flying altitudes than during daylight operations; this increased the likelihood of scoring direct hits against targets. Yet most importantly night bombing had a greater impact on morale. What could be more terrifying than bombardment by an unseen enemy against whom there was no defense?

Yet there were a multitude of disadvantages to night bombardment. Navigating to the target area and then distinguishing the target were especially difficult on dark nights or in bad weather -- some targets simply could not be seen. Therefore only large readily-identifiable targets which could not be camouflaged, such as railway yards and

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[22]*Ibid.*, 69-70; Bruce. *Aircraft of the RFC*, 296-303.

cities, could be selected as objectives. Since the enemy knew the probable targets for night bombers, elaborate ground defenses were soon established. Hence the fliers often had to dodge searchlights and shrapnel on their bombing runs, often with the consequence of decreased bombing accuracy.

Probably the most hazardous aspect of night flying however was merely attempting to make a safe landing. Since fog or mist often obscured the ground at low altitudes, landings remained dangerous even after the advent of standardized airfield lighting in 1916. Additionally, forced landings due to motor failure were a persistent threat to plane and pilot.

Part of the difficulty stemmed from the use of day bomber planes for night use. Just as early bombers were limited because they had been designed for observation, so too were there disparate requirements for effective day and night bombardment aircraft. The Handley Page, Gotha, and Caproni dominated World War I strategic night bombardment, yet these planes had not been designed from the outset for strictly night operations. Size and slowness banished them into the night, where they nevertheless performed admirably.

One of the first aviators to make a clear distinction between day and night craft was Commander Samson of the RNAS. In a letter to the British Admiralty early in 1915, Commander Samson argued that the following requirements were necessary for a successful night bombing capability:

(1) Very reliable engine.
(2) Speed of seventy miles per hour or more.
(3) Capability to carry 300 pounds of bombs.
(4) Pusher biplanes.
(5) Silenced engine very desirable.[23]

These were for the most part very modest requirements, clearly fulfilling tactical rather than strategic purposes. Though the pusher had been propelled into daylight obsolescence by the fighter, its wide range of visibility made it useful at night. In point of fact the concept remained in vogue throughout the war even for strategic bombers. By means of multi-engine design, the nose of such craft remained open, providing the requisite visibility for night operations.

The French put great stress on this matter of visual field. They claimed that German night bombing was no serious threat so long as the Germans used C-planes:

> The lack of progress in enemy night bombardment has been due to the type of airplane it used, with the motor in the front. Only exceptionally is it possible to do something worthwhile with this type of aircraft at night. You need a night with particularly good visibility, an easy route to follow, and objectives easy to find. . . . A full and unobstructed field of view, both front and straight down is the first requirement of a night aircraft. . . . *No airplane with the motor in front can be a good plane for night use.*[24]

The German *Nachtflugzeug* (N-plane) was the first aircraft particularly designed for night bombardment. With abnormally cambered wings capable of lifting heavy loads

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[23]Letter, Samson to Admiralty, 6 February 1915, quoted in Samson, *Fights and Flights*, 191-193.

[24]*Capitaine* Personne, "Bombardements de nuit," 30 *août* 1917, 1, box A164, *SHAA*.

over short distances, the N-plane was a compromise between the C- and G-planes. The unusual wing configuration also yielded a shorter takeoff roll, with obvious benefits for night flying. However, only about 200 of these airplanes were produced between 1916 and 1918, as aircrews preferred the proven abilities of the G-plane.[25]

Nighttime bombardment could never completely replace the day function however. Daylight bombing was favored over night employment simply because it could be carried out against a wider array of military targets; obviously if the night bombers could not see the target they could not bomb it. Many military leaders considered night bombardment as little more than of nuisance value against the enemy; attacks on bivouacs disrupted sleep, and token raids on cities bred dissension among some of the civilian populace. Yet night attacks on factory complexes and blast furnaces could achieve little long-term effect due to the limited scale in which they were carried out. Hence military authorities continually pressed for the establishment of credible daytime bombardment even as enemy defenses increased.[26]

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[25]Neumann, *German Air Force*, 49, 180; Robert Casari, "The Development of German Army Aircraft, 1914-1918," *Cross and Cockade Journal* (U.S.) 1, no. 3 (Autumn 1960), 7-8; Höppner, *Germany's War*, 75.

[26]Christienne and Lissarague, *French Military Aviation*, 83-84, 89-90.

In the course of 1916 the increase in French night bombing activity coincided with a number of organizational changes: by 11 March 1916 *GB* 3 was officially recognized as the first French night bombardment unit; by May practically all French bombers flew under cover of darkness. Even the new types of bombing aircraft added to the French inventory at this time -- the Bréguet-Michelin (BM) IV, Caudron G-4, and Caproni -- could not compete against the Fokker in daylight operations. They too were assigned to night bombing.[27]

German bombardment also underwent modification at this time as part of a larger reorganization of German aviation in late 1915/early 1916. *BAO* was redesignated *Kampfgeschwader 1 der Obersten Heeresleitung*, or *Kagohl* 1. In all, five *Kagohls* were formed, each with six *Kampfstaffeln*. The *Kampfstaffeln* were individually equipped with six C-planes, the multi-purpose airplane type dominating the German air inventory by the end of 1916. *Kagohls* were used for tactical bombing operations but could not be considered strictly bombardment units like the French *GBs*. When required, the *Kagohls* also performed daylight observation, escort, and defensive patrol work. With but twenty-four G-planes on active duty into late 1916, German aviation

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[27]Christienne and Lissarague, *French Military Aviation*, 89-90, 100-102; Peter Kilduff, "The History of Groupes de Bombardement 4 and 9," *Cross and Cockade Journal* (U.S.) 15, no. 1 (Spring 1974), 3.

continued to lack a heavy-bombardment capability. However this situation was soon to change.[28]

Increasing availability of aircraft enabled the German Army Air Service to yet again reorganize their force structure in October 1916. By then seven *Kagohls* were in existence due to the boost in C-plane production. However as the war dictated further specialization of aircraft duties, the *Kagohls* were reduced in number to three (*Kagohls* 1, 2, and 4), becoming strictly bombardment units. Their bombers increasingly flew under cover of darkness. The excess *Kagohls* were formed into units which took over those non-bombing missions, such as escort duty, formerly required of the bombing squadrons.[29]

As previously noted, the Dunkirk region provided the RNAS with opportunities for bombing targets in German-occupied Belgium. Though Commander Samson and his No. 3 (N) Squadron were reassigned to the Dardanelles in March 1915, No. 1 (N) Squadron continued sporadic bombing throughout 1915. By early 1916, new units and aircraft joined the RNAS at Dunkirk. French-built Caudron G4 and Sopwith 1½ Strutters joined Bréguets and Farmans in the RNAS bomber force. No. 1 (N) Squadron had been reorganized into a wing by the end of 1915. Several months later the unit was

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[28]Imrie, *German Air Service*, 31; Morrow, *German Air Power*, 74-75.

[29]Imrie, *German Air Service*, 40-41; Neumann, *German Air Force*, 164-165, 179.

joined at Dunkirk by No. 4 and No. 5 (N) Wings. These units performed all types of airplane missions, including bombardment, which was by this time usually carried out at night. Additionally, RNAS plans called for No. 3 (N) Wing to be developed into a strategic bombardment force.[30]

Through 1915 the RFC continued to stress reconnaissance as its primary duty. However apparently due in part to losses against the Fokker, General Haig, the British Expeditionary Force (BEF) Commander, authorized night bombing of objectives "up to a distance of five or six miles over the lines" by two airplanes per army per night. The first such RFC mission occurred on 19 February 1916 when two pilots flying BE2c aircraft from No. 4 Squadron attacked the Cambrai aerodrome. During the mission one of the British pilots bombed the airplane sheds from a height of only thirty feet! General Trenchard, the RFC Commander-in-the-Field, then directed his pilots to gain experience in night flying on the British side of the lines. Quite understandably, these airmen were required to fill out reconnaissance reports.[31]

Inevitably, the disparity between the perceived roles of the RFC, emphasizing observation, and the RNAS, pressing for offensive action embodied in bombardment, was bound to lead to conflict. Such confrontation would later erupt over

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[30]Wise, *Canadian Airmen*, 133-134, 139, 143-148.

[31]H. A. Jones, *The War in the Air*, vol. 2 (Oxford: Clarendon Press, 1928), 183-184.

RNAS land-based strategic bombing. Foreseeing the availability of Sopwith 1½ Strutters, the Admiralty made plans in early 1916 to assault German war industry in Essen and Düsseldorf. Fearing that proposed flights from Detling, near Maidstone, England might inadvertently violate Dutch neutrality, the Admiralty approached the French with the idea of a joint venture on the continent. Support of the BEF commander was sought and easily obtained. In fact, General Haig insisted that unless the flights would cross the British lines, he was "not concerned and [saw] no necessity for his concurrence to be obtained." Yet Trenchard and General David Henderson, the Director of Military Aeronautics, prevailed upon Haig to reverse his stance toward the RNAS wing at Luxeuil. The conflict between the RNAS and RFC had only just begun.[32]

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[32]Policy statement on air bombing issued by GHQ BEF, 3rd June 1916, quoted in Neville Jones, *The Origins of Strategic Bombing: A Study of the Development of British Air Strategic Thought and Practice up to 1918* (London: William Kimber, 1973), 79-81, 97-98.

CHAPTER 3

TACTICAL NIGHT BOMBARDMENT

Tactical bombardment pertains mainly to those objectives located in or near the ground battle zone. Colonel William Mitchell defined it in 1917 as bombing occurring within 25,000 yards [fifteen miles] of the front. Targets typically include enemy airfields, railway lines, supply dumps, munitions depots, troop and convoy movements, cantonments, bivouacs, assembly points, command posts and headquarters of front-line units, and similar objectives which have an immediate bearing upon the ground campaign. Bombardment aviation attacks these targets by day and night.[1]

Tactical aerial bombardments had been carried out from the opening days of the First World War; in fact the French GB 1 was considered an extension of the ground artillery when first organized. As such, the bomber crews limited

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[1]Stencil #664, Information Section - Air Division, Office of the Chief Signal Officer (IS - AD OCSO), entitled "Air Service: Its Part in Warfare," by William Mitchell, 20 November 1917, 3, RG 18, Entry 114, box 4, vol. 3, NA; "Night Bombardment and Provisional Air Service Drill Regulations," trans. from French by Col. C. H. Hunter (Information given to General Mitchell by the Commanding Officer, Bombing Regiment, Neustadt), n.d. [late 1918?], 5, 248.222-58, HRC.

operations to within thirty miles of the front lines. Yet the desire to take the war to Germany could not long be contained; strikes were soon carried out against targets at Freiburg, Essen, and Ludwigshafen. Unfortunately the limited bombload and inadequate endurance of operational bombers reduced the effectiveness of strategic raids. When increasingly competent German air defenses were factored into the equation such forays proved too costly to continue. Hence by the second half of 1915 the French were among the first to turn toward routine tactical employment of bombardment aviation.[2]

Several benefits could be gained by using early bombing craft against objectives within the battle zone. First, since less fuel was needed, more bombs could be carried; moreover it was possible to send the bombers on more than one mission in a *single* day or night. For example, one RFC pilot made six raids against German billets "immediately behind the line" during one night late in 1917. Briefer penetrations over hostile territory reduced exposure to enemy fighter and AAA defenses; a switch to night tactical bombing narrowed the threat even further since fighters rarely flew at night and AAA was much less

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[2]Lee Kennett, *A History of Strategic Bombing* (New York: Schribner, 1982), 27-28; Christienne and Lissarague, *French Military Aviation*, 89-90. See appendix 3 for disposition of French bombardment aviation at beginning of 1916.

accurate. The opening of the 1916 campaign along the Verdun sector demonstrated these advantages.[3]

Formation flying became standard for day bombers as did attempts to provide fighter escorts in the high-threat daytime skies over Verdun. However, flying under the cover of darkness offered the greatest opportunity for successful tactical bombardment. The Germans carried out numerous night bombardment missions against French railway yards and airfields during the opening stages of their offensive. In one such operation eighteen C-planes dropped approximately 1,500 pounds of explosives in the vicinity of Amiens without losing a single airplane. Yet for all the heroic efforts of German aviation, only 4,500 pounds of bombs were dropped during day and night missions in support of the February ground advance. Such limited tonnage could do little to stem the continuous flow of supplies into the French sector; the task of isolating the French fell to German heavy artillery. The lack of specialized German bombardment aircraft was clearly evident at Verdun; only two early-model G-planes were available during most of the offensive.[4]

As a supplement to the limited-capacity C-planes, the German High Command incorporated dirigibles into its air plan for Verdun, designating them for night missions against

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[3]D. H. Montgomery, *Down the Flare Path* (London: John Hamilton, [1937]), 54.

[4]Neumann, *German Air Force*, 178-179; Imrie, *German Air Service*, 32-33.

enemy supply lines. However, as attested by the assault on Nancy during the night of 22 February 1916, the German airships were not up to the task when faced with a combination of heavy French AAA defenses and poor winter weather. Of four airships employed during the operation (*SL7, LZ77, LZ88,* and *LZ95*), only one was able to bomb the objective. The other three were either destroyed or forced to turn back. Already overburdened, the *Kagohls* would receive little lighter-than-air bombardment support during the battle.[5]

Slowly the tide turned toward French air superiority in the sector. Germany's effort to deny French use of the airspace over Verdun had required continuous daytime employment of its air assets along the front. Such flying fatigued both men and materiel. Eventually the French gained superiority in fighter strength and forced German air power on the defensive. While *Kagohl* strength had increased to four units by April, the squadrons were nevertheless obliged to give up bombardment for defensive support missions. Their main duties now became daylight contact patrol and aerial combat. Even the G-planes, specifically built for bombardment, flew defensive "fighter" missions behind the German lines. With the loss of air superiority

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[5]Imrie, *German Air Service*, 37.

the German air service could do little to prevent resupply of the French defenders.[6]

French bombardment units fared somewhat better than the *Kagohls* during the fighting at Verdun. Though German pursuit aircraft initially inflicted a high loss rate on the outclassed pushers, the French compensated by increasingly flying under cover of darkness. As one example, *Escadrille* MF 25, the first French bomber unit to arrive in the Verdun sector, became a fully operational night bombardment flight in April 1916. Interestingly *GB* 3, the first French *night* bombing group (recognized as such on 11 March 1916), did not participate at Verdun; the group remained at Malzéville until April when it moved to Esquennoy in the Somme sector.[7]

While the French were able to continue bombing the fourteen rail lines feeding into the Verdun sector, little lasting success was achieved; "continuous" day and night bombardment was necessary yet impossible with existing capabilities. An experimental British study performed in the last year of the war illustrates the difficulty of putting railroads out of commission through aerial bombardment. The study found that the damage caused by the direct hit of one 112-pound bomb dropped from a height of

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[6]Christienne and Lissarague, *French Military Aviation*, 95-96, Imrie, *German Air Service*, 32-33.

[7]Christienne and Lissarague, *French Military Aviation*, 100-102.

3,000 to 4,000 feet could be repaired in "one to one and a half hours." The track would be out of operation for the added time required to get repair crews to the scene; night bombings might have increased the time delay even further if crews were compelled to wait for daylight before starting their repair work. With German reliance on its rail net for resupply, it seem likely that sufficient laborers would have been close at hand for repair of important track sections.[8]

Interestingly, the British tests disclosed that only one bomb in four [112- or 230-lb.?] dropped from a height of 500 feet could destroy a double track railway. Only night fliers could attempt such a low pass, and only along undefended sections of track; French night bombers likely delivered many of their bombs from a higher altitude. If the bombing accuracy noted in the British tests were an indication of French night bombardment performance at Verdun, then German resupply was little hindered. Only six to twelve French planes (each with a 200-kilo bombload) could routinely be employed in night bombing raids -- weather permitting. As the fighting at Verdun waned by late

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[8]Statistical Analysis of Aerial Bombardment, Report No. 110, Statistics Branch - General Staff, War Department, 7 November 1918, *Gorrell's History of the American Expeditionary Forces Air Service, 1917-1919* (*Gorrell's History*), vol. B-7, 99, RG 120, NA. This study used the microfilm edition of *Gorrell's History*: M990.

September, most of the French bomber units had already been transferred to the Somme sector.[9]

Applying lessons learned at Verdun, the French dispersed their bomber bases more widely over the Somme sector; the planes then flew different routes to their objectives. In this way they achieved a more complete reconnaissance of the region while at the same time complicating the task of the German air defense system. Additionally, the French often sent Voisin or Bréguet-Michelin gunships (equipped with 37-mm guns) ahead of the main night assaults in an effort to neutralize enemy searchlight defenses. Finally, the French air service brought German airfields under systematic night bombardment. Presumably this was to aid the day fliers in gaining and maintaining air superiority. At the same time French night bombers continued to give attention to German rail targets and troop concentrations.[10]

Interestingly, the British bombing efforts on the Somme remained primarily daylight operations. Though both the British (RFC) and French had been able to keep air superiority over the front for much of 1916, the French increasingly preferred to bomb at night. Here was a fundamental difference in bombing philosophy between the

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[9]Christienne and Lissarague, *French Military Aviation*, 102.

[10]*Ibid.*, 103-105.

Allies in 1916; French authorities supported an expansion of night bombing while the RFC leadership basically did not.

Fortunately the accomplishments of French night bombardment aviation in the last six months of 1916 have been preserved and offer valuable insight with regard to its employment. Probably the most striking observation to be gained from Table 1 is the limited capacity of French bombardment. Remember that night bombardment during this period represented nearly the totality of French air service bombing operations. Aerial bombardment was carried out an average of only nine nights per month, with poor winter weather a likely factor in reducing operations to a low of four nights in December.

Additionally, the thirteen sortie average per flying night delivered less than 2000 kilos of bombs against only four targets. Railway objectives were overwhelmingly targeted from late summer to early fall, especially in the opening weeks of the offensive, in an attempt to reduce the flow of supplies to the German battlefront (see Table 2). Enemy troop concentrations and command facilities in towns and cantonments were similarly targeted during the period of fighting.

During October the Germans began to turn the tide in the air battle over the Somme. In response the French air service commenced systematic night bombing of German airfields; the only previous aviation related objective

TABLE 1

FRENCH NIGHT BOMBARDMENT AVIATION, JULY - DECEMBER 1916

1916	No. FLYING NIGHTS	SORTIES	BOMBS DROPPED	WEIGHT OF BOMBS (Kg)	No. of OBJECTIVES	ACFT LOSSES* Lost/Damaged	
JULY	13	127	958	9015	41	1	1
AUGUST	9	85	1201	10490	30	1	0
SEPTEMBER	11	192	2944	26910	78	1	2
OCTOBER	7	102	1506	15152	22	0	1
NOVEMBER	10	156	3087	2877X	50	1	1
DECEMBER	4	46	58	4852	24	0	2
TOTAL	54	708	9754	95189	245	4	7
MONTHLY AVG.	9	118	1626	15865	41	0.6	1
NIGHTLY AVG.		13	181	1763	4	-	-

* Lost means did not return from behind enemy lines for whatever reason; Damaged includes from hostile actions or from hard landings. X = illegible

The Oberndorf raid of 12 October 1916 is not included in calculations, though listed in source material as a night raid. Figures are a best estimate from imprecise source material.

Source: *Operations de Bombardement de Nuit Effectuees par l'Aviation de Bombardement, juillet-décembre* 1916, box A21, *SHAA*.

TABLE 2

TYPES OF OBJECTIVES FOR FRENCH NIGHT BOMBARDMENT AVIATION
JULY - DECEMBER 1916

1916	TOTAL	RAILWAY+	AIRFIELDS	BILLETS*	FACTORIES FURNACES	DEPOTS	TOWNS	OTHER
JULY	41	34(83%)	0	0	0	0	6(15%)	1
AUGUST	30	23(77%)	0	3(10%)	1	0	2	1
SEPTEMBER	78	34(44%)	1	4	12(15%)	8	18(23%)	1
OCTOBER	22	13(59%)	3(14%)	3(14%)	2	1	0	0
NOVEMBER	50	15(30%)	19(38%)	4	6(12%)	5(10%)	1	0
DECEMBER	24	3(12%)	6(25%)	0	7(29%)	5(21%)	2	1
TOTAL	245	122	29	14	28	19	29	4

+Railway lines, passenger and freight stations *Billets, bivouacs, cantonments

The Oberndorf raid of 12 October 1916 is not included in calculations, though listed in source as night raid, was in fact a day operation.

Figures are a best estimate from imprecise source material.

Source: *Operations de Bombardement de Nuit Effectuees par l'Aviation de Bombardement, juillet-décembre* 1916, box A21, *SHAA*.

being the airfield hanger at Tergnier on the night of 16/17 September. Attacks against German airfields reached their peak in November 1916. The importance of these attacks is evident; they constituted the first time (in the study period) that railways were not the most frequently targeted objectives of French night bombardment aviation. As the offensive came to an end and winter weather set in the French turned their night bombers against more strategic targets. While French bombardment played a minor role in the events of July through December 1916, night flying allowed it to operate nonetheless; and with relative ease. In testimony to the value of night flying is the extremely low loss rate exacted during combat missions (see Table 1). As a means of comparison, more French bombers were lost during the daylight raid against Oberndorf on 12 October 1916 (eight, including three gunships) than during six months of night operations. Indeed if the figures are accurate, the combination of lost and damaged aircraft amount to less than two percent of the total sorties flown during the period!

During the battle of the Somme, RFC bombers were mostly used in the daytime for artillery and infantry cooperation in addition to operating against typically tactical targets such as railroads and other lines of communication to the front. Many of the tactical bombing missions were of only "nuisance value," primarily designed to divert German fighter strength from over the front lines.

Such action assisted the British in maintaining air superiority and increased the effectiveness of ground artillery. However, the introduction of Roland and Halberstadt fighters during the fall of 1916 made RFC daylight bombing increasingly costly. But instead of turning toward the night skies *en masse*, the British bombers continued day operations -- with an new emphasis on targeting German airfields. Additionally the RFC secured Sopwith 1½ Strutters, which had been destined for RNAS No. 3 Wing at Luxeuil, to redress the growing imbalance over the front.[11]

Due to improvements in the British fighter arm, German *Kagohls* were once again forced into a defensive role during most of the battle of the Somme. *Kagohl* 1 was present at the start of the offensive in July 1916; three additional *Kagohls* moved into the sector with the end of active fighting at Verdun. Their most important contribution during the fray was in providing protective escorts for observation planes. As at Verdun, the German air service was unable to provide wide-ranging tactical bombardment in support of the ground war.[12]

At the beginning of 1917, French bombardment aviation found itself no closer to reestablishing an extensive daylight capability. The Paul Schmitt bombers which were

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[11]Wise, *Canadian Airmen*, 363, 368, 376-381; Imrie, *German Air Service*, 34-35.

[12]Imrie, *German Air Service*, 34-36.

coming on line for day work in four *escadrilles* (PS 125 - 128) proved too slow and cumbersome. Equally unsatisfactory for night operations, the Schmitt bombers were a procurement failure and soon removed from service. The French air service had to await the arrival of the Bréguet 14 B 2 late in 1917 before day bombing would gain equal footing with night bombardment. The Voisin Type 8 replaced the less capable Type LA 5 for night use during this time. While the Voisin 8's more powerful Peugeot engine offered greater lifting capacity, it was subject to chronic breakdown; night aviators henceforth worried about forced landings. Basically, the problem with French night bombardment aviation in 1917 was not one of quantity of available aircraft as much as it was one of quality.[13]

Much tactical night bombing occurred in the Champagne region during the first half of 1917, followed by operations in the Argonne and Verdun sectors. Aerodrome attack and counterattack between French and German night bombers became almost routine during the latter half of the 1917 campaign, with each side trying to knock out the other's aerial bombardment capabilities. Not surprisingly, the Germans, with their heavy-bombardment G-planes, produced greater

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[13]Christienne and Lissarague, *French Military Aviation*, 114-115; *Commandant* Orthlieb, *L'aèronautique Hier - Demain* (Paris: ? , 1920), 58-59; Simone Pesquiès-Courbier, "*Le Groupe de Bombardement 1 Durant la Guerre de 1914-1918: Analyse du Journal de Marche*," *Revue Historique des Armées* No. 152 (No. 3, 1983), 97. See appendix 4 for French bombardment organization in September 1917.

damage to French airfields. As an example, Sénard, Lemmes, and Osches aerodromes were hit hard by German bombers on the night of 26 September 1917; twenty-five French aircraft were destroyed with approximately twenty more damaged.[14]

German night attacks forced the French to more widely disperse their Bessoneau shelters on many aerodromes. Some landing fields could no longer support their full complement of aircraft. After housing up to five *escadrilles* during the August 1917 offensive, Lemmes could now only handle one or two flights; Osches was now suitable for two *escadrilles* -- half its previous complement. Many airfields either had to be enlarged or abandoned. Often both French and German planes retired before nightfall to airfields more distant from the front, returning to their home base early in the morning. In this way men and machines did not fall victim to the enemy's night attacks -- at a cost however of increased fatigue and decreased operational efficiency.[15]

The increasing amount of airfield bombardment led to the establishment of "dummy" aerodromes. These false fields gave the appearance of active aerodromes by day and night in the hope that enemy bombers would be fooled into releasing

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[14]Christienne and Lissarague, *French Military Aviation*, 116-118; Orthlieb, *L'aèronautique*, 56-57; Stencil #718, IS-AD OCSO, entitled "Report on the Bombardment of the Aviation Fields in the Second Army Zone on the Nights of September 26/27, 1917," by *Commandant* Voisin, 1, RG 18, Entry 114, box 4, vol. 14, NA.

[15]Orthlieb, *L'aèronautique*, 57; Stencil #718, IS-AD OCSO, 1, NA.

their bombload a mile or two from the real airfields. At night active fields remained concealed in darkness until an airplane was properly identified through flare signals; often the aircraft also signalled a unique morse identifier from a light on the plane. Once ground personnel were satisfied with the identity of the airplane they illuminated the landing grounds. The lights were extinguished as soon as the airplane had landed. Dummy aerodromes were likely most effective during periods of poor visibility when ground details were indistinct.[16]

British night bombardment advanced in February 1917 with the formation of No. 100 Squadron. As the first RFC squadron dedicated strictly to night bombardment, the unit learned its vocation through practical experience -- flying night missions behind the lines. By utilizing obsolete FE2b and BE2e aircraft the squadron paralleled French night bombardment *escadrilles* in that they all flew aircraft with limited capacity for destruction. For much of the war Allied night bombardment appeared as the "poor relation," receiving hand-me-down aircraft no longer fit for day use. The FE2b had first flown in 1915; it had a maximum ceiling of 9,000 feet, a lifting capacity of only three 112-pound bombs, and no more than three hours endurance under its

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[16]Summary of Air Information [no no.], Second Section, General Staff, G.H.Q.A.E.F. (2dS GS), 8 April 1918, 940.4473 Un3s, AUL; Montgomery, *Flare Path*, 20-21.

maximum load. Nevertheless, British aviators carried out many audacious night attacks with their FEs.[17]

No. 100 Squadron's first wartime mission was an attack against Douai aerodrome on the night of 5 April 1917. Manfred von Richthofen, assigned to the field at the time, noted that the planes came in as low as 150 feet to drop their bombs. He also found that the attack was something to be enjoyed, declaring that many pilots, himself included, manned machine-gun posts as if at a turkey shoot. The FEs and their paltry payloads caused some physical damage to the airfield but failed to reduce German morale. If one is to believe Richthofen's story, the attack enhanced the "Red Baron's" spirits.[18]

The squadron flew nine missions during the month of April 1917, attacking airfields, railway stations, trains, and cantonments. Night operations continued at the greatest possible pace throughout the summer and fall in support of the Battles of Arras, Messines, and Third Ypres. On the night of 3/4 July 1917 No. 100 Squadron struck Ramilies Chin and Chateau du Sart aerodromes; thirty German aircraft were destroyed on the ground. With the termination of the Third

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[17]C. Gordon Burge, *The Annals of 100 Squadron: Being a Record of the War activities of the Pioneer Night Bombing Squadron in France during the period March 1917 to November 11th 1918, including its operations against German Towns whilst serving in the Independent Force of the R.A.F.* ([London]: Herbert Reiach, [1919]; repr., London: Bivouac Books, [1975]), 2-3; Wise, *Canadian Airmen*, 287.

[18]Burge, *100 Squadron*, 51-54.

Battle of Ypres in October, No. 100 Squadron moved from Trezennes aerodrome, near Aire, to Ochey. By that time Nos. 101 and 102 Squadrons had already been performing night bombardment duties with the FE2b. Organized British night bombardment -- nonexistent for the first two-and-a-half years of the Great War -- would constitute nearly half of British bombardment aviation by war's end.[19]

German military aviation was profoundly influenced by the United States declaration of war in April 1917. While German authorities fully appreciated the limited capacity for American aircraft production in 1917, they were nevertheless concerned; skilled American technicians and business leaders sent overseas might be able to immediately increase the output of existing British and French aero industry. To counter this possibility the Germans began a rapid buildup of air assets under the *Amerikaprogramm*. The plan was simple: use all available resources to force a decision on the Western Front before American industry was fully geared to war production -- it was Germany's only chance.[20]

The *Kagohls* had increasingly become night bombers as the transition to G-planes neared completion. Aerodromes and troop concentrations remained important targets

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[19]*Ibid.*, 55-56, 67-70; Jones, *War in the Air*, Appendices, appendix XXIX. See appendix 5 for growth of British night bombardment during 1917-1918.

[20]Morrow, *German Air Power*, 95-96.

throughout 1917. With the buildup resulting from the *Amerikaprogramm*, the *Kagohls* took a new designation in late 1917 as part of an overall redesignation of German aviation: *Bombengeschwader der Obersten Heeresleitung* (*Bogohl*). Seven *Bogohls* were in existence by the end of the year, each containing three *Bombenstaffeln* with an individual strength of six G-planes. The only exception was *Bogohl* 3, the *Englandgeschwader*, which contained six *staffeln*. For the first time in the war Germany had air units employed strictly for bombardment.[21]

The long-awaited French daylight bomber manifested itself in the Bréguet 14 B 2; the plane had begun to enter the French air inventory in quantity by the end of 1917. While the Bréguet transformed many existing *escadrilles* into daylight units, other *escadrilles* within the same group remained dedicated to night bombing; these *GBs* were known as "mixed" groups. Apparently many problems resulted in the mixed units from trying to combine two distinct functions within one organization. Therefore in January 1918 a fundamental reorganization of French bombardment aviation occurred when the mixed *GBs* were separated into unique day-flying and night-operating units (each *GB* containing three *escadrilles*) as follows:

GB 1 became *GB* 1 (night) and *GB* 6 (day)
GB 3 became *GB* 8 (night) and *GB* 3 (day)
GB 7 became *GB* 7 (night) and *GB* 5 (day)

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[21]Imrie, *German Air Service*, 46-49.

Additionally, *GB* 4's five Sopwith-equipped *escadrilles* began converting to the Bréguet the same month. As the aircraft changeover neared completion, three *escadrilles* were taken from the group to form *GB* 9.[22]

Further refinement came with the "Instruction" of 11 February 1918 when most of the French *GBs* became components of a larger organization, the *escadre*. The *escadres* were formed by order of *Général* Pétain to make mass employment of day or night bombardment easier to coordinate and carry out. *Escadre* 11, containing the French night *GBs*, was assigned to the strategic blockade of the Briey basin. *GB* 8 remained independent to provide tactical night bombardment against targets during the upcoming German spring offensive. In April 1918 the second night bombardment *escadre* (no. 14) was formed by grouping together *GBs* 2 and 8.[23]

Tactical bombardment intensified on both sides of the front as the 1918 spring offensives approached. Supply depots, railroads, lines of communication, and choke points (such as bridges) close to the front became critically targeted objectives as Allied and German bombardment

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[22]Christienne and Lissarague, *French Military Aviation*, 123; Orthlieb, *L'aèronautique*, 60; Kilduff, "GBs 4 and 9," 17.

[23]*Général* Voisin, *La Doctrine de l'Aviation Française de Combat Au Cours de la Guerre (1915-1918)* (Paris: Ed. Berger-Leurault, 1932), 66-67; *Commandant* H. Langevin, "'Action de masse' aérienne dans une bataille défensive," *Revue des Forces Aériennes* 6 (*janvier* 1930), 30; *Commandant* Brumelot, "Le 11^{e} Régiment d'Aviation de Bombardement," *Revue des Forces Aériennes* 6 (*janvier* 1930), 132-133.

aviation sought to gain the advantage for their comrades on the ground. The British were forced to abandon nearly two dozen airfields between 21 - 25 March 1918 as the Germans rapidly advanced westward. However most were damaged and not immediately unavailable for forward staging of German aviation. Once repaired, some of these airdromes became bases for German bombardment aviation; *Bogohl* 6 for example took up residence at Matigny aerodrome in April. Many Allied positions previously safe against German air attack were now subject to bombardment.[24]

Indeed, the number of targets exceeded the capacity of the seventy-two German bombers committed to the offensives; here the lack of an effective day bombing capability was clearly felt. Due to the scarcity of raw materials, German aviation production under the *Amerikaprogramm* had been limited to existing aircraft types -- resources simply could not be spared to develop a day bomber. The British official historian conceded the gravity of the situation, declaring that with more aircraft the *Bogohls* might possibly have changed the entire outcome of the war. While inflicting serious damage, notably the destruction of two British ordnance depots in May, German bombardment aviation nevertheless failed to turn the tide.[25]

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[24]Wise, *Canadian Airmen*, 483, 494; Summary of Air Information No. 13, 2dS GS, 15 May 1918, AUL.

[25]Imrie, *German Air Service*, 52-55; Jones, *War in the Air*, vol. 6, 419-423; *Ibid.*, Appendices, appendix 16; Summary of Air Information No. 8, 2dS GS, 9 May 1918, AUL.

To cope with the German offensives, the British reorganized their tactical bomber units in March 1918. Day and night wings were organized with 54th (Night) Wing containing Nos. 58, 83, 101, 102 Squadrons, all flying the FE2b. The overriding objective of British tactical night bombing missions was to hamper German resupply. However the light-bombardment aircraft of the 54th Wing were unable to frustrate enemy activity of such enormous scale. Even had weather cooperated and allowed British bombing every night, the damage inflicted would likely have little changed the final outcome -- a massive German push into Allied territory. The FEs, with their small payload, proved to be little more than a nuisance.[26]

On the ground Allied forces prevailed and began counterattacking in July 1918; by then an American army was on the front. British and French day and night tactical bombardment aircraft flew in support of the United States Army during its ground offensives, especially against the St. Mihiel salient. The bombardment plan for this offensive is included in appendix seven and is likely representative of tactical bombardment plans for all the belligerents on the Western Front. To be expected, numerous railway and

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See appendix 6 for distribution of German bombardment aviation in July 1918.

[26]Wise, *Canadian Airmen*, 483.

airfield objectives were targeted to reduce the German ability to respond to the American assault.[27]

As the offensive kickoff time neared, Allied aerial bombardment progressed from outlying objectives to those closer to the battle zone. However, the tempo of bombing was to remain constant prior to the start of the campaign for deception purposes (was there any surprise left after the artillery preparation began?). During the day of attack enemy troop concentrations and command posts were priority targets in support of the ground forces. Interestingly, the Metz-Sablon railway was targeted through all stages of the offensive.

An important addition to bombardment aviation occurred during the "war of movement" in 1918; belligerents mounted bomb-racks on observation and pursuit aircraft for attacks against personnel. Rather astonishing was the fact that sixty-seven percent (900 long tons) of bombs dropped by the British between 1 January and 15 May 1918 were Cooper twenty-five pound antipersonnel fragmentation bombs. In fact fighter and reconnaissance squadrons accounted for forty-six percent of all British bombardment during the period. While few enemy casualties resulted from the anti-

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[27]Colonel Edgar S. Gorrell, *The Measure of America's World War Aeronautical Effort* [Northfield, Vermont: Norwich University, 1940], 42; "The Plan of Bombardment Aviation," Appendix No. 2 to Annex No. 3 (Field Orders No. 9) Plan of Employment of Air Service Units, 1st American Army, HQ, First Army, AEF, 7 September 1918, RG 120, Entry 806, box 8501, 370.2, NA.

personnel bombings, they were considered important for impeding movement and creating disorganization.[28]

Though aerial opposition remained intense, the Allied air services' ability to mount both day and night bombardment helped keep the German ground forces on the defensive until the armistice of 11 November 1918. Interestingly the German night bombers continued tactical operations at a feverish pace (see Table 3). Rarely did a night go by without bombardment missions. Many G-plane crews carried out more than one sortie per night; an average of forty-one aircraft per night were reported in both May and August 1918. Most striking is once again the very low loss rate. Even if the total number of German bombers reported during the period is in error by fifty percent (1857 instead of 3714), the overall loss rate due to British defenses amounts to little more than five percent of all German bombing sorties. Such results (in the face of stiff defenses) reveal the security of flying at night.

Tactical night bombardment clearly played a minor role during the First World War. Limited aircraft capabilities reduced the effectiveness of the bombardments, while poor weather conditions often prevented follow-up raids on a frequent basis. Therefore, only short-term isolated gains could be hoped for. Yet tactical aerial bombardments

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[28]Statistical Analysis of Aerial Bombardment, Report No.110, *Gorrell's History*, vol. B-7, 75, 92-93, 114, RG 120, NA.

TABLE 3

GERMAN BOMBARDMENT ON BRITISH FRONT, MAY-OCTOBER 1918

MONTH	No. NIGHTS EMPLOYED	No. ACFT REPORTED	No. BOMBS DROPPED	No. ACFT DESTROYED
MAY	22	896	3720	27
JUNE	25	572	2313	9
JULY	22	564	2177	14
AUGUST	21	854	3287	23
SEPTEMBER	21	512	3001	24
OCTOBER	16	316	1587	20
TOTAL	127	3714	16085	117
MONTHLY AVERAGE	21	619	2681	19

Source: adapted from H. A. Jones, *War in the Air*, Appendices, appendix 43.

supported the ground forces by striking targets which could not be effectively targeted by artillery. Bombardment aircraft were first of all more mobile than ground batteries. They could provide covering fire while artillery units moved into new positions. Additionally bomber planes could strike troop concentrations protected from artillery behind hills or in ravines. Finally tactical bombardment could strike fleeting targets of opportunity such as trains or motor convoys out of sight of artillery spotters.

Though the results of tactical bombardment aviation were small, the capability to perform such missions was nonetheless important; bombers increased the options available to ground commanders. Flying under cover of darkness increased the flexibility of air operations and

kept bomber losses at an acceptable rate. Yet the impact of tactical bombardment was hampered without a daylight bombing capacity. Gains made during the night were often lost without rapid follow-up -- witness the quick repair of railways for example. The intrepid night bombers did the best they could in support of their country's war effort.

CHAPTER 4

STRATEGIC NIGHT BOMBARDMENT

Strategic bombardment deals with the destruction of targets which are not supporting the immediate ground battle. Often but not always, these targets are located at a distance from the front. During the First World War the industry and civil population of enemy cities were important strategic targets. Other areas of strategic value included marshalling areas and arteries for moving manpower and materiel to the front, supply and ordnance depots, arsenals, interior airfields, military and naval bases, mobilization centers, and similar objectives.[1]

Destruction of industry would result in long-term reduction of war reserves; destruction of stockpiled reserves would have a near-term impact on the front when resupply could not keep pace with battlefield attrition. Both types of destruction limited the ability of a nation's armed forces to wage war. However strategic bombardment had another important purpose; it brought the war to the home front. Such bombing was believed to have an important

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[1] "Night Bombardment and Provisional Regulations," trans. Col. Hunter, 7, 248.222-58, HRC.

psychological impact on the civilian population. Hence the overarching purpose of strategic bombardment during the Great War was to damage a belligerent's capacity and *willingness* to wage war by targeting the military, economic, and civilian segments of society.

The idea of strategic aerial bombardment predates 1914. Though dirigibles appeared the only viable facilitators of such bombardment as the war neared, that great prophet of air power, Clément Ader had foreseen the day of the great bombing planes. Ader, writing in the 1890s, noted their use against tactical military targets. Yet he proclaimed an important strategic role for bomber aircraft:

> Unfortunately their work will also require them to bomb enemy cities. And how can we expect to avoid such catastrophes? Don't battleships bombard port cities? Since airplanes will drive away or destroy these naval monsters, they may be excused for a few misdeeds of their own!
>
> The great *bombing planes* [author's emphasis] will become veritable terrors! I am convinced that their awesome power and fear of seeing them appear will provoke salutary reflections among the statesmen and diplomats who are the real dispensers of peace and war, and that in the final analysis these planes will serve the cause of humanity.[2]

Although Ader's hope for peaceful outcome of bomber development failed, his vision of strategic terrorizing did become reality -- but not until an airplane with great

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[2]Clément Ader, *Military Aviation* (Paris: ? , 1909), unpub. trans. Lee Kennett, 31-32.

lifting-capacity, extended endurance, and the ability to drop bombs with precision came into existence.

For want of such a plane, the first air strikes at strategic targets were missions made by daring individuals who were willing to take large risks to achieve comparatively small gains. One example was the attack by *Escadrille* MF 29, flying the Maurice Farman 7 "longhorn," against the poison gas facilities at Rössler on the night of 29 July 1915. The MF 7 could lift only about 300 pounds of bombs (maximum), and no doubt less on long-distance flights. Widespread destruction was beyond the capabilities of such an aircraft and the Farmans inflicted only minimal damage to the Rössler installation.[3]

Without question, the airship appeared as the ideal strategic bombardment platform when war first erupted. On the night of 19/20 January 1915, German dirigibles began a strategic bombing campaign against Great Britain. But British defenses forced the airships to ever-increasing altitudes, making accuracy against military targets impossible; therefore civilian casualties continued to mount with each raid. The night-flying Zeppelins visited England twenty times during 1915. While the following year saw a slight increase in the number of "successful" airship bombing operations flown over the island, there was a much greater number of airships, on average, carrying out these

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[3]Kilduff, "Groupes de Bombardement 4 and 9," 3; Bruce, *Aeroplanes of the RFC*, 241.

missions. However, airship losses mounted during the period due to improved British defenses and the hazards of flying into unforeseen bad weather.[4]

Weather forecasting proved difficult for the Germans since most weather patterns move from west to east across Europe. Analysis of pressure changes, wind direction, and cloud patterns over occupied Belgium offered the best means available to forecast future weather conditions over the British Isles. But these forecasts proved to be inaccurate at times and were often ignored, sometimes with disastrous consequences.[5]

Douglas H. Robinson contends that the raid made over England on the night of 23 September 1916 was "for the German Naval Airship Division . . . a turning point in the war." Two of their newest Zeppelins were destroyed during the operation, with several other airship crews watching one of the craft burn through the clear night sky (seen as far as 125 miles away). Pessimism pervaded the Division as many flying personnel began to discuss "not their chances of survival, but what they could do when the inevitable catastrophe should overtake them." By the time strategic operations against England were put on hold at the end of November 1916, nine dirigibles had been lost in forty-three

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[4]Robinson, *Zeppelin in Combat*, 57-64; Cole and Cheesman, *Air Defence of Britain*, 24-25, 448.

[5]White, *Gotha Summer*, 136; Robinson, *Zeppelin in Combat*, chapter 19 (The "Silent Raid").

night raids over the island -- eight in the last seven months alone.[6]

However Germany would no longer be solely dependent upon its airships for strategic operations against Great Britain once the G-plane became fully operational. During 1916, German authorities recognized the importance of night bombing operations along the front; by flying tactical missions the G-plane crews gained valuable night experience which would later be needed for strategic operations against England. The G-plane proved to be a useful bomber for the duration of the war.[7]

On the Eastern Front German strategic air operations were carried out by a unique aircraft type in 1915/1916 -- the *Riesenflugzeug* (R-plane), an aircraft with a wingspan of more than 138 feet. Later fully functional in the West, R-plane prototypes were flying in the East as early as April 1915. Interestingly, the only specification which put the R-plane in a class by itself was the requirement that the engines had to be "fully accessible, serviceable and capable of being repaired *in flight*" [authors' emphasis]. As engine breakdowns were frequent, such capability was critical for successful long-range operation. Through the various stages

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[6]Robinson, *Zeppelin in Combat*, 189; Cole and Cheesman, *Air Defence of Britain*, 172, 448.

[7]Neumann, *German Air Force*, 178-179.

of R-plane evolution, the number of motors per plane varied up to a maximum of six.[8]

Early R-plane experimentation by the firms of Zeppelin-Werke Staaken G.m.b.H. (Staaken) and Siemens-Schuckert Werke G.m.b.H. (SSW) was viewed with much skepticism by German military authorities. However, the realization of airship limitations under combat conditions led these same officials by mid-1916 to support an expansion of R-plane production. Nevertheless, only fifty-five to sixty-five such aircraft would be manufactured before the end of the war, with roughly thirty performing combat operations. Clearly the R-planes were amazing technological achievements, with two British authors contending that they "would have earned lavish praise had they been British products."[9]

Even on the less hostile (for aircraft) Eastern Front R-planes were very soon forced to fly under cover of darkness. During these missions the aircraft flew at an altitude of between 6,500 and 7,800 feet, and carried up to a 1,700 pound bombload. Missions routinely lasted from three to five hours. As the number of available aircraft increased during 1915, they were formed into two independent flights. *Riesenflugzeugabteilung* (*RfA*) 500 was assigned to

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[8]Haddow and Grosz, *German Giants*, 6; Cole and Cheesman, *Air Defence of Britain*, 308.

[9]*Ibid.*, xii, 11; Cole and Cheesman, *Air Defence of Britain*, 308.

Alt-Auz, while *RfA* 501 was stationed at Vilna. Later the R-planes would commence operations along the Western Front.[10]

Strategic airplane operations against London began with an incredibly audacious solo attack by the crew of a German Albatros C VII aircraft on 5 April 1917. Aided by favorable winds and a full moon, the aircraft reached the capital and dropped five twenty-two pound bombs. While the British official historian argues that the event was "without particular significance," the mission must have made British home defense personnel take notice that a new threat might not be far over the horizon.[11]

In an effort to divide the French and British alliance after the bloodletting of 1916, German authorities began serious consideration of bombarding London by airplane. The plan came under the code name *Türkencreuz* (Turk's Cross). For the German army, 1916 had conclusively demonstrated the costliness of airship raids. Only one army airship, *LZ107*, raided England in the first half of 1917; the army then suspended all dirigible operations in June. In all, German army airships had performed 232 strategic and tactical bombing sorties during almost three years of warfare -- twenty-six army airships were destroyed. Refusing to admit defeat, the German Naval Airship Division continued to mount occasional raids over the British Isles until the night of

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[10]*Ibid.*, 12.

[11]Jones, *War in the Air*, vol. 5, 60; Cole and Cheesman, *Air Defence of Britain*, 200-201.

5/6 August 1918. On that night, *Fregattenkapitän* Peter Strasser, Chief of the Naval Airship Division, and the crew of Zeppelin *L70* were lost when the airship went down in flames off the coast of England (see Table 4). Soon after the Division became ineffective even for reconnaissance work.[12]

The central London business and government district was to be the principle target area for the daylight bombing campaign envisioned in *Türkencreuz*. Notably included were the newspaper offices on Fletcher Street. As the primary objective of the offensive was to bring about a separate peace with Great Britain, what better way to spread the panic than to bring the bombing "home" to the press?[13]

Halbgeschwader 1, made up of *Staffeln* 1, 4, and 6 of *Kagohl* 1, was the selected unit to carry out this elite operation. The army pilots trained at Heligoland and on the Isle of Sylt, where they learned how to navigate over the North Sea. Surprisingly, German naval pilots who were accustomed to such flying were never incorporated into the army scheme -- interservice rivalry had struck again. On closer observation this situation appears as a complete reversal of the British RFC-RNAS squabbling over strategic bombardment from Luxeuil. There naval pilots were making

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[12]Cole and Cheesman, *Air Defence of Britain*, 199-200, 229; Robinson, *Zeppelin in Combat*, 331, 337-339.

[13]White, *Gotha Summer*, 36-39.

TABLE 4

GERMAN STRATEGIC RAIDS AGAINST GREAT BRITAIN

Year	No. Raids	No. Dispatched/ No. Attacked	Destroyed
		AIRSHIPS	
1915	20	49/39	1 bombed by plane
1916	23	164/123	5 by British fighters 2 by British AA 1 by weather
1917	7	46/29	1 by British fighter 2 by French AA 4 by weather
1918	4	18/11	1 by British fighter
Total	54	277/202 c	17
		AIRPLANES	
		Daylight Phase May - August 1917	
	8	193/143	6 British fighters 2 British AA 4 weather
		Night Phase September 1917 - May 1918	
	19	253/187	7 British fighters 7 British AA 2 Forced landed in UK
Total	27	446/330	28

Source: adapted from Cole and Cheesman, *The Air Defence of Britain, 1914-1918*, 448.

long flights over land, while operation *Türkenkreuz* had military pilots flying across water.[14]

Kagohl 1 was redesignated *Kagohl* 3 after being re-equipped with the improved G.IV-type aircraft; the squadron was informally referred to as the *Englandgeschwader* due to its strategic mission. Subordinate *Staffeln* (13 -18) were authorized six G.IVs each, although the full complement of thirty-six aircraft was slow to materialize. In April 1917 the unit moved to new aerodromes at Melle-Gontrode and St. Denis-Westrem in preparation for the offensive. Engine problems then delayed operations against England until 25 May, when the first mass daylight airplane raid occurred. The daylight campaign lasted for approximately three months, causing considerable damage to structures in isolated areas. The cost in German aircraft was high, though due mainly to poor weather and not British defenses. Clearly the campaign could not continue indefinitely at a loss rate of roughly twenty percent.[15]

The Gotha night bombing of England began in earnest on the eve of 4 September 1917. Four *Englandgeschwader* aircraft hit Chatham, killing and wounding over 200 naval recruits. Before the month was out, a combined operation

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[14]*Ibid.*, 35; Raymond H. Fredette, *The Sky on Fire: The First Battle of Britain 1917-1918, and the Birth of the Royal Air Force* (New York: Harcourt Brace Jovanovich, 1976; repr., Washington, D.C.: Smithsonian Institution Press, 1991), 38.

[15]Later two *Staffeln* were based at Mariakerke airfield. *Ibid.*, 52, 79.

utilizing G- and R-planes was carried out against the British Isles. An Allied reconnaissance plane had photographed a R-plane at St. Denis-Westrem three days before the raid, however both RNAS and RFC bombings failed to neutralize this new threat.[16]

Bad weather prevented systematic strategic raids against England during the last quarter of 1917. Though Germany had begun to concentrate all of its available air assets on the Western Front in late 1917/early 1918 in preparation for the spring offensives, raids across the Channel continued into the spring. Somewhat surprisingly, only nineteen night raids could be mounted by the *Englandgeschwader* during the eight month campaign which came to an end in mid-May 1918 (see Table 4).[17]

German air service night bombers also struck many strategic targets in France during 1917. *Bogohl* 2 bombed war industry in the vicinity of Nancy; for one example the unit attacked factories at Neuve Maison during four night raids. Dunkirk was a favored German target, with sporadic bombings lasting for upwards of six hours per night. During one such bombing of Petite Synthe aerodrome (near Dunkirk) a RNAS night bomber pilot refused to get out of bed to take

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[16]*Ibid.*, 83; *Ibid.*, 301-302; Stencil #761, IS-AD OCSO, entitled "Germany's Night Bombing Activities," 2, RG 18, Entry 114, box 4, vol. 14, NA; Jones, *War in the Air*, vol. 4, 197.

[17]Jones, *War in the Air*, vol. 6, 425; Cole and Cheesman, *Air Defence of Britain*, 414, 446.

cover; he had a mission in two hours (using a Sopwith 1½ Strutter) and was going to get all the rest he could.[18]

The British RNAS had flown strategic bombing missions from Dunkirk against the German naval bases and Zeppelin sheds in Belgium from the early weeks of the war. Yet the limited-ability airplanes achieved only minor successes; hence it was not surprising that strategic bombing operations were suspended in June 1916. The campaign resumed later in the year when improved equipment became available. By then the strength of German air defenses forced the RNAS bombers to fly under cover of darkness.[19]

The RNAS and the French air service planned a joint bombing offensive designed to destroy steel manufacturing in the Saar-Lorraine-Luxembourg region. Decreasing the U-boat threat at its source was the primary reason for RNAS interest. To begin the offensive, the RNAS argued that it needed fifty heavy bombers, eighty light bombers, and fifty long-range fighter escorts. The RFC took issue with the estimate, and ultimately diverted at least sixty Sopwith 1½ Strutters previously destined to the RNAS when fighting intensified on the Somme in mid-to-late 1916. Additionally, the French units involved in the strategic offensive sought

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[18]Höppner, *Germany's War*, 76; Stencil #761, IS-AD OCSO, 15 December 1917, entitled "Germany's Night Bombing Activities," RG 18, Entry 114, box 4, vol. 14, NA; C. P. O. Bartlett, *Bomber Pilot, 1916-1918* (London: Ian Allan, 1974), 68.

[19]Jones, *Strategic Bombing*, 59, 63, 82-83.

the use of 1½ Strutters, further limiting the RNAS buildup. Throughout the spring and summer *GB* 4 and RNAS No. 3 (N) Wing, stationed at Luxeuil, carried out sporadic joint and individual missions, by day and night, waiting for enough aircraft to begin a general offensive.[20]

Surprisingly, a long-distance daylight raid against the Mauser arms factory at Oberndorf was selected as the first large-scale joint mission of the untested (in combined operations) Allied units. After suffering heavy losses during the raid, which was carried out on 12 October 1916, *GB* 4 restricted the operation of its obsolete Farman and Bréguet aircraft to darkness. Both units then moved to Ochey airfield in order to concentrate on the German steel industry of the Saarland. The French unit conducted several night missions during November and December 1916 against these targets (see table 5).[21]

No. 3 (N) Wing continued to perform mainly daylight missions, and received its first Handley Page 0/100 during this time. The aircraft had a cruising speed of 60-75 miles per hour, an endurance of nine-and-a-half hours with a load of ten 112-pound bombs, and a bombing altitude of 6,000 feet. Up to sixteen 112-pounders could be carried internally for shorter-distance missions. The aircraft's

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[20]Cooper, *Independent* Airpower, 49; Jones, *Strategic Bombing*, 103-104, 108-109.

[21]Wise, *Canadian Airmen*, 264-268; Kilduff, "Groupes de Bombardement 4 and 9," 8.

TABLE 5

GROUPE DE BOMBARDEMENT 4 STRATEGIC NIGHT BOMBARDMENT
IN CONJUNCTION WITH RNAS No. 3 (N) WING
OCTOBER - DECEMBER 1916

Date	*Escadrille*	No. of sorties	Weight of bombs (kg)	Target
OCT				
9/10	F 123	1	200	Mülheim rail depot
10/11	F 123	1	120	Stuttgart rail depot
11/12	F 29	4	480	Oberndorf factories
	F 123	5	580	
	BM 120	8	1790	
22/23	F 29	4	520	Hagendingen blast-furnaces
	F 123	4	220	
	BM 120	4	1248	
NOV				
10/11	F 29 & F 123	4	480	Völkingen steel mills
	BM 120	4	960	
11/12	F 29 & F 123	8	780	Völkingen steel mills
	BM 120	3	792	
23/24	?	4	360	*Völkingen steel mills
DEC				
27/28	F 123 & BM120	9	600	Factories and blast furnaces of Brebach, Bous, Durbach, Neunkirchen, Völkingen

Source: *Operations de Bombardement de Nuit Effectuees par l'Aviation de Bombardement, octobre - décembre 1916*, box A21, *SHAA*. *Kilduff lists the target as the Dillingen blast furnaces in "History of Groupes de Bombardement 4 and 9," *Cross and Cockade Journal* (U.S.) 15, no. 1 (Spring 1974), 9.

slow speed and lack of maneuverability necessitated duty as a night bomber.[22]

RNAS plans called for the development of a squadron of Handley Page bombers within No. 3 (N) Wing. However, factories were not producing the planes in any quantity during the winter of 1916-1917; hence, the unit had but two on its rolls by March 1917. The first night mission with one of these aircraft occurred on 16/17 March, against the Moulin-les-Metz railway station. The Handley Pages were used on several more individual night missions before the wing was disbanded in April 1917.[23]

Poor weather and limited availability of aircraft hampered the performance of the Allied strategic offensive from Luxeuil and Ochey. Though one author indicates the campaign was "remarkably successful," another contends that the "low operational effectiveness . . . only supports the case against the raids ever having been attempted in the first place." Nonetheless, the latter concedes that regardless of the results, "bombing attacks on German cities were becoming a necessary feature of a popular [British] war policy." RNAS bombing operations continued from the Dunkirk

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[22]Christienne and Lissarague, *French Military Aviation*, 104-105; Jones, *Strategic Bombing*, 113-116, 122; Kilduff, "Groupes de Bombardement 4 and 9," 8-9; Wise, *Canadian Airmen*, 271.

[23]Jones, *Strategic Bombing*, 122; Paul Bewsher, *"Green Balls": The Adventures of a Night Bomber* (London: William Blackwood, 1919), chapter 3 comments on the first Handley Page raids from Luxeuil.

aerodromes against heavily-defended German positions along the occupied Flanders coast -- Ostend, Zeebrugge, Bruges, Blankenberghe.[24]

The mobilization of No. 100 Squadron as the first RFC *night* bombing squadron in February 1917 likely resulted from No. 3 (N) Wing activities at Luxeuil. The RFC had sought the disbandment of the RNAS wing on the grounds that bombardment operations against Germany were clearly the responsibility of military, and not naval aviation. Yet the RFC was forced to organize a unit whose utility, from the official RFC perspective, was at best questionable. For without such a night bombing unit, the RFC might well have had difficulty in convincing the home government of its capacity to successfully replace No. 3 (N) Wing.[25]

Having suffered through three months of daylight attacks, the British public was outraged by the country's seeming defenselessness against the night raiders. Reorganization of home defense swiftly followed, leading to an improvement in capabilities especially for the region around London. Additionally, politicians, press, and public clamored for reprisals against German cities.[26]

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[24]*Ibid.*, 123; Cooper, *Independent Air Power*, 64-65. See appendix 8 for one pilot's ode to night bombing from Dunkirk.

[25]Burge, *100 Squadron*, 1.

[26]Jones, *War in the Air*, vol. 5, 64-65; Cole and Cheesman, *Air Defence of Britain*, 302, 306-307.

The British selected Ochey aerodrome in October 1917 as the home field for the 41st Wing, RFC, their answer to the Gotha bombings. At Ochey No. 100 Squadron was joined by 'A' Naval Squadron, flying the Handley Page bomber. To these night squadrons was added No. 55 Squadron, flying the DH4 daylight bomber. The complementary nature of the wing, with a day unit and short- and long-distance night elements, made the reprisal effort extremely flexible. Unfortunately only fourteen missions (five by night) were executed by the end of the 1917; adverse weather conditions prevented more extensive operations. Rather appropriately, the RFC strategic bombardment of German cities met with the same meager results which had characterized No. 3 (N) Wing strategic operations from the same airfield six months earlier.[27]

However, by this stage of the war bombardment aviation was on the increase, regardless of actual operational results. On 22 December 1917 General Trenchard announced British plans for a strategic bombardment force to strike at German industrial centers (the eastern limit of operations being roughly Cologne-Frankfurt-Stuttgart) during a meeting with *Général* Maurice Duval, *Chef du Service Aéronautique*, and an American representative. *Général* Duval explained

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[27] 'A' Naval became No. 16 (N) Squadron on 8 Jan 1918. Jones, *War in the Air*, vol. 5, 56; Wise, *Canadian Airmen*, 286-287; Maurice Baring, *Flying Corps Headquarters, 1914-1918* (London: Buchan & Enright, 1920), 275; Jones, *Strategic Bombing*, 165; Jones, *War in the Air*, vol. 6, 122-123.

that France considered the blockade of raw material movement out of the Briey basin most crucial. France would continue bombing the rail lines in an effort to hamper German war production. Duval also reminded Trenchard that reprisals against French cities was easier than Allied attacks on German cities -- France clearly did not want to bear the brunt of German reprisals caused by indiscriminate British activity.[28]

RFC plans called for the expansion of night bombing by eight additional squadrons; work was begun on airfields at Xaffévillers and Roville to accommodate the increase. In February 1918, 41st Wing came under VIII Brigade command, later becoming part of the Independent Forces, Royal Air Force (RAF).[29]

The British strategic bombers of VIII Brigade continued to strike the industrial centers of western Germany in the early months of 1918. However once the Ludendorff offensive began in March 1918 the squadrons began bombing tactical targets in support of the British ground forces -- especially the rail supply lines to the German front. The planes were able to resume strategic operations once the offensive stalled in mid-May 1918. Two day bombing units were added to VIII Brigade during the offensive. With

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[28]Edgar S. Gorrell, Early History of the Strategical Section, Air Service, in "History of the Air Service, AEF," *Gorrell's History*, vol. B-6, 390-391; Jones, *War in the Air*, vol. 6, 122-125.

[29]Wise, *Canadian Airmen*, 290.

the increasing mix of day and night units a reorganization was necessary to maintain efficiency. 41st Wing was assigned operational control of the day squadrons; the newly formed 83d Wing took charge of the night elements. Further recognition came with the title "Independent Forces, RAF" on 6 June 1918.[30]

Table 6 compares the activity of British day and night bombardment units between 1 January and 30 June 1918. Only three squadrons, Nos. 55, 100, and 216 were specifically apportioned for strategic operations. Yet most of their missions during the period were against targets supporting the German spring offensives (see Table 7). Not surprisingly, the British bomber force was most active in March. Of interest is the operational capability of the short-range night bombers which carried out operations only two fewer days per month on average than their daytime compatriots.

Amongst the night aircraft, the limited operations of Handley Page squadrons is clearly evident. Had larger numbers of the planes been available, their heavy bombload, which was more than five times that of the FE2b, would certainly have helped in the effort to hamper German resupply. During the period no more than two of the large

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[30]Wise, Canadian Airmen, 292-293; Jones, *War in the Air*, vol. 6, 135.

TABLE 6

COMPARISON OF BRITISH DAY AND NIGHT BOMBARDMENT SQUADRON ACTIVITY
1 JANUARY - 21 MAY 1918

DAY BOMBARDMENT (DH 4 and DH 9)

Squadron No.	18	25	27	49	55	57	205	206	211	Total
No. of days in commission	137	138	137	70	129	139	74	49	37	910
No. of days of activity										
January	8	7	7	0	2	14	0	0	0	38
February	7	3	11	0	4	11	0	0	0	36
March	24	17	22	9	10	18	19	0	0	119
April	19	6	7	7	3	7	9	10	10	78
May	14	9	11	8	7	14	11	12	12	98
Total	72	42	58	24	26	64	39	22	22	369
Avg/month	15.8	9.1	12.7	10.3	6.0	13.8	15.8	13.5	12.2	12.2
Total tons dropped**	68.3	37.6	54.6	29.6	27.2	76.0	61.5	26.4	12.0	393
Avg/month	14.9	8.2	11.9	12.7	6.3	16.4	24.9	16.2	9.8	13.0
Avg/day of activity	0.95	0.90	0.94	1.23	1.05	1.19	1.58	1.20	0.55	1.07

NIGHT BOMBARDMENT (FE2b and HANDLEY PAGE)

Squadron No.	58	83	100	101	102	148	TOTAL	214	216	Total
No. of nights in commission	88	60	135	140	138	3	564	50	118	164
No. of nights of activity										
January	0	0	7	9	8	0	24	0	2	2
February	3	0	5	7	12	0	27	0	2	2
March	18	9	3	15	13	0	58	1	2	3
April	9	8	4	9	10	0	40	2	3	5
May	9	8	3	11	10	2	43	8	1	9
Total	39	25	22	51	53	2	192	11	10	21
Avg/month	13.3	12.5	4.9	10.9	11.5	20.0	10.2	6.6	2.5	3.8
Total tons dropped**	67.1	45.0	22.8	111	111.1	1.5	358.5	33.1	9.6	42.7
Avg/month	22.9	22.5	5.1	23.8	24.2	15.0	19.1	19.8	2.4	7.6
Avg/night of activity	1.72	1.80	1.04	2.18	2.10	0.75	1.87	3.01	0.96	2.03

* Squadrons 103 and 207 are not included, as they made only one raid each.
** British long tons (1 ton = 2,240 pounds)

Source: adapted from Table No. 4, "Statistical Analysis of Aerial Bombardment," Report No. 110, Statistics Branch - General Staff, War Department, 7 November 1918, *Gorrell's History*, vol. B-7, 115, NA.

TABLE 7

BRITISH BOMBARDMENT OBJECTIVES, 1 JAN - 19 MAY 1918

DAY BOMBARDMENT (DH 4 and DH 9)

Sqdn No.	18	25	27	49	55+	57	103	205	206	211
First raid Last raid	Jan 3 May 19	Jan 1 May 18	Jan 3 May 19	Mar 11 May 19	Jan 14 May 22	Jan 1 May 19	May 19 May 19	Mar 7 May 19	Apr 1 May 19	Apr11 May19
No. of towns with objectives	*	*	*	24	17	*	1	14	18	14
Objectives										
Railway stations	5	19	26	5	18	3	1	2	3	3
Railway sidings	3	2	5	1	11	8	0	10	1	0
Docks and Canals	0	0	0	3	1	0	0	0	0	9
Factories	0	0	0	0	12	0	0	0	0	0
Dumps	6	3	1	14	0	17	0	4	2	3
Aerodromes	7	6	7	2	0	4	0	16	9	2
Billets	12	3	5	1	8	5	0	6	0	1
Unknown	93	19	12	15	0	53	0	8	14	12

NIGHT BOMBARDMENT (FE2b and HANDLEY PAGE)

Sqdn No.	58	83	100+	101	102	148	207	214	216+	TOTAL DAY AND NIGHT
First raid Last raid	Feb 21 May 18	Mar 21 May 18	Jan 1 May 17	Jan 3 May 21	Jan 2 May 18	May 17 May 18	Mar 31 Mar 31	Mar 31 May 18	Jan 21 May 17	
No. of towns with objectives	33	15	22	*	*	2	2	9	10	-
Objectives										
Railway stations	21	2	22	19	1	2	1	5	8	166
Railway sidings	5	0	13	0	2	0	0	0	7	68
Bridges	0	0	2	2	7	0	0	0	1	12
Docks and Canals	0	0	0	0	0	0	1	10	1	25
Factories	0	0	5	1	0	0	0	2	4	24
Dumps	2	5	0	9	0	0	0	0	0	66
Aerodromes	11	0	3	28	20	0	0	0	0	115
Billets	3	1	0	2	12	0	0	0	0	59
Unknown	12	20	2	48	60	2	0	3	0	403

* Activities widely dispersed + 41st Wing strategic bombers

Source: adapted from Table No. 5, Statistical Analysis of Aerial Bombardments," Report No. 110, Statistics Branch - General Staff, War Department, 7 November 1918, *Gorrell's History*, vol. B-7, 116, NA.

aircraft in No. 216 Squadron participated in specific missions.[31]

Interestingly, night bombardment units flew only one-third of all 41st Wing/VIII Brigade missions up to the creation of the Independent Force. Yet the loss of night fliers was proportionally greater than that of day bombers. The Canadian official historian argues that difficulty in night navigation and the lack of an effective German daylight defense were the main factors in such a disparity between British day and night strategic bombardment aviation.[32]

From the time the Germans were put on the defensive in July 1918 until the end of the war, the Independent Force, RAF was able to concentrate on strategic bombardment. By the end of August the force had expanded to nine squadrons, of which five were night bombers. General Trenchard decided to attack as many large industrial centers as possible instead of concentrating the Independent Force on several of the most important. He felt that the moral effect would be greater, as no inhabitants of western German could feel immune from attack. Additionally, the German military would have to build up and maintain more home defense, thereby taking men and material away from the front. It was further

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[31]"Statistical Analysis of Aerial Bombardment," Report No. 110, Statistics Branch - General Staff, War Department, 7 November 1918, *Gorrell's History*, vol. B-7, 80, 84, RG 120, NA.

[32]Wise, *Canadian Airmen*, 295-297.

decided that when conditions prevented distant strikes, attacks on railroads would receive priority attention. Next on the list were blast-furnaces since they were "easy to find at night."[33]

In September and October 1918 some Independent Force bombers supported the French and American ground offensives by bombing railway targets (see appendix 7). Weather often hampered strategic operations in the closing months of the war. When long-distance missions were undertaken, the day bombers had to fend off stiff German fighter opposition and heavy anti-aircraft fire. As an example of the capability of German night defenses four Handley Page bombers were lost on a raid against Cologne; an estimated 173 searchlights were involved and over 16,000 AAA rounds were fired.[34]

The French continued strategic operations against targets in the Briey basin after the demise of No. 3 (N) Wing in early 1917. As an estimated seventy-five percent of Germany's iron ore was being mined in the Saar-Lorraine-Luxembourg region, the strategic operation deserved high priority. Additional estimates declared that 10,000 railroad cars moved through the basin daily. These cars funneled through three critical choke-points -- Thionville, Bettembourg, and Metz -- which were regularly targeted.

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[33]Jones, *War in the Air*, vol. 6, 136-137, 142. See appendix 9.

[34]*Ibid*. 146-152.

Blast-furnaces and steel mills were also important targets in the Briey basin.[35]

The Basin remained *the* strategic concern of French bombardment aviation into 1918. With the exception of *GB* 8, all night bombing groups, under *Escadre* 11, continued to pound the region until the German March offensives diverted their attention. Soon afterwards strategic operations in Lorraine resumed their pre-offensive intensity. Two factors led the French air service to concentrate strategic aviation against the Briey basin during the last two years of the war.[36]

First, the Lorraine-Luxembourg iron-ore region was the only important center of German war industry which could effectively be targeted by the short-range Voisin pushers (which were a majority of French bombers for most of the war). Additionally but just as importantly, was the fear of German reprisal against French civilians should the French bomb German municipalities. French short-range bombers could not effectively carry out retaliation against German cities; hence it made sense not to get into a "war of reprisal."

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[35]Jones, *Strategic Bombing*, 107-109; Lecture IV, untitled [dealing with bombardment aviation], n.d. [late 1917-early 1918?], RG 120, Entry 807, 350.001, NA.

[36]*Général* Voisin, "La Doctrine de l'Aviation française de combat en 1918: L'aviation de combat independente (2e periode), *Revue des Forces Aériennes* 26 (*septembre* 1931), 1035.

Therefore when the Inter-Allied Independent Air Force (IAIAF) was established on 3 October 1918, it remained "business as usual"; the Independent Forces RAF bombing interior German industrial centers, French *GBs* 2 and 18 striking the Briey basin. Table 8 shows the increasing importance of strategic strikes against Germany. In a memorandum sent by Marshal Foch, the Commander-in-Chief of the Allied Armies, to French President Clemenceau on 13 September 1918, Foch made it clear that the proposed raids on German population centers by the IAIAF were not reprisals but "like poison gas [were] a means of warfare which was first used by the enemy and which we are therefore forced to use in our turn." Foch then reiterated that the "best way of affecting the German metal industry *at the present date*" was at "the very source of production, i.e. *localized supplies of iron ore*, the transport of which takes place via certain *obligatory routes*."[37]

In view of maximizing efficiency, Marshal Foch declared that only long-distance bombing aircraft should be incorporated into the IAIAF. Once sufficient heavy-bombers were in place, the Briey basin iron district would no longer be targeted by the force. "These raids will be carried out

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[37]"An agreement reached between the British and French Governments and transmitted, through the Supreme War Council, to the American and Italian Governments for approval," 3 October 1918; quoted in Jones, *War in the Air*, Appendices, appendix 11; Memorandum, Marshall Foch to M. Clemenceau, 13 September 1918, quoted in Jones, *War in the Air*, Appendices, appendix 10, 33, 35, 37. See appendix 10 for objectives of IAIAF.

TABLE 8

BRITISH AND FRENCH STRATEGIC BOMBARDMENT OF GERMANY

Year	Day Missions	Night Missions	Estimated No. Bombs
1915	44	7	940
1916	21	75	917
1917	45	130	5234
1918	119	234	7117
Total	229	446	14208

Source: German official figures listed in Jones, *War in the Air*, vol. 6, 152.

by French aeroplanes having an average load [the Voisin 10 and Bréguet 14 B 2 for instance]." The French were clearly unwilling to relinquish control of bombing activities in the region, especially to the British. For two years French bombers had attempted to blockade the basin by destruction of the rail net. Minimizing collateral damage to territory the French considered their own had remained a constant concern. At the time of the armistice *Escadre* 11 had 245 bombers committed against the Briey basin, an increase of one hundred airplanes since 1 March 1918; however the number of F 50 and C 23 heavy-bombers still remained limited at the end of the war. Hence with the formation of the IAIAF in

October 1918 Allied strategic bombardment changed in name only.[38]

The United States was anxious to assist its Allies in the air war. Two months after declaring war on Germany, an aeronautical commission headed by Major Raynal Bolling was sent to Europe in order to gain a better understanding of Allied requirements for American aviation. The final report of the commission, filed on 15 August 1917, contained interesting ideas regarding the use of night bombardment aviation. Major Bolling declared that as there was "practically no effective means of preventing night-bombing . . . [c]ould night bombing be conducted on a sufficiently great scale, there seems good reason to believe that it might determine the whole outcome of military operations."[39]

One author contends that Bolling was overly influenced by then Lieutenant Colonel William Mitchell's concept of airpower -- the Major having talked with Mitchell in Paris. Upon visiting a French night bombardment group Mitchell found great *esprit* among its crew members. They insisted that with enough equipment "there would be nothing left of Germany." Bolling suggested in his report that more than

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[38]Memorandum, Foch to Clemenceau, 13 September 1918, 38; Orthlieb, *L'aéronautique*, 65.

[39]R. Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1907-1960*, vol. 1 (Maxwell Air Force Base, Alabama: Air University Press, 1989), 19-20; Report of Aeronautical Commission, 15 August 1917, quoted in Maurer, *U.S. Air Service*, vol. 2, 132-133.

one-third of all American aircraft production should be night bombers. General Benjamin Foulois, Chief of Air Service, believed that Germany was preparing to secure "air supremacy in night bombing" in 1918. He surmised that the solution to the problem was simply "to build more night bombing squadrons than the enemy and carry out a greater offensive bombing campaign against him."[40]

Preparations for a night bomber arm within the USAS began when Handley Page 0/400 drawings were received by the U.S. War Department in August 1917. The Caproni Ca. 5 was believed superior to the Handley Page but drawings were not readily available. Additionally, Glenn Martin began designing and building a bomber that ultimately proved faster and higher flying than either of the other two models. Unfortunately, the Martin bomber was not in full production at the time of the armistice.[41]

As American production of Handley Page aircraft was proceeding slowly, General Foulois tried to obtain twelve French Voisin aircraft to establish a USAS night bombardment

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[40]Futrell, *Ideas*, 20; William Mitchell, *Memoirs of World War I: "From Start to Finish of Our Greatest War."* (New York: Random House, [1960]), 48-51; Report of Aeronautical Commission, 15 August 1917, quoted in Maurer, *U.S. Air Service*, vol. 2, 133; Benjamin D. Foulois, Report on Air Service problems, A.E.F., and recommendations re same, 23 December 1917, in Maurer, *U.S. Air Service*, vol. 2, 161-163. See appendix 11 for USAS comments on bombardment.

[41]Theodore M. Knappen, *Wings of War: An Account of the Important Contributions of the United States to Aircraft Invention, Engineering, Development and Production during the World War* (New York: Putnam's Sons, 1920), 162-170. A picture of the Martin bomber faces page 170.

squadron. Apparently six were delivered by the end of March 1918 but their disposition is uncertain. Adding further to the night bombardment dilemma was the reinstatement in early June 1918 of the "260-squadron Plan," which was originally formulated in September 1917.[42]

The plan called for the formation of sixty night bombardment squadrons, with twenty-one replacement squadrons estimated to maintain the full complement of service squadrons. To improve coordination of many different activities, the USAS organized the Night Bombardment Section on 28 June 1918. Yet for all the effort only one USAS night bombardment squadron, the 155th, arrived at the front on 9 November 1918, too late to carry out combat missions.[43]

However the United States did indeed carry out a strategic night bombardment during the Great War -- through the United States Naval Aviation Forces Northern Bombing Group. Organized in April 1918 the Northern Bombing Group was the United States' answer to the RNAS effort against the submarine bases in German-occupied Flanders. Initial

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[42]Letter, Foulois to *Monsieur* Le Sous, 23 January 1918, RG 120, Entry 806, NA; Memorandum, Airplane deliveries by foreign governments to USAS to March 28th [1918], P869 - 6B, 10 April 1918, 1, Henry H. Arnold MSS, Library of Congress (LC). See appendix 12 for USAS squadron projections.

[43]Maurer, *U.S. Air Service*, vol. 2, 195-196; Letter, The Adjutant General of the Army to M/G W. L. Kenly, 14 June 1918, *Arnold MSS*, box 222, LC; Memorandum entitled "American Program" (initialed by Kenly), n.d., *Arnold MSS*, box 222, LC; Memorandum from Office of Chief of Air Service, 28 June 1918, *Gorrell's History*, vol. B-6, 47-48, RG 120, NA; Maurer, *U.S. Air Service*, vol. 1, 76. See appendices 13 and 14 for USAS night bombardment squadrons.

requirements called for the establishment of six night bombardment squadrons utilizing either the Handley Page or the Caproni heavy bombers; additionally plans called for the formation of six day squadrons equipped with DH 9 or Bristol aircraft. Naval aviators manned the night squadrons while Marine aviators staffing the day units.[44]

Unfortunately the Caproni Ca 5s provided the Night Wing were equipped with faulty Fiat motors; only eight of the seventeen Ca 5s survived the ferry flight from Italy to the Night Wing base at St. Inglevert! On 15 August 1918 the Northern Bombing Group Night Wing carried out its only operation of the war -- with only one Caproni. The airplanes simply could not be kept in usable condition. Nonetheless several naval aviators performed night missions as observers with RAF No. 214 Squadron, flying the Handley Page bombers. The United States failed in its attempts to join the Allies in strategic bombing.[45]

The French were constrained by geography and aircraft to the strategic bombardment of the Briey basin. Limited-capability bombers which were forced to fly at night could carry out an extended campaign nowhere else. Even had

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[44]Telegram, Captain Cone to Admiral Sims, 17 April 1918, quoted in Ralph D. Paine, *The First Yale Unit: A Story of Naval Aviation, 1916-1919*, vol. 2 (Cambridge, Massachusetts: Riverside Press, 1925), 185-186; "Naval Aviation Overseas," *Cross and Cockade Journal* (U.S.) 4, no. 1 (Spring 1963), 66. See appendix 15 for Night Wing projections.

[45]"Naval Aviation Overseas," 66.

extended-range bombers been available early in the war strategic targeting would likely have remained the same. The basic problem was that French cities were vulnerable to German reprisal -- Paris was little more than fifty miles from the front. France would have lost a war of "city busting." In this situation, the railways and industry of the Briey basin appeared to be the only strategic option for France.

Great Britain had two distinct opinions regarding strategic bombardment. The RNAS minority opinion pressed for the strategic targeting of German steel production as well as of naval related objectives along the Belgian coast. The RFC believed its bombing assets were best used in a tactical role over the battle zone. They were forced into accepting a strategic role due to RNAS strategic activity. Only grudgingly did the RFC incorporate the Handley Page heavy-bomber into its inventory. The French feared the British would use its strategic capacity for indiscriminate bombing of German targets. Yet fully forty percent of Independent Forces RAF bombs (220 of 543 tons) were directed at German airfields; to damage and subdue German night bombing and fighter squadrons. These were usually the target of the FE2b-equipped night bomber squadrons. Additionally railway targets constituted a main objective of the British strategic campaign. The bombing of industrial targets in German cities was simply not as widespread as the French had feared. Therefore on closer examination, the

French and British strategic campaigns were not as disparate as would appear.[46]

German airship and airplane raids against England proved ineffective in reducing British war resolve. Were the campaigns wasteful expenditures of limited German resources? Certainly the airship program was extremely expensive for the results achieved. However the number of airplanes flying against England remained a minority of the German bomber force. Additionally the bombers of *Bogohl* 3 and *Rfa* 501 were often used for tactical missions, especially during the Spring 1918 offensives. It seems unlikely that their exclusive use for tactical bombing operations in 1917 and 1918 would have made a greater impact on the outcome of the war.[47]

The British were forced to invest heavily in defending the island. One author contends that the equivalent of ten full strength fighter units and two or three short-range bombardment squadrons (that could have been formed and utilized on the Western Front) were tied up in home defense duties. Germany, already outnumbered on the front, could have ill-afforded such an addition to the enemy camp.

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[46]Jones, *War in the Air*, vol. 6, 158-159.

[47]Summary of Air Information No. 8, 2dS GS, 9 May 1918, AUL.

Therefore the decision to implement the strategic bombardment campaign of England was not totally in error.[48]

World War I strategic night bombardment evolved from daring individual missions in converted observation airplanes into highly developed operations using large aircraft capable of carrying a heavy bombload into the enemy's heartland. From now on urban civilian populations far from the front could have a first-hand view of the horrors of war.

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[48]Imrie, *German Air Service*, 48; Cole and Cheesman, *Air Defence of Britain*, 446-451.

CHAPTER 5

THE FOUNDATIONS OF NIGHT FIGHTING

Aerial combat proved to be the most frustrating of all night flying attempted during the First World War. Night bombers flew to their objective, unloaded their cargo, and returned home; night reconnaissance aircrews similarly flew over a designated route to expose whatever hostile activities were taking place. But night pursuit aviators had no set itinerary -- they patrolled the skies looking for an illusory enemy whose black-painted aircraft blended into the darkness. Sometimes the hunter saw his quarry momentarily illuminated by searchlight; other times the prey was but a fleeting shadow against the lighted moon; occasionally brightly colored engine exhaust gases were the only indication that the game was nearby. Most often the hunter came home without firing a shot. Yet by the end of the war night pursuit pilots were often successful at stalking their quarry.

Paris and London were of vital importance to both the Allies and Germany. German bombardment of the capital cities would bring the war right to the halls of government. Additionally many civil and military authorities feared that

such bombings would damage civilian morale, thereby reducing popular confidence in national leadership. The capitals had to be defended day *and* night by all possible means; pursuit aviation was part of that defense.

From the opening days of the war the French air service dedicated large numbers of airplanes to the defense of Paris; by the summer of 1916 over 100 airplanes were performing such duty. These planes maintained a constant daylight patrol against German incursions but also supplemented searchlight and anti-aircraft defenses when German airships threatened the city by night. During the summer of 1916 six aviators and their Nieuport *Bébé* aircraft stood by on night alerts; the remaining Paris defense pilots were expected to answer a call as soon as possible. Aviators flew over the city, which was divided into three sectors for night defense, at designated altitudes between 1200 and 4000 meters; they met with little success however.[1]

The British also expected a massive Zeppelin attack against London soon after the outbreak of hostilities. Airplanes were quickly assigned to supplement the few anti-aircraft guns available for home defense, even though the Admiralty and War Office had little faith in their capacity for night interception. Nevertheless on the night of 5/6

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[1]Cole and Cheesman, *Air Defence of Britain*, 37; Stencil #281, IS-AD OCSO, 15 August 1917, entitled "Defense of Paris" (18 July 1916), RG 18, Entry 114, box 2, vol. 6, NA.

September 1914 Claude Graham-White and Richard Gates flew a Farman on the first nighttime Zeppelin patrol over London. They returned to Hendon after searching for the phantom airship for over an hour.[2]

Two RFC crews assigned to Joyce Green field ventured into the blustery night of 19/20 January 1915 to oppose the first genuine Zeppelin intrusion against England. Both airplanes experienced engine problems and made forced landings without sighting the airships. By the end of January 1915 RNAS coastal airfields each had three airplanes on alert status while the RFC stations east of Farnborough maintained two airplanes for anti-Zeppelin missions. Emergency night landing fields were soon established throughout London to provide a safeguard in the event of engine failure over the city.[3]

Yet interservice bickering between the RFC and RNAS over home defense responsibilities limited the effectiveness of night airplane operations during much of 1915. Even the question of airplane armament remained unsettled. When RNAS Flight Sub-Lieutenant R. A. J. Warneford succeeded in downing a Zeppelin (on the continent) in the early morning hours of 7 June 1915, he did so by dropping bombs on the airship. While some British authorities henceforth discounted the use of machine guns and incendiary bullets

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[2]Cole and Cheesman, *Air Defence of Britain*, 7.

[3]*Ibid.*, 15-16, 26-28.

against airships, others were not so sure. When the Board of Invention and Research Sub-committee for Aeroplanes filed its report on night flying in September 1915 the Board members complained that night navigation and landing facilities remained inadequate -- a year after the war had begun. Research and experimentation with British night pursuit continued at a fast pace but produced little tangible results during 1915. By the end of the year the RFC had but a total of twenty aircraft, mainly of the BE2c type, on alert at ten airfields (two per field) across southern England. The only results from 115 night home defense sorties flown during the first full year of fighting were negative; three British aviators were killed and eighteen aircraft damaged.[4]

In March 1916 British home defense reorganization called for the establishment of ten squadrons; only five squadrons (Nos. 33, 36, 38, 39, and 51) were in existence when the Home Defense Wing came into being in June -- aerial fighting on the Somme took priority. During the summer of 1916 a major change in night employment occurred. Formerly home defense pilots patrolled only in the immediate vicinity of their airfield; new arrangements called for a barrage-line of searchlights and airplanes running near the east

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[4]*Ibid.*, 31-33, 45-46, 448; R. A. J. Warneford, Official Report of 7 June 1915, copied in Stanley M. Ulanoff, ed., *Bombs Away: True Stories of Strategic Airpower from World War I to the Present* (New York: Doubleday, 1971), 14-15; Jones, *War in the Air*, vol. 3, 160-162.

coast of England from Dover to Edinburgh, with home defense airfields roughly twenty miles apart. Pilots would now patrol between stations in their hunt for enemy aircraft. Along with the increasing efficiency of home defense organization and employment came a major advance in armament. Incendiary and explosive bullets brought within sight "the end of the Zeppelin as a raiding weapon." Additionally No. 11 Reserve Squadron, the primary night-flying training unit, was transferred to the Home Defense Wing in August. The unique demands of home defense were finally being recognized.[5]

On the night of 2 September 1916 Lieutenant William Leefe Robinson was flying his BE2c on patrol between Hornchurch and Joyce Green when he spotted German airship *SL11*. Flying through the AAA barrage Robinson emptied three drums of the new explosive and incendiary ammunition into the German ship. The airship quickly turned into a roaring inferno as it fell from the sky. Robinson won the Victoria Cross for this first victory against an enemy dirigible over England. Morale soared for the home defense pilots and British populace. Further victories followed in rapid succession during September and October. Germany

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[5]Jones, *War in the Air*, vol. 3, 164-168; Cole and Cheesman, *Air Defence of Britain*, 153.

temporarily halted airship operations against Great Britain by the end of November.[6]

The RNAS claimed a secondary share of the home defense role during 1916 but carried out its duties with seemingly little enthusiasm. The Canadian official historian declares that:

> in the RNAS scheme of things, the home defense establishment was really coterminous with its night-flying training. In April 36 per cent of the 304 aeroplanes on active RNAS duty were being used for this combination of home defense and night-flying duties. By the end of the year the number of aeroplanes on such duties had increased only slightly; more significant, all but ten had been downgraded to the category of second-class aircraft. In other words, as the Admiralty reordered priorities for its air service, the home aeroplane element lost most of its experienced pilots and its aircraft were allowed to become largely obsolescent.
>
> With the exception of a few veteran pilots retained for night flying, the RNAS used the home aeroplane organization as a graduate course for inexperienced pilots.[7]

The night training on the home front gave the RNAS a large pool of experienced pilots for duty on the continent.

In early 1917, with the British Isles now "safe" from Zeppelin attack, the RFC reduced home defense by conscripting pilots for No. 100 Squadron, the newly formed night-bomber unit. Presumably most of the personnel were more than happy at the opportunity to fly on the Western Front. Most home defense patrols were lonely solo affairs

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[6]Cole and Cheesman, *Air Defence of Britain*, 162-163; Gunston, *Night Fighters*, 21.

[7]Wise, *Canadian Airmen*, 144.

searching for an elusive, or often phantom, airship. As the Germans had sent but forty-two airship missions against England during twenty-nine months of fighting, anxious home defense pilots awaited notifications which often never came.[8]

Airships had proven to be a difficult target for night pursuit pilots during 1915 and 1916; night "dogfights" between airplanes still appeared unfeasible. Yet night airplane bombardments had become routine by 1917 and searchlight and AAA defenses seemed impotent to stop them. In a chance encounter during the night of 11 February 1917 *Leutnants* Peter and Frowein of *Feldfliegerabteilung* 12, flying a C-plane, succeeded in shooting down two French bombers as they returned to Malzéville aerodrome; the wingtip navigation lights gave away the location of the French planes and made them easy targets. Such loitering over enemy night bomber aerodromes would become a favorite tactic of the First World War night fighter.[9]

The Germans formed *Kampfeinsitzerstaffeln* in a fashion similar to the British home defense units. These *staffeln* of single-seat fighters originally defended Alsace and Lorraine against French night bombers. With the extension of Allied bombardment into Germany during the final year of

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[8]Cole and Cheesman, *Air Defence of Britain*, 188-189.

[9]Neumann, *German Air Force*, 180-181; Gebhard Aders, *History of the German Night Fighter Force, 1917-1945* (London: Jane's, 1979), 2.

warfare new units were organized further to the rear. The *Jagdstaffeln* increasingly were responsible for night fighting close to the front; *Jasta* 73 alone shot down seven Voisins between 20 August and 25 September 1918. Additionally two special squadrons (one army, one navy) of six C-planes each were formed in June 1918 for the express purpose of attacking Allied night bombers as they were landing at their aerodromes. German night fighters performed admirably during the closing stages of the war.[10]

French pilots made several bold night pursuit flights during the battle of the Somme in 1916, but French air service officials remained skeptical over the possibilities of night fighting. The following summer (1917) *Capitaine* Langevin, the *commandant* of *Escadrille* 313, began night pursuit flights on his own initiative; he flew Nieuport 15-meter single-seat aircraft from Couderkque (near Dunkirk). This appears to be the first systematic testing of *fast* fighter aircraft for night work by any of the belligerents during the Great War. Night fighting had been performed with fairly stable, slow-flying planes; military authorities

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[10]Summary of Air Information No. 41, 2dS GS, 1 September 1918, AUL; Aders, *German Night Fighter*, 3-4; Erich Frintrop, "Nachtluftjagd: Aus den letzten Tagen des Weltkrieges," *Der Luftweg* (Berlin) 44/45, 18 November 1920, 1-2.

believed that planes landing at high speed were likely to crash.[11]

Langevin began his experimental work on moonlit nights over the North Sea since German bombers used a water route along the coast to Dunkirk. He was able to spot Voisins from *Escadrilles* V 109 and V 116 returning from night missions; from above they appeared silhouetted by moonlight reflecting off the sea. The French aviator succeeded in locating a G-plane by this method while flying at an altitude of 3200 meters during the early morning hours of 3 September 1917; unfortunately the plane was lost to view when it passed over the coastline. The following night Langevin spotted two more planes flying at roughly 3000 meters. French AAA batteries began to score against the German bombers after realigning their barrage fire to this altitude.[12]

Initially Langevin recommended two-seaters for night pursuit work. He believed that an observer was critical for successful operations as the pilot was occupied with flying the plane. He also advocated a standing patrol over Dunkirk in advance of anticipated German bomber activity. With further experience Langevin refuted both concepts; fast single-seaters were needed to close quickly on enemy planes

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[11]*Capitaine* H. Langevin, Rapport No. 59, La Chasse la Nuit, 29 *juillet* 1917, 1; *Commandant* H. Langevin, "Les prémices de la 'Chasse de nuit' en France," *Revue des Forces Aériennes* 9 (*avril* 1930), 400-402.

[12]Langevin, "'*Chasse de nuit,*'" 407-408.

and standing patrols wore down both men and materiel. *Commandant* Brocard, commander of *Groupe de Combat* 12, forwarded Langevin's report of 29 July 1917 to *Général* Duval with his endorsement. Interestingly Brocard argued that a "practical solution" might be the transfer of an existing night bombardment *escadrille* to night pursuit work. He apparently believed night flying experience was more valuable than acrobatic skills; nighttime "dogfights" did not exist in the same sense as day combats between pursuit planes.[13]

The French air service began night instruction with Nieuport aircraft at its training center at Avord as *Escadrille* 313 expanded its night activities. *GQG* ordered the *escadrille* to take up night pursuit on a full-time basis in late September. Delays in adapting the flight's Nieuport and Sopwith 1½ Strutters for night work kept the *escadrille* out of action during the most intense period of German night bombing of Dunkirk. The unit was ready for action at the end of October 1917, however enemy bombing declined as the battle of Flanders came to an end.[14]

Apparently the unit maintained single-, two-, and three-seater aircraft for three distinct night missions

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[13]*Ibid.*, 408, 410; Letter, *Commandant* Brocard to *Général* Duval, 23 *août* 1917, box A89, *SHAA*.

[14]Stencil #271, IS-AD OCSO, 27 July 1917, entitled "Training (French), Organization of Aviation School at Avord [sic]," 3, RG 18, Entry 114, box 2, NA; Langevin, "'*Chasse de nuit*,'" 408-409.

during 1918. The single-seaters provided point defense over Dunkirk and Calais; the two-seaters flew patrols between the two cities; while the three-seaters were used to attack German bombers over the enemy's aerodromes. During the spring offensives the unit also performed night reconnaissance missions.[15]

The French air service organized a detachment at Pars-les-Romilly for night fighting experimentation in mid-September 1918. Just three weeks before the armistice the detachment became the *Centre d'Instruction pour l'Aviation de Chasse de Nuit*. The center had the dual purpose of first assuring liaison with the anti-aircraft school and instructing pilots destined for night pursuit units, and secondly, developing night fighter tactics as well as assisting in anti-aircraft training and experimentation. Coordinated training with anti-aircraft units had been occurring by July 1918 (at the latest). Such instruction usually had ground searchlights attempting to illuminate a decoy Voisin bomber, followed by aerial intercept by Nieuport, Spad, or Bréguet fighters.[16]

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[15]Langevin, "'Chasse de Nuit,'" 414; Aders, *German Night Fighter*, 5.

[16]Ordre No. 25.145, Constitution du Detachment d'Aviation de Nuit de Pars-les-Romilly, 18 *septembre* 1918, box A3; Note No. 29.833, Note fixant le But, l'Organisation et le fonctionnement du Centre d'Instruction pour l'Aviation de Chasse de nuit, 22 *octobre* 1918, box A3; Essais de Chasse de Nuit, 15 juillet 1918, 17 *juillet* 1918, box A89; Note pour le Service de D.C.A., 3 *août* 1918, box A89, *SHAA*.

Unfortunately the instruction center experienced a critical shortage of planes equipped for night flying. *Capitaine* de Lesseps, the school commander, even requested that Spad pilots begin training at the *Centre d'Instruction de l'Aviation de Chasse et de Bombardement* (*CIACB,* at la Perthe). Yet the *CIACB* also had no night-ready aircraft. Presumably no night pursuit pilots completed the program of instruction at Par-les-Romilly before the end of the war. The school was finally closed in February 1919. At the time it had ten Spad 7, five Bréguet 14 A 2, three Nieuport 120, 3 Voisin Renault, and one Voisin Peugeot aircraft -- a case of too little too late.[17]

The RFC had been hesitant to try fast fighters for night pursuit work. However on the night of 3 September 1917 Sopwith Camels were used by three pilots from No. 44 (Home Defence) Squadron for the first time against the German G-planes attacking London; two RFC pilots on the continent flew Camels the same night. Major-General E. B. Ashmore, the commander of British home defense, considered the accomplishment "perhaps the most important event in the history of air defense." By the end of the year Camels were

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[17]Letter, *Capitaine* de Lesseps to *Général* Duval, 17 *octobre* 1918, box Ba; Ordre No. 13.740, Dissolution du Centre d'Instruction pour l'Aviation de Chasse de Nuit (C.I.A.C.N.), 8 *février* 1918, box A3; Compte Rendu de dissolution du Centre d'Instruction pour l'Aviation de Chasse de nuit (C.I.A.C.N.), 23 *février* 1918, box A3, *SHAA*.

being modified for home defense work along with SE5a and Bristol fighters.[18]

No. 44 Squadron Camels later were used to form part of No. 151 Squadron, the first British night pursuit unit to go to France. The late date of formation -- 12 June 1918 -- is rather surprising since the Germans had been carrying out night bombardment of British rear areas for many months. Nevertheless No. 151 Squadron "very nearly exterminated the Boche night bombers of the 1st and 3rd Army fronts," tallying at least twenty-five victories. No. 152 Squadron was sent to France in October 1918 but was barely operating when the armistice came; another squadron was preparing to leave England by mid-November.[19]

The United States had high hopes for night pursuit in the closing weeks of the war; plans were developed for the training of 300 night pursuit pilots. The 185th Aero Squadron was formed in early October 1918 for night fighting and equipped with Sopwith Camels. Major Harold Hartney, commanding the First Pursuit Group, decided to learn about night fighting through first-hand experience. On the night of 22 October he encountered a G-plane at 12,000 feet; the engine exhaust flames giving away the bomber's location.

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[18]Jones, *War in the Air*, vol. 5, 62; Gunston, *Night Fighters*, 25-26; Major General E. B. Ashmore, *Air Defense* (London: Longmans, Green and Co., 1929), 53.

[19]Jones, *War in the Air*, vol. 5, 151; Group-Captain A. J. L. Scott, *Sixty Squadron R.A.F.: A History of the Squadron, 1916-1919* (London: William Heinemann, 1920; repr., London: Greenhill, 1990), 71-72; Ashmore, *Air Defence*, 105.

Being unaccustomed to night flying the aviator nearly rammed the German bomber, then stalled his machine and fell out of position. After recovering Hartney succeeded in firing on the Gotha but the bomber continued to fly. In the excitement of the moment the major had switched off his engine and was forced to give up the chase. Yet he apparently succeeded in crippling the bomber; a G-plane was found on the ground not far from the area of Hartney's encounter soon after the armistice; it was full of bullet holes. This would be the 185th's only "victory."[20]

Night pursuit proved most successful when fighter aircraft and ground searchlight defenses performed coordinated actions. Searchlights were of great importance in locating enemy bombers since night pursuit pilots could rarely locate other aircraft at distances beyond 700 meters even in bright moonlight. On dark nights identification was reduced to one hundred meters or less and was usually limited to spotting the glowing engine exhaust gases. Even when the searchlights failed to illuminate hostile aircraft they provided the night fighter with a smaller search area.[21]

Additionally, advanced listening posts near the front provided early warning, thereby negating the need for

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[20]Harold E. Hartney, *Wings Over France*, ed. Stanley M. Ulanoff (Folkestone, UK: Bailey Brothers and Swinfen, 1974), 221-227.

[21]Major H. E. Hartney, *Observations on Night Pursuit*, n.d. [late 1918?], 167.601-3, HRC.

standing patrols. Information concerning hostile aircraft crossing the lines was telephoned to searchlight and night pursuit locations. Such coordinated defenses increased night fighter efficiency. Because of the difficulties in locating aircraft, night pursuit pilots also needed to study and recognize aircraft by their unique silhouettes; friendly bombers returning from across the lines might otherwise be mistaken.[22]

By the end of the First World War night bombers could no longer disregard the threat of pursuit aviation. The British were the most successful; with years of experience in home defense the RAF pilots of No. 151 Squadron proved their skills in the darkened skies over northern France. Similarly the aerial defenders of Germany took an increasing toll against French and British night bombers. Night pursuit could indeed no longer be overlooked.

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[22]Doyen P. Wardwell, "Night Pursuit Flying," *Air Power Journal* 6, no. 2 (June 1920), 173; Report on Pursuit Training, Office of Chief Training Section, Air Service, AEF, nd [1918?], *Gorrell's History*, vol J-6, 312, RG 120, NA.

CHAPTER 6

NIGHT OBSERVATION AND RECONNAISSANCE

In the opening weeks of the First World War aircrews darted back and forth across the skies of Flanders and northeastern France seeking to discover the intentions of enemy ground forces. Airplanes had but one mission in those days -- reconnaissance. While many if not most military leaders regarded the airplane as little more than a supplement to cavalry, early successes led to acceptance of the airplane as an independent information gatherer. Only aircraft could provide timely reconnaissance across such a broad, fluid front. Yet no night reconnaissance missions were flown in 1914 or for that matter for most of the war. This is the great paradox of World War I night flying: while reconnaissance was *the* perceived duty of aviation, night observation was one of the last organized functions to appear as a specialized task during the Great War. Why was this true?

The advent of trench warfare brought an abrupt end to cavalry's contributions on the Western Front. Military leaders were now forced to depend more heavily upon aviation for intelligence of enemy activities behind the lines.

However at the same time, the need for *immediate* knowledge of enemy operations subsided. Face to face on a heavily-defended front bounded by impassible geographical features, there was little fear, nay any possibility, of being quickly outflanked by an unseen opponent. In addition to the ongoing daylight reconnaissances, airplanes began to make dusk and dawn patrols to determine changes made under cover of darkness. Therefore, daylight airplane observations provided adequate intelligence gathering -- with one very important addition.

The captive balloon, clearly the oldest method of aerial intelligence gathering, reappeared behind the battlefront. While the Allies considered the balloon obsolete for military use in 1914, the Germans maintained a usable inventory of Drachens when hostilities erupted. Soon afterwards the French engineer Albert Caquot developed a balloon superior to the Drachen for Allied use. These balloons provided stable platforms for observation across the trench lines. From several thousand feet in the air balloon observers could watch activity up to fifteen miles behind the lines, and provide "real time" information to ground forces through the use of telegraph or telephone.[1]

Balloons were also easily employed at night. Though many details are obscured by the darkness, observers nevertheless gained valuable frontline intelligence, such as

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[1]Kennett, *First Air War*, 23-25.

determining the limits of an enemy attack, reporting infantry signals during artillery barrage fire, and reporting enemy marker signals for hostile bombardment aircraft. The observation balloon was in fact so useful that aircraft and artillery continually sought its demise. The development of the USAS Balloon Section demonstrates this point; in less than nine months of operation, thirty-five companies tallied a total of 3,111 hours of frontline observation, including night work. The section not surprisingly was first commanded by Colonel Frank P. Lahm, the winner of the 1906 James Gordon Bennett balloon competition. Hence the combined system of captive balloons, with their limited night capability, and daylight airplane reconnaissance provided adequate intelligence gathering during the period of static warfare -- specific night aircraft reconnaissances were simply not needed.[2]

For much of the First World War the airship was used for intelligence gathering at sea. Interestingly the first operational British aircraft of the war was the non-rigid Parseval airship *No. 4*, which conducted a patrol at the mouth of the Thames River on the night of 5/6 August 1914; British blimps were to fly a total of over 86,000 hours in the course of the war. Owing to their lack of endurance

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[2]"Instructions For Balloon Observers," in Maurer, *U.S. Air Service*, vol. 2, 257; The Balloon Section, part 13 of "Final Report of Chief of Air Service," in *ibid.*, vol. 1, 137-138; "Tactical History of American Observation Balloons," in *ibid.*, 379.

however, the blimps could only provide short-range fleet support, convoy escort, and submarine patrols. Additionally, due to the failure of the British rigid airship program, aerial convoy escort duty along the dangerous western approaches was never adequately filled.[3]

German airships likewise performed in a reconnaissance role over the North Sea. As early as 1908, some German naval officials believed that the airship would make a fine strategic scout, especially if Germany was blockaded. In the last year of the war routine night reconnaissance flights were carried out toward the coast of Norway, and to within fifty miles of the English coast. However the airships, flying at an altitude of 13,000 feet, garnered little usable information on these patrols. Fear of British airplanes evidently prevented the vulnerable German airships from flying at lower elevations.[4]

While 971 reconnaissance flights were made over the North Sea during the course of the war, weather greatly hampered German airship operations; in fact on the average, airships were able to perform scouting missions on but one day in every four. Such a lack of regular reconnaissance led Douglas H. Robinson to conclude that German airships were improperly employed in North Sea scouting, especially late in the war. Strategic scouting missions along the

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[3]Higham, *British Rigid Airship*, 63, 123.

[4]Robinson, *Zeppelin in Combat*, 19, 315-316.

western approaches, he argues, were feasible for the high-speed *L70* class of airships. Clearly a coordinated effort with German submarines against Allied convoys during their period of unrestricted warfare might well have had decisive outcome. Yet with the existing state of technology, could greater results realistically have been expected from airships?[5]

Night bomber crews were expected to perform aerial reconnaissance during their missions over the lines. The French quickly recognized the importance of such duty:

> During the flight pilots and passengers will try to collect all possible information on the enemy, noting very exactly the time and the place. Upon return this information will be collected by the commander of the *group*, who will collate it and immediately make a report by telephone to army headquarters. A written version in two copies will then be sent to the *Deuxième* Bureau and to the commander of the *army's bombardment* aviation.[6]

One of the earliest efforts to achieve systematic results occurred in 1916 during the battle of the Somme. There, French night bombers made detailed observations after unloading their bombs; RFC airmen similarly undertook occasional night reconnaissance missions at this time. During this period and on into early 1917, *GB* 3 carried out

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[5]*Ibid.*, 350-351.

[6]*Capitaine* Faure, "Instruction Relative aux Bombardements Par Avions," 10 *juillet* 1915, 3, box A21, *SHAA*.

reconnaissance in conjunction with bombing missions fifteen to fifty kilometers behind the lines.[7]

Night artillery spotting was tested by both the French and Germans in late 1917. The French found that large targets were clearly visible in moonlight and offered the best opportunity for success. Attempts at ranging cannon fire against enemy batteries were less effective due to the difficulty in determining their exact coordinates in the darkness. During the night of 25 September 1917 a German airplane flying over the North Sea between Coxyde and Dunkirk directed fire from the infamous "Lengenboom" cannon via radio.[8]

Unable to prevent Allied day observation behind their lines, the Germans began moving troops and supplies strictly at night. By masking their spring 1918 offensive preparations in this manner, the Germans successfully limited Allied information. French air service commanders reminded night bombers to be ever vigilant:

> Observers should not lose sight of the fact that the reconnaissance, which is part of each bombing mission, has a very great importance and that the information it provides can have broad consequences. In flying over a zone of attack, the bombardier with experience in night

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[7]Christienne and Lissarague, *French Military Aviation*, 103; Jones, *War in the Air*, vol 2, 184; *Capitaine* Etournaud, Rapport Sur les Reconnaissances et Bombardements de Nuit, 6 *mars* 1917, 1, box A21, *SHAA*.

[8]Stencil #902, IS-AD OCSO, subsection entitled "Artillery Control by Night," 29 January 1918, 2, File S0002300, NASM; Stencil #867, IS-AD OCSO, entitled "German Aeronautics," 24 January 1918, RG 18, Entry 114, box 4, vol. 15, NA.

> observation can sometimes tell at a glance in which sector the enemy will direct his efforts, simply by noting the differences in lighting and in rail activity.[9]

Yet the night bombers proved incapable of supplying enough information. Fully expecting a German offensive but unable to determine when or where enemy troops would go "over the top," Allied commanders called for a series of night flights whose purpose was strictly reconnaissance. Such activity offered the surest means for uncovering German intentions.[10]

Not surprisingly, the British called on their old workhorse, the FE2b, with RFC airmen carrying out thirteen night reconnaissance missions during the week of 13-18 March 1918. However, the Germans were prepared to meet these nighttime probes with the utmost discipline. One German aviator moving with ground forces toward the front noted in his diary the impact of flares dropped from these British scouts: "all traffic stops, and the troops crouch lifeless under the shelter of trees and houses. Nothing must be given away."[11]

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[9]*Commandant* Armengaud, Conférence sur le bombardement de nuit, 21 *février* 1918, 15, box A164, *SHAA*.

[10]Muir S. Fairchild, "Notes on Type VIII Night Observation," 26 October 1922, 1, 168.7001-85, HRC; Montgomery, *Flare Path*, 142-145; Hiram S. Bingham, *An Explorer in the Air Service* (New Haven, Connecticut: Yale University Press, 1920), 109-111.

[11]Captain Thomas A. Box, "Night Reconnaissance," n.d. [post 11 November 1918?], 1, *Gorrell's History*, vol. J-3, 391, RG 120, NA; Supplement to Summary of Air Information, 6 April 1918, 2dS GS, AUL; Rudolf Stark, *Wings of War: An*

Discipline was apparently so great that the British reported no use of artificial light for troop and materiel movements within fifteen miles of the front during the spring. Hence captive balloons were "blind" to German activities. Main roads were little utilized and it was even conjectured that "flaming onion" batteries firing phosphorescent shells were used to warn ground forces of the imminent approach of hostile aircraft. Few lights were even noticed in villages forty miles from the front![12]

The French likewise were performing night reconnaissance along their sector, the work being performed by the bombers of *GB* 8. Yet the Allies remained unable to gain a clear understanding of enemy intent. As the magnitude of the offensive became apparent, *Escadre* 11's night *GBs* (1 and 7) quickly shifted from Lorraine to the *Groupe d'Armées du Nord* (*G.A.N.*) to supply added night reconnaissance capability.[13]

The Germans were able to make great progress during their March 1918 offensive in large part due to the night movement of troops. With the stalling of the offensive,

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Airman's Diary of the Last Year of the War, trans. Claude W. Sykes (London: John Hamilton, 1933), 29.

[12]"Notes on Night Reconnaissance and Bombing (July 1918)," Bulletin of the Information Section, AS, AEF, 6, no. 251, 21 August 1918, *Gorrell's History*, vol. L-10, 7-8, RG 120, NA.

[13]Voisin, *La Doctrine de l'Aviation de Combat (1915-1918)*, 67-68.

surprisingly little was done by the Allies to establish a permanent night reconnaissance capability -- even though the Allies could not hope to stop many more German offensives on the magnitude of the March assault without better preparation. For the two-and-one-half months between 25 April and 9 July 1918, *Général* Henri Pétain, *Général Commandant en Chef* of French forces, lacked firm intelligence on German offensive movements and intentions. An order from the German Army Chief of Staff reinforced the importance of night preparations:

> *1. Large troop movements* and *marches* incidental to a change of billets *will, as a rule, only take place at night*. When troops on the march are taken by surprise at night by parachute flare dropped by a hostile airplane they *will stop immediately and not move*.[14]

As the situation became critical *Général* Duval, on 3 July 1918, ordered the establishment of night reconnaissance detachments for all French Armies as a means to improve information gathering. These detachments, to be composed of four planes, four pilots, and the necessary ground elements, were to be attached to army *escadrilles* for administrative and materiel support. Day observation pilots with night flying experience were drafted for rapid implementation of the night reconnaissance program. Additionally, the order required two observers, specializing in night observation, to be attached to the individual armies. Five such

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[14]Summary of Air Information No. 31, 2dS GS, 29 June 1918, translation of document signed by von Sauberzweig, AUL.

detachments were to be established immediately, while night bombardment *escadrilles* (V 25, V 101, and V 118) providing provisional support as needed.[15]

Between 7 and 9 July 1918, French night reconnaissance units had great success, noting "abnormal illumination of railroad stations and railway, and numerous movements on the roads." This time the Allies knew the German offensive was not far distant and readied themselves to meet it. So critical was the information gained in the week prior to 15 July that General Mason Patrick insisted the Allies "owed mainly to night reconnaissance" the knowledge of the attack on the Marne. Against a prepared opponent the German offensive quickly stalled.[16]

Though limited in resources and planning, French night reconnaissance units performed quite admirably during the German advance in Champagne. Soon after the tide turned, *Général* Pétain reiterated his support for continued expansion of French aviation units specializing in night reconnaissance. Clearly the *GBs* could no longer be expected

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[15]Major H. H. C. Richards, "The Use of Observation at Night," 15 May 1928, 8, 248.262-31, HRC; Ordre No. 2.011, Constitution de Détachments d'Avions de Reconnaissance de nuit dans les Armées, G.Q.G., 3 *juillet* 1918, 1, box A14; Ordre No. 2.011, 2, box A14, *SHAA*; Langevin, "*Action de masse*," 24-28.

[16]Richards, "Observation at Night," 8, 248.262-31, HRC; Commandement de l'Aeronautique, VIII[e] Armée, *Ordre d'Operations pour la journee du 10 juillet* [1918], RG 120, Entry 805, decimal 319.1, NA; The Changing Methods of Aerial Warfare, "Final Report of Chief of Air Service," quoted in Maurer, *U.S. Air Service*, vol. 1, 81.

to execute two separate missions of critical importance. The need for comprehensive intelligence of enemy dispositions was simply too crucial to the continued success of the Allied advance (which had begun with a counterattack on the heels of the German offensive). The seeds of night reconnaissance had begun to bear fruit.[17]

Impressed with the possibilities of such activity, Colonel William Mitchell, then Chief of Air Service, U.S. First Army, directed the formation of the 1st Night Reconnaissance Flight. Three experienced day observation teams were selected to fill the new unit, as plans called for the rapid formation of an entire night reconnaissance squadron. Training immediately commenced at Vandey aerodrome under French direction, with the Bréguet 14 B 2 selected for use. Additionally, at least one observation squadron, the 90th, attempted night flying in early August 1918. After several crashes the practice was apparently stopped.[18]

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[17]Ordre 27.717, translation entitled "Practical instruction upon the execution of Aerial Reconnaissance," 22 July 1918, quoted in Richards, "Observation at Night," exhibit "K," 248.262-31, HRC.

[18]Charles Woolley, "History of the Ninth Aero Squadron," *Cross and Cockade Journal* (U.S) 12, no. 2 (Summer 1971), 146; Minutes of the Second Meeting of the Strategic Section, Air Service, 23 July 1916, 6, RG 120, Entry 806, NA; Peter Kilduff, ed., "Observations: The War Diary of Lt. Gustaf L. Lindstrom," *Cross and Cockade Journal* (U.S.) 13, no. 2 (Summer 1972), 107. See appendix 16 for aircraft specifications.

The 1st Night Reconnaissance Flight was absorbed into the 9th Aero Squadron on 2 September 1918. Twelve days later the squadron, flying from Amanty aerodrome, recorded its first successful operational night reconnaissance mission during the Allied advance against the St. Mihiel salient. Soon after the offensive, the unit moved to Vivancourt aerodrome. The 9th remained the sole squadron specifically charged with night reconnaissance for the USAS in the final two months of the war.[19]

Both French and American night reconnaissance units obtained their operations directives from the aeronautical commander at the Army level. Aircrews were then assigned specific routes to be flown to and from their objectives; in this way the possibility of collision with other Allied night fliers was greatly reduced. Additionally, a more complete reconnaissance of the sector could be achieved through set routes. Furthermore, strategic missions were usually carried out at night due to the decreased efficiency of enemy defenses. With the ability to penetrate further into hostile territory, night scouting was complementary to

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[19]The organization of night reconnaissance units can be found in "Routine Procedure of Air Service Units," Air Service Bulletin 7, no. 305 (24 December 1918), 15, 167.601-7, HRC; Woolley, "Ninth Aero Squadron," 147-148; History of the 9th Aero Squadron, *Gorrell's History*, vol. E-2, 3-4, RG 120, NA.

day activity -- both were needed for a comprehensive picture of enemy activity.[20]

Visibility dictated the altitude employed during night reconnaissances, the ability of aircrews to locate objects on the ground being dependent upon several factors, including the amount of moonlight and the clarity of the atmosphere. Even the capacity to distinguish the most basic of ground features was influenced by these factors. The British found in their experience that three components were essential for successful night scouting without artificial illumination. In addition to the absence of fog or mist near the ground, bright moonlight was important because it increased the contrast of ground features, and cast distinct shadows which aided aerial identification. Finally, low flying simplified the observer's task and was even a necessity for visual reconnaissance.[21]

Ground features were recognizable under full moonlight. Woods and forests appeared black, towns and

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[20]General William Mitchell, Provisional Manual of Operations, 23 December 1918, in Maurer, *U.S. Air Service*, vol. 2, 280; *Chef d'Escadrons* de Vergnette, Projet de constitution du Détachment d'Avions de Reconnaissances de Nuit de la II° Armée, G.Q.A., 6 *août* 1918, 2, box A20, *SHAA*; Captain W. W. Thomas, "Night Reconnaissance and Observation: First Lecture," Air Service Bulletin 7, no. 314 (21 December 1918) 4, 167.901-9, HRC; "Night Bombardment and Provisional Regulations," trans. Col. Hunter, 4, 248.222-58, HRC.

[21]Summary of Air Information No. 77, 2dS GS, subsection entitled "Night Reconnaissances," 17 October 1918, 2, AUL; Thomas, "Night Reconnaissance and Observation," 3, 167.901-9, HRC; "Notes on Night Reconnaissance and Bombing," Bulletin no. 251, *Gorrell's History*, vol. L-10, 1-2, RG 120, NA.

villages looked gray, while less traveled open roads seemed whitish. Canals and waterways reflected moonlight, hence were quite visible. Railroads could likewise be easily identified. Factories in operation cast a "luminous glow" which could be seen for miles. Finally, aerodromes, and camps and bivouacs in open ground were identifiable under bright moonlight. Reconnaissance crews could cut down on glare by flying with the moon shining from the back of the airplane.[22]

During periods of bright moonlight detailed movements could be observed from a height of between 1,500 and 2,000 feet along broad, open roads. Such activity could be identified up to fifteen kilometers distant from the aircraft. When first detected, transports appeared as black dots, troop movements as oblong masses. Additionally, road movements during dry spells often resulted in a visible dust "cloud." The billowing smoke emitted from steam engines made train movements easy to recognize.[23]

During the half-moon phase diminished light forced reconnaissance flights to an altitude of 1,500 feet, and often to 1,000 feet for useful information gathering. Using only natural lighting, which often was presumed adequate for

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[22]Thomas, "Night Reconnaissance and Observation," 3-4, 167.601-9, HRC; "Notes on Night Reconnaissance and Bombing," Bulletin no. 251, *Gorrell's History*, vol. L-10, 1-2, RG 120, NA; Mitchell, Provisional Manual of Operations, in Maurer, *U.S. Air Service*, vol. 2, 283.

[23]"Notes on Night Reconnaissance and Bombing," Bulletin no. 251, *Gorrell's History*, vol. L-10, 2, RG 120, NA.

observation, an observer would frequently miss concealed movements -- half-moon periods resulted in more inaccurate reconnaissances than any other time of the month. Hence the parachute flare provided an important tool during such missions.[24]

Natural land features remained distinguishable in quarter-moon light, but were hardly recognizable on totally dark nights. In fact, on moonless nights with overcast skies, fog, or mist, the challenge was simply for the scouts to remain on their intended course; therefore, concealed movements on the ground became nearly impossible to detect. As an aid to such flying, special night maps showing only the most visible ground features -- roads, rivers, towns, forests, and "permanent" lights, for example - were used for night navigation. Obviously such dark conditions required the artificial light provided by parachute flares.[25]

Among the Allies the Bourges flares were favored for target illumination. They provided optimal ground illumination for between a one-quarter square mile and one square kilometer of territory when ignited at a height of roughly 1,800 feet. The flares would then continue burning for approximately four minutes. Typically, for a complete road reconnaissance several flares, dropped at interval, produced an overlapping coverage which proved valuable in

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[24]*Ibid.*, 3-4.

[25]*Ibid.*, 4-5; Thomas, "Night Reconnaissance and Observation," 1-2, 167.601-9, HRC.

determining any abnormal activity. Additionally, reconnaissance observers found flares useful in illuminating stationary objectives such as railroad yards.[26]

The German army recognized the need for increased night reconnaissance to enhance its defensive posture soon after the Allied counteroffensive commenced in late-July 1918. As with the French, German night scouting had been a secondary role for bombardment aircraft. However, the German leadership believed that twin-engine G-planes were too noisy for the low-level missions required once the Allies began a concerted effort to carry out night movements. If the loudness of the engines betrayed the German presence, Allied troop and supply convoys could quickly disperse and take cover, thereby preventing effective reconnaissance.[27]

Occasional night flights by day observation units occurred throughout the summer, and by late summer *OHL* was seriously considering the organization of special night reconnaissance units. One major concern for the use of night scouting was in locating Allied tank assembly areas. Tanks, if properly employed with infantry and artillery support, provided the Allies with weaponry capable of

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[26]Thomas, "Night Reconnaissance and Observation," 3, 167.601-9, HRC; Letter, 2d Lt W. H. Leininger to Commanding Officer, 9th Aero Sqdn., A.E.F., 20 November 1918, *Gorrell's History*, vol. E-2, 143-144, RG 120, NA.

[27]Summary of Air Information No. 77, 17 October 1918, 2, AUL.

smashing through the German defenses. Hence the Germans needed to know the advance location of tanks. With such information the tanks could be targeted and hopefully destroyed before their use in a ground offensive.[28]

Meanwhile, the French were expanding their night reconnaissance capabilities. Since accurate information of German defenses would be critical for the impending Allied assault on the Saint Mihiel salient, more night reconnaissance units were needed. To resolve the shortage of night scouts, *Général* Pétain authorized the creation of a training center for "special missions" at Herbisse.[29]

Organization of the Center of Instruction for Long Distance Night Reconnaissance Aviation called for five instructors and between twelve and fifteen trainees. Additionally, a night bombardment *escadrille* was to furnish ten Voisin Renault aircraft; the training *escadrille* being designated V 200. The school had barely begun to function

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[28]*Ibid.*, 2, AUL; Hanns-Gerd Rabe, "Night Reconnaissance: A Personal Memoir of Hanns-Gerd Rabe, *Flieger-Abteilung (A) 253*," *Cross and Cockade Journal* (U.S) 14, no. 1 (Spring 1973), 65-71.

[29]Letter, *Chef d'Escadrons* de Vergnette *à Chef du Service Aéronautique*, G.G.A., 4 *août* 1918, box A20, *SHAA*; Constitution de Detachment d'Avions de Nuit de la 2e Armée, G.Q.G., 21 *août* 1918, box A20, *SHAA*; Letter, *Le Général Commandant en Chef à le Général Commandant le G.A.C.*, G.Q.G., 1 *septembre* 1918, box Aa3, *SHAA*.

when its work was interrupted by the armistice: six days later the school at Herbisse was dissolved.[30]

A few French night reconnaissance *escadrilles* did come into existence before the end of the war: for example, in October the First Army detachment was expanded into *Escadrille* V 293. With the training center in operation, *Général* Duval announced that *escadrilles* would replace all existing detachments. Additionally, these units were to be equipped with faster, more capable aircraft, most likely the Bréguet 14 B 2; operational effectiveness would greatly improve.[31]

The Americans were less successful. As their projections for the formation of night reconnaissance squadrons had not been met, the USAS was forced to rely on French night bombardment aviation for reconnaissance assistance during the Saint Mihiel offensive. Soon after, on 27 September 1918, all USAS observation and two-seat pursuit planes were authorized to be equipped for night flying. Standard provisions for night scouting planes, as

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[30]Note No. 6796 Fixant le But, l'Organization et le Fonctionnement de Centre d'Instruction pour les Reconnaissances de Nuit à Longue Portee, G.Q.G, 5 *septembre* 1918; Ordre No. 6425, Constitution de Centre d'Instruction pour les Reconnaissances de Nuit à Longue Portee, G.Q.G., 5 *septembre* 1918; Ordre No. 26549, Dissolution du Centre d'Instruction d'Aviation pour les Reconnaissances de Nuit à Longue Portee et de l'Escadrille 200, G.Q.G., 17 *novembre* 1918, box Aa3, *SHAA*.

[31]Ordre No. 13.003, Constitution de l'Escadrille 293, G.Q.G., 10 *octobre* 1918; Order No. 24.581, Note Sur l'emploi des Escadrilles de nuit d'Armée, G.Q.G., 17 *octobre* 1918, box A14, *SHAA*.

well as day observation aircraft, included bomb carriers for eight to ten fragmentation bombs. Clearly these were meant for troop concentrations, convoys, and other "soft" targets. Allied air power sought to maintain the ground initiative through round-the-clock harassment of the enemy.[32]

Additionally, the USAS had contemplated the use of FE2bs for night reconnaissance work during July 1918. The British had agreed to deliver a total of 114 of these aircraft to the Air Service, with roughly one third of the number being delivered per month, beginning in September. The Air Service also considered the Voisin aircraft as a night bomber (the USAS had been unable to secure any Handley Page aircraft); night reconnaissance missions could have easily been accomplished with the planes. Although USAS leaders recognized the FE2b and Voisin aircraft as obsolete, the urgent need for night reconnaissance and bombing planes dictated such action.[33]

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[32]The USAS planned to have nine night reconnaissance squadrons on active service by the end of December 1918. "History of the Aircraft Armament Section Including Description of its Organization and Functions," *Gorrell's History*, vol. I-2, 29-33, RG 120, NA; "Plan for the Employment of the Observation Aviation of the First U.S. Army," Appendix No. 4 to Plan of Employment of Air Service Units, 1st American Army, Annex No. 3 (Field Order No. 9), 7 September 1918, 167.601-9, HRC.

[33]Thirty-one FE2bs were delivered to the USAS by 17 November 1918. "Minutes of the Second Meeting of the Strategic Section, Air Service," 23 July 1918, 6, RG 120, Entry 806, NA; "History of the Aircraft Armament Section," *Gorrell's History*, vol. I-2, 55-56, RG 120, NA; Fairchild, "Notes on Type VIII Night Observation," 26 October 1922, 2, 168.7001-85, HRC; Memorandum, Captain Averill Tilden to Assistant Chief, Supply Section, 19 November 1918, Arnold

Night bombardment aircraft had performed satisfactorily in a reconnaissance role for much of the First World War. However, once the "war of movement" began during the spring of 1918, the Allies found day observation planes and night bombers could no longer supply their reconnaissance needs. The development of specialized Allied night reconnaissance units was essential for meeting Germany's next advance. Germany also recognized the valuable contribution that night observation offered when forced onto the defensive in the latter-half of 1918. Night reconnaissance had become an integral element of air employment by war's end.

MSS, box 222, LC.

CHAPTER 7

MEN AND MATERIEL FOR NIGHT FLYING

Night flying placed special demands upon both the airmen and the machines in which they flew. Takeoffs, landings, cross-country navigation, indeed the basics of flight could no longer be taken for granted. During the Great War belligerents had to overcome immense challenges for successful military night aviation; daytime flying over the Western Front was difficult enough without the compounding factor of darkness. Yet by November 1918 sophisticated night navigation systems were developed and in place; an increasing variety of aircraft were being fitted and employed in night flying; and aviators were graduating from comprehensive training programs as night aviators. In the space of four years night flying had gone from being a stunt of foolhardy exhibition pilots to an indispensable component of military plans for bombardment, pursuit, and reconnaissance aviation.

The evolution in night flying training might be understood by reviewing the developments in bombardment instruction, since bombardment was the first and most widespread form of night aviation employed during the First

World War. France had but two military aviation schools, Pau and Avord, when war erupted in August 1914. Expansion quickly followed, with the aviation training centers becoming collectively known as the "Schools of the Interior." During 1915 the *idea* was conceived of graduating mission-ready pilots for pursuit, bombardment, and observation -- capable of day or night flying. Yet it was not until April 1916 that advanced bombardment and night flying training was established at Avord. By this time, *GB* 3 was already recognized as a night unit; the group either developed its own unique training or had night instruction at the *Groupe de Division d'Entraînement* (*G.D.E.*), the center for assigning aviators to *escadrilles*.[1]

French bombardment training, like that of all the belligerents, was in a state of continuous evolution as the demands of combat and increasing technological capabilities required better trained, more specialized aviators. In 1917 the school at Avord offered advanced night bombardment training for Voisin and Caproni aircrews. Instruction included ground work on bombardment theory, navigation, and the rolling carpet; the rolling carpet was basically a treadmill painted to look like the ground when seen through a bombsight from a height of several thousand feet. Bombardiers sat on a wooden platform overlooking the carpet

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[1]Stencil #269, IS-AD OCSO, 14 August 1917, entitled "Training (French)," 2, 6-7, RG 18, Entry 114, box 2, vol. 6, NA; "Object and Organization of the French G.D.E.," *Gorrell's History*, vol. B-9, 45, RG 120, NA.

and released small darts (simulated bombs) to gain experience in bomb-sighting. Aerial instruction included bombing practice with live and dummy projectiles. Additional French bombardment schools were located at Cernon, Clermont-Ferrand, Le Crotoy, and Villeneuve.[2]

Due no doubt to the growing dependence on night bombardment, the French conducted night tests of Michelin and Gros bombs at Clermont-Ferrand during July 1916. Presumably these tests were part of ongoing investigations into the uses and capabilities of night bombardment. The Michelin illuminating bombs proved satisfactory for lighting the target area. However a longer lead time, of at least 200 to 300 meters vertical descent, was recommended before flare ignition. This would ensure that the airplane was well away from the illuminated sky, hence remaining undetected.[3]

The Gros Andreau 115mm short-bomb testing was conducted from a height of 2,000 meters against illuminated targets one hundred meters in diameter. No bombs hit the target areas; in fact the nearest strike was ninety meters distant. In the end, the trial "proved nothing

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[2]Stencil #271, IS-AD OCSO, 27 July 1917, entitled "Training (French), Organization of Aviation School at Avord [sic]," 2-3, RG 18, Entry 114, box 2, NA. See appendices 17 and 18 for French night bombardment training.

[3]Stencil #708, IS-AD OCSO, 5 December 1917, entitled "Tests at the Military Aviation School at Clermont-Ferrand with the Michelin and Gros Andreau Bombs made on July 29, and 30, 1916," 8, RG 18, Entry 114, box 4, vol. 14, NA.

conclusively, as to the accuracy of night bombing." The difficulties of precision night bombing were therefore known from an early date. Undeterred by the results, Ferdinand Gros, the bomb builder, attempted to justify the inaccuracy of night bombing. He asserted that targets in the size of 500 square meters could be successfully reduced. Such objectives included cities, railway marshalling yards, camps, aviation grounds, and other open targets.[4]

Clermont-Ferrand offered training on the BM IV aircraft; the plane was obsolete and removed from French *GBs* by late 1917. After basic and advanced flying instruction the prospective bomber pilot entered the division of bombardment training. Here the pilot was immediately crewed with a bombthrower (bombardier) recruited from the School of Aerial Gunnery at Cazaux. Notably only the bombardiers with the "most serious general education" were selected due to the "delicate nature" of bombardment, especially night bombardment. The crew made three 150-kilometer cross-country flights navigating by map and compass. Quite likely these trips were made at night; the BM IV flew operationally only under cover of darkness.[5]

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[4]*Ibid.*; Stencil #699, IS-AD OCSO, 4 December 1917, trans. of "Aerial Bombardment" by Ferdinand Gros, 2, RG 18, Entry 114, box 4, vol. 14, NA.

[5]Stencil #269, 8, RG 18, Entry 114, box 2, vol. 6; Stencil #301, IS-AD OCSO, 22 August 1917, entitled "Training: Purpose and Organization of the Military Aviation School of Clermont-Ferrand," 1, RG 18 Entry 114, box 2, vol. 7, NA.

The concern with high-quality observers is a recurring theme in French night bombardment development during the war. Few pilots sought assignment to night bombing units; in fact many pilots considered it a disgrace. Most pilots wanted the glory associated with pursuit aviation; few looked forward to flying obsolete aircraft through the darkness. Because there were never enough volunteers to fill the requirements of night bombardment *escadrilles* many pilot trainees of marginal capability were retained in flight instruction; they could look forward to becoming night bomber pilots. With many pilots having a sour attitude toward night bombardment, authorities selected only the best observer-bombardiers.[6]

In addition to an "unshakeable calmness and coolness" observers needed "a firm determination to reach the target, and a scrupulous conscience." Night missions were individual affairs which could not easily be verified. Authorities were forced to rely on the crews' sense of duty to see that missions were accomplished. Since "the value of a night unit [was] never any more than the sum of the values of the individuals of the crew that compose it," high-caliber observer-bombardiers a necessity.[7]

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[6]*Lieutenant* des Forts, "Le Bombardement de Nuit," Conference sur le bombardement de nuit, *GB* 1, 27 *decembre* 1917, 1, box A21, *SHAA*; Night Bombardment and Provisional Regulations, trans. Col. Hunter, 2-3, 248.222-58, HRC.

[7]Night Bombardment and Provisional Regulations, trans. Col. Hunter, 3, 248.222-58, HRC.

Apparently the situation was not much different in other countries. Upon being informed of selection for Handley Page training one RFC pilot trainee could only ask "why me?" The reason was simple enough; he had an excellent record of takeoffs and landings. Certainly not all night bombardment pilots were frustrated fighter pilots -- it only seemed that way.[8]

By the spring of 1916 General Trenchard decided his RFC aviators might benefit from night flying. The official British historian notes that Trenchard was afraid that the Germans were getting too far ahead of the RFC in gaining such experience. Indeed both the Germans and the RNAS had been carrying out night bombing operations, albeit sporadic, for twelve months, and the French for better than six! Even the tiny Belgian *L'Aviation Militaire* carried out a night bombing mission against German bivouacs in the Houthoulst Forest during the previous summer. At the time Trenchard was more concerned about the possibilities of aerial reconnaissance under the cover of darkness than with developing a night bombardment capability.[9]

The RNAS led the way in British night bombardment instruction. By October 1917 at least three RNAS schools, Cranwell, Frieston, and Manston, offered such training. One

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[8]Lieut. Hugh B. Monaghan, *The Big Bombers of World War I*, ed. Jack R. Eder (? : JaaRE, 1985), 71.

[9]Jones, *War in the Air*, vol. 2, 183; Lt Col Avi Bem M. C. Terlinden, "Mass Bombing in 1915," *Cross and Cockade Journal* (U.S.) 14, no. 3 (Autumn 1973), 244-247.

trainee recalled his first night flight in a Handley Page (at Manston) with nonchalance; it was of "thirty-three minutes duration and at an altitude of 2,000 feet." The RFC performed experimental night bombing work at Orford, yet as late as October 1917 did not have an active bombardment training school.[10]

RFC pilot trainees saw little night flying in basic flight schools; apparently only BE2 and FE projected pilots were required to make two landings in the dark to be graduated as Flying Officers in early 1917. One such trainee, A. R. Kingsford, had ten solo hours in FEs when "requested" to make the night landings. He was not pleased with the idea of "groping around in the dark trying to find the ground at its right level." Even less gratifying was his posting to No. 33 Home Defence Squadron; on arriving at the squadron, Kingsford was informed that the Adjutant was away at a funeral - the result of a night flying accident![11]

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[10]F. T. Blakeman, "Report on Aerial Bombardment Instruction in England, from data collected by Lts. Blakeman and Ellis acting under special order No. 45, paragraph 5, Paris, Sept. 22nd, 1917," 13 October 1917, 1-3, RG 120, Entry 807, decimal 353., NA; Geoffrey Linnell, "Big Bird Jockey," *Cross and Cockade Journal* (U.S.) 4, no. 2 (Summer 1963), 180.

[11]Stencil #127, AS-ID OCSO, 19 June 1917, 4, RG 18, Entry 114, box 1, vol. 3, NA; "Reminiscences of Lieut. G. S. B. Fuller," *Cross and Cockade Journal* (U.S.) 10, no. 1 (Spring 1969), 36; A. R. Kingsford, *Night Raiders of the air, being the experiences of a night flying pilot, who raided Hunland on many dark nights during the war* (London: John Hamilton, [1939]), 66, 69-70.

RFC night bomber crews were usually drawn from Home Defence squadrons at this point in the war (1917). They went to France with an abundance of night flying but little formal bombardment instruction. Such was the case for Kingsford, who was transferred to No. 100 Squadron. He flew the same airplane, the FE2b, in both units.[12]

The RNAS often selected bombing teams from its aviators at Dunkirk. Once back in England the teams progressed through several separate schools until the training was completed. The course contained the following stages:

1) Ground work on bombs, carriers, and gears
2) Rolling carpet
3) Flights over batchelor mirror or camera obscura [for bombing practice without bomb-dropping]
4) Cross-country flying by day and night
5) Bomb dropping
6) Formation flying for day bombers

In 1918 the RNAS bombardment course was consolidated in what became (on 1 April) Royal Air Force No. 1 School of Navigation and Bombing, located near the ancient monoliths of Stonehenge.[13]

Similarly the German air service developed a specialized *Nacht-Bombenflieger-Schule* at Paderborn, Prussia for G-plane instuction. Training was given on the Gotha,

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[12]Kingsford, *Night Raiders*, 79, 85, 98-99.

[13]F. T. Blakeman, "Report on Aerial Bombardment Instruction in England, 3-4; "Royal Air Forces No. 1 School of Navigation and Bombing," Bulletin of the Information Section, AS, AEF, 4, no. 169 (4 June 1918), *Gorrell's History*, vol. L-8, RG 120, NA.

Friedrichshafen, and Allgemeine Elektrizitäts Gesellschaft (A.E.G.) versions of the bomber. Such training enabled crew members to quickly adapt to aircraft at the front. Aviators entering the school had already completed basic flight training at one of the numerous *Flieger Ersatz Abteilungen* or *Militär Fliegerschulen*.[14]

Students first took the G-planes into the air during daylight hours to gain experience in handling the large aircraft. Then came twilight flights in smaller dual-controlled C-planes; eventually the trainee made takeoffs and landings during hours of total darkness. With this experience the bomber students began G-plane night flights accompanied by an instructor. Finally solo flights commenced, sometimes with fatal results.[15]

Apparently the citizens of Paderborn appreciated night flying as much as many of the trainees -- it disturbed their sleep! Responding with typical Prussian candor, the Deputy-General Commanding the Seventh Army Corps suggested that the townspeople compare their lack of sleep due to aviation training to that experienced by the citizens of Metz, where "not only is the night's rest disturbed by their own aerial

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[14]John H. Knauer, "Flying the A.E.G. G.IV," *Cross and Cockade Journal* (U.S.) 15, no. 2 (Summer 1974), 120; Summary of Air Information No. 58, 2dS GS, 28 September 1918, entitled "Training of Bavarian Aviation Personnel," AUL.

[15]"*Vizefeldwebel* Kurt Weil," *Cross and Cockade Journal* (U.S.) 3, no. 4 (Winter 1962), 312-315.

activity, but also by bomb raids by enemy airmen." In other words -- get used to the noise.[16]

R-plane training was totally separate from the instruction at Paderborn. The *Riesenflugzeug Schulabteilung* was formed at Vilna during the summer of 1917 after *Rfa* 501 had transferred from the base to the outskirts of Berlin. *Rfa* 501 personnel learned how to operate the new Staaken R.VI aircraft. The training section at Vilna used older SSW R-planes for instruction. Additionally a *Riesenflugzeug-ersatzabteilung* (*Rea*) was established at Döberitz with three SSW R-plane training ships. The *R-Schulabteilung* at Vilna closed around January 1918, being replaced by a new *Rea* at Cologne.[17]

In June 1916 the United States Army began night flying in earnest, including it for the first time in the training curriculum at the Signal Corps Aviation School, North Island, San Diego. Such instruction was initially limited to moonlit nights. Later, training was carried out on dark nights with only the lights of San Diego harbor used for landing assistance. The Signal Corps aviation school at Mineola, New York conducted bombing experiments and had planned extensive research into night flight at the time of America's entry into the war. Day and night bombardment

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[16]"Night Flying Over the Town of Paderborn," Weekly Training Bulletin No. 4, Office of the Chief of Air Service Training Section, *Gorrell's History*, vol. J-1, 165, RG 120, NA.

[17]Haddow and Grosz, *German Giants*, 25.

training was eventually limited to Ellington Field, Texas.[18]

Several American air officers went to Paris in April 1917 to coordinate the United States' entry into the air war. Captain Joseph Carberry recommended the establishment of American flying training in France; US facilities were simply incapable of meeting the rapid influx of trainees. Four specialized schools were envisioned, with one for day and night bombardment instruction. Until the schools could be established the US made an agreement for training of night bombardment units at the French school at Cernon. After completing instruction the USAS night bombers were to be sent to the front for "battle training" with *GB* 1, commanded at that time by *Commandant* Chabert.[19]

Ostensibly the transfer of the French bombardment school at Clermont-Ferrand to the USAS in November 1917 made such a scheme unnecessary. Clermont-Ferrand became known as the Seventh Air Instruction Center (AIC), with the first night flying attempted during February 1918. Unfortunately the mountainous terrain surrounding the field made forced landings too risky -- night instruction was soon

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[18]Hennessy, *Army Air Arm*, 73, 158, 181.

[19]"History of the Training Section, Air Service, A.E.F.," *Gorrell's History*, vol. J-1, 3, RG 120, NA; "Final Report of Chief of Air Service," in Maurer, *U.S. Air Service*, vol. 1, 55-58, 93.

discontinued. Night training at the Eighth AIC, Foggia, Italy, proved even less satisfactory.[20]

On 26 January 1918 General Foulois entered into an agreement with the British Air Minister for the training of American night bombardment personnel. Additionally, facilities were to be supplied for the assembly of U.S. manufactured Handley Page component parts. The original accord called for thirty long-distance night bombardment squadrons to be organized in England. However progress was slow; the prototype American-built Handley Page bomber, the "Langley," was not completed until July 1918.[21]

The British allowed the USAS to open an American-operated Handley Page training school in England. Four aerodromes in varying stages of completion (Emsworth, Ford Junction, Rustington, and Tangemere -- collectively known as the Chichester Area) were turned over to the the USAS until such time that Handley Page night bombardment training schools were fully operational in the United States. The

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[20]"History of the Training Section," *Gorrell's History*, vol. J-1, 41, 56-57; "Final Report of Chief of Air Service," *Gorrell's History*, vol. A-29, 82-83; Lt. Lucien H. Thayer, *America's First Eagles: The Official History of the U.S. Air Service, A.E.F. (1917-1918)*, ed. Donald J. McGee and R. James Bender (San Jose, California: R. James Bender; co-published Mesa, Arizona: Champlin Fighter Museum Press, 1983), 68-69.

[21]"Rothemere-Foulois Agreement," 26 January 1918, copy in "Appendix to History of the Night Bombardment Section in France," *Gorrell's History*, vol. B-6, 21-25; "Triumph of America's Handley Page Bomber," *Air Service Journal* 3, no. 2 (11 July 1918), 41-45.

objective of the Chicester area was to furnish completely trained night bombardment squadrons for the front.[22]

The school at No. 1 Field (Ford Junction) was opened on 15 August 1918 although instruction was delayed until at least 20 September due to lack of aircraft. Of twenty to thirty airplanes received at Ford Junction only one was a Handley Page; it was received just prior to the armistice. Activities at Ellington Field were realigned to provide Ford Junction with trainees well versed in night flying. The final three weeks of the Texas-based program included advanced night flying, night bomb-dropping, and practice night bombing raids. Nevertheless the United States failed to attain its goal of operational night bombardment squadrons before the armistice.[23]

Just as the training of airmen for night flying advanced throughout the war so to did the capabilities of aircraft improve for flying during darkness. The most basic necessity for night-flying aircraft was a simple means of

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[22]A fifth aerodrome, Goring, was originally included in the Chichester area but was subsequently dropped from the plan. Memorandum, General Patrick to Chief of Staff, GHQ, AEF, entitled "Instruction Center for Night Flying and Bombardment Training in England," 27 June 1918, *Gorrell's History*, vol. B-9, 16-17; General Order No. 60, HQ Base Section No. 5, SOS, AEF, London, 21 August 1918, *Gorrell's History*, vol. B-9, 17, RG 120, NA.

[23]Memorandum, Colonel Monell to Coordination Staff, 3 September 1918, *Gorrell's History*, vol. B-6, 61; Report of the Activities of the Mobilization and Training Department of the Night Bombardment Section, *Gorrell's History*, vol. B-9, 22-23, RG 120, NA; "Ellington Field," *Air Service Journal* 3, no. 10 (5 September 1918), 349. See appendices 19 and 20 for USAS night bombardment training information.

instrument illumination. The use of hand-held flashlights proved cumbersome and inconvenient for aircrews; yet the pilot needed to know what his instruments were reading. Much experimentation was required since individual aviators complained that the illumination was either too strong or too weak.

One of the earliest methods involved placing small electric light bulbs behind translucent instrument dials. During the war the most extensive research involved the use of self-luminous materials, namely a combination of zinc sulphide and radium. These were applied to instrument dials like paint; the instruments could then be read solely by their "phosphorescent glow."[24]

Luminous materials were well known prior to the First World War. By adding a small amount of radium, the responsive base remained in a state of continuous stimulation due to alpha particle bombardment; hence the term "self-luminous." Controlling the brightness of self-luminous material proved quite difficult. A host of other limiting factors, including the resolving power and sensitivity of aviators' eyes, confounded the scientists. Nevertheless self-luminous paints became widespread for

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[24]Mayo D. Hersey, "General Classification of Instruments and Problems, Including Bibliography," Technical Report No. 125 of the National Advisory Committee for Aeronautics (NACA), included in the *Seventh Annual Report of the NACA, 1921* (Washington, D.C.: Government Printing Office, 1923), 487; William J. Hammer, "Phosphorescent Aircraft and Landing Stages," *Aeronautics* (New York) 14, no. 6 (31 March 1914), 94.

night instrument illumination during the First World War (see figure 2).[25]

The final scheme for night illumination of aircraft instruments was the use of small, shielded incandescent lamps placed next to the dials. Importantly, these lamps could be turned on and off as needed. However engine vibrations often caused light bulbs or electrical connections to fail, becoming a "great nuisance" to night fliers. Even the small amount of light emitted by such lamps could cause great difficulty for novice night aviators -- it was simply too dazzling.[26]

Willis Fitch recalled that on his first Caproni night solo, the plane kept rolling into steep dives for no apparent reason. Frantically trying to figure out what was wrong, Fitch caught a glimpse of light above his head as he was trying to pull the aircraft out of yet another dive. Glancing up at what he presumed to be the moon, Fitch was

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[25]A. L. Hamlin, "Efficient Instrument Illumination for Military Fliers," *Aviation and Aeronautical Engineering* 1, no. 5 (1 October 1916), 152; N. E. Dorsey, "Self-luminous Materials," Report No. 33 of the NACA, included in the *Fourth Annual Report of the NACA, 1918* (Washington, D.C.: Government Printing Office, 1920), 339-343; Summary of Air Information No. 20, 2dS GS, 26 May 1918, subtitle "Luminous Metals," AUL; An example of luminous instrument requirements is "Treatment of Aeroplane Instruments with Luminous Paint," Royal Aircraft Factory Specification No. 157 (14 February 1917), File M3006800, National Air and Space Museum Library (NASM).

[26]Hersey, Report No. 125, 487; "Instruments Used on Aeroplanes: Comments on Their Functions and Defects," *Scientific American Supplement* No. 2062, vol. 80 (10 July 1915), 23; Kingsford, *Night Raiders*, 162.

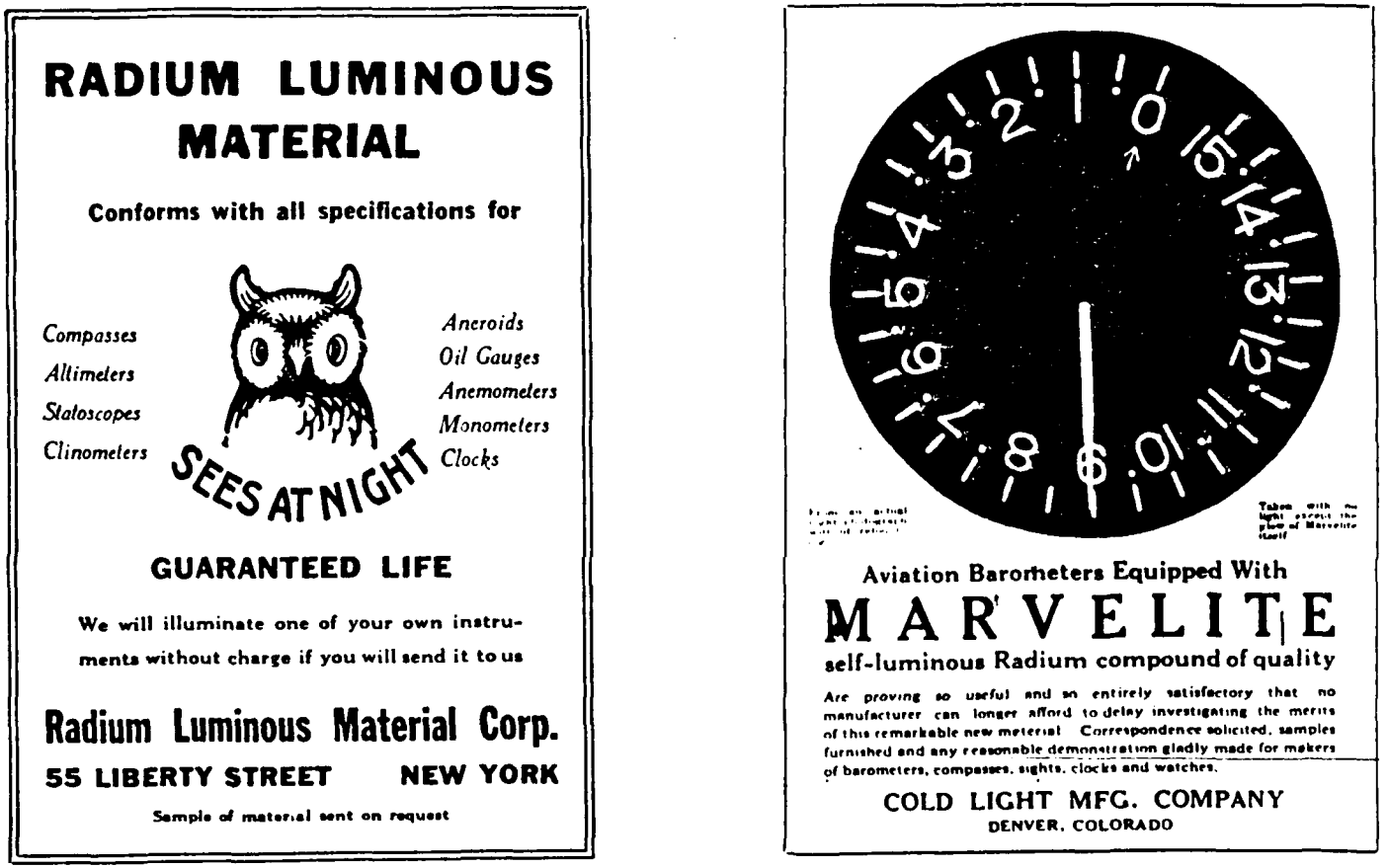

Fig. 2. Trade advertisements for self-luminous compounds, 1917.

shocked to discover the light being emitted from an aircraft hanger -- he was flying upside down! Turning the wheel for all he was worth, the pilot found great relief after the hanger lights once again "rested on the ground where they belonged." Fitch's control problems resulted from inadvertently having left the instrument board illuminated during flight; the glare hampered the aviator's night vision. One can only wonder how many crashes resulted from similar circumstances.[27]

Special aircraft instruments were developed specifically for night flying; one important example is the Jenkins Night Altitude Indicator. The indicator, developed in Great Britain, determined height above ground level (to 500 feet) through the use of three optical projectors, two of which were fixed in positions parallel to each other. The third projector was rotatable; its light shaft moved between the two fixed projectors as the plane decreased in altitude. Plans called for the incorporation of the Jenkins indicator as standard equipment on Handley Page night bombers. Nearly five years after the war experiments were still being conducted to determine its value to civil aviation.[28]

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[27]Fitch, *Wings in the Night*, 104-110. [first citation?]

[28]"Instructions for the Use of the Jenkins Night Altitude Indicator," Bulletin of the Intelligence Section, Training Department, AS, AEF, vol. 1, no. 39 (9 February 1918), *Gorrell's History*, vol. L-5, 300; "Schedule of Equipment for Handley Page Bombing Machines; Schedule B," *Gorrell's History*, vol. B-6, 248, RG 120, NA; John A. C. Warner, "An Optical Altitude Indicator for Night Landing," *Aerial Age* 16, no. 6 (June 1923), 274-275.

Signalling devices were necessary for communications with the ground. The flare gun provided the most basic means of signalling; the Allies used the Chobert -- more commonly known as the "Very" pistol. British and American night squadrons used three different colored "Very" cartridges; red, white, and green. Interestingly, each cartridge had a different milling along its metal base flange; aviators could quickly "feel" for the correct shell in the dark.[29]

To determine friend or foe, Allied ground AAA batteries challenged planes by signalling with a searchlight the Morse code letter of the day; the aircrew responded by firing a "Very" pistol loaded with the "color of the day." The "color of the day" was changed at least daily and provided a means for identifying aircraft. If the wrong color was fired or the plane failed to respond, the AAA was authorized to fire on the aircraft. The signal pistol was also a key element for communication between ground personnel and aircrews during the takeoff and landing phases of night operations.[30]

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[29]"Pyrotechnica," *Gorrell's History*, vol. I-2, 72; Lecture IV (Bombardment Aviation), 7th AIC, n.d. [late 1917-early 1918], 4, RG 120, Entry 807, decimal 350.001, NA.

[30]Bewsher, *"Green Balls,"* 140; Memorandum from Col Milling (First Army AS) to Group Commanders, 27 October 1918, regarding letter from Headquarters anti-Aircraft Defense, A.P.O. 731-A, RG 120, Entry 805, NA. See appendix 21 for night signalling.

During the war aircraft-mounted searchlight experimentation and application was extensive. The lights, powered by dynamo or battery, offered adequate means for night landing, communication between aircraft, and signalling from air to ground. However their use by night pursuit planes for sweeping the sky to locate enemy aircraft proved quite unsatisfactory.[31]

More often than not all that was accomplished was showing oneself to the enemy. One author noted that in the Paris nighttime sky, it was a common site to see aircraft flying with their projectors (searchlights) illuminated. He contended that the hunter had now become the hunted, sarcastically noting that with "all these luminous targets, it would be possible to become a Guynemer in a single night." Nevertheless, airplane-mounted projectors became standard equipment for many aircraft during the war.[32]

Illuminating flares were developed for target acquisition and landing assistance. One of the most

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[31]"A Sperry Night Flying Equipment," *Aviation and Aeronautical Engineering* 1, no. 5 (1 October 1916), 164; Stencil #104, IS-AD OCSO, 14 June 1917, subtitled "Searchlights on Airplanes," RG 18, Entry 114, box 1, vol. 3; Stencil #228, *ibid*, 14 July 1917, entitled "Airplane Searchlights," RG 18, Entry 114, box 2, vol. 5, NA; *Capitaine* Petitalot, "Utilisation de l'Électricité à bord des Avions," in *L'Aeronautique Pendant la Guerre Mondiale*, ed M Brunoff (Paris: ? , 1919), 240-253; "Catalogue of Radio and Electrical Equipment on Order June, (1918)," *Gorrell's History*, vol. L-3, RG 120, NA.

[32]Orthlieb, *L'aeronautique*, 157; Bewsher, *"Green Balls"*, 121-122. A photograph in *Flying* 5, no. 9 (October 1916), 375, shows the vulnerability of using projectors.

important was the "Holt" wingtip landing flare. Useful in an emergency or under inadequate field lighting conditions, the Holt flare was ignited electrically (by dry cell battery) from a push-button in the cockpit. Typically the flare would burn for a maximum of two minutes, at up to 20,000 candlepower. However, the flares were used cautiously, as a crash or hard landing could bend the bracket and cause burning magnesium to ignite the wing. To reduce this hazard, brackets were later devised with a hinged base and elastic cord. The flare could move backward if the plane rocked on landing and the wingtip touched the ground; the elastic cord sprung the bracket back into its original position.[33]

Obviously once the flare ignited, it continued to burn until all the fuel was exhausted. Such lack of operational flexibility ensured that its improper use could have serious consequences. At least one instance was noted of a Holt flare being inadvertently lit over enemy territory. Pilots flying tractor aircraft found themselves blinded by the glare reflected off the propeller. Henceforth propellers were painted a dark, flat brown or black. Additionally, pilots found that one burning flare worked best; they could look over the opposite wing during approach without getting

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[33]"Making a Safe Landing at Night From an Airplane," *Popular Science Monthly* 91, no. 5 (November 1917), 752; Benedict Crowell, *America's Munitions, 1917-1918* (Washington, D.C.: Government Printing Office, 1919), 316; Catalogue of Radio and Electrical Equipment on Order June, (1918), *Gorrell's History*, vol. L-3, 13-15, RG 120, NA.

blinded. Due to the everpresent danger that a flare might burn out before the plane landed, Holts were ordinarily used in conjunction with larger parachute flares, sometimes referred to as illuminating bombs (see figure 3).[34]

The Michelin parachute flare was the most widely used Allied flare of its type. Because the flare burned for seven to eleven minutes when deployed at altitude, it was very useful during forced landings; however, the flare was primarily intended for target illumination. Another French-designed illuminating bomb, the Bourges lighting grenade, was favored by night reconnaissance aircrews because of its smaller size. The British and Americans experimented with illuminating-type bombs but relied upon the Michelin for wartime night operations.[35]

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[34]Memorandum from 1st Lt Muir S. Fairchild to Chief Engineer, 7 March 1921, entitled "Observations on Night Flying Tests Conducted at Wilbur Wright Field, Nights of Feb. 24th, and 25th, 1921," 1-2, 168.7001-6, HRC; Doyen P. Wardwell, "Night Pursuit Flying," *Air Power Journal* 5, no. 2 (June 1919), 56; *Capitaine* H. Langevin, Rapport sur la Chasse la Nuit, 29 *juillet* 1917, 3, box A89; Letter, *Capitaine* de Lesseps *à Chef du Service Aéronautique*, 17 *octobre* 1918, box A27, *SHAA*.

[35]Letter, Lt Frederick T. Blakeman to Chief, Instruction Bureau, 21 September 1917, RG 120, Entry 656, 452.7, NA; "'B' Course in Bombs for Instrument Repairmen, Riggers, Fitters, and Carpenters," *Gorrell's History*, vol. B-5, 384, RG 120, NA; Stencil #567, IS-AD OCSO, 6 November 1917, subtitled "Illuminating Bombs," RG 18, Entry 114, box 3, vol. 12; Stencil #603, IS-AD OCSO, 26 November 1917, entitled "Bourges's Lighting Grenade for Dirigibles," RG 18, Entry 114, box 4, vol. 13, NA; "Pyrotechnica," *Gorrell's History*, vol. I-2, 71-76; RG 120, NA; Hennessy, *Army Air Arm*, 134-135; "Experiments in Signalling," *Aviation and Aeronautical Engineering* 1, no. 7 (1 November 1916), 233.

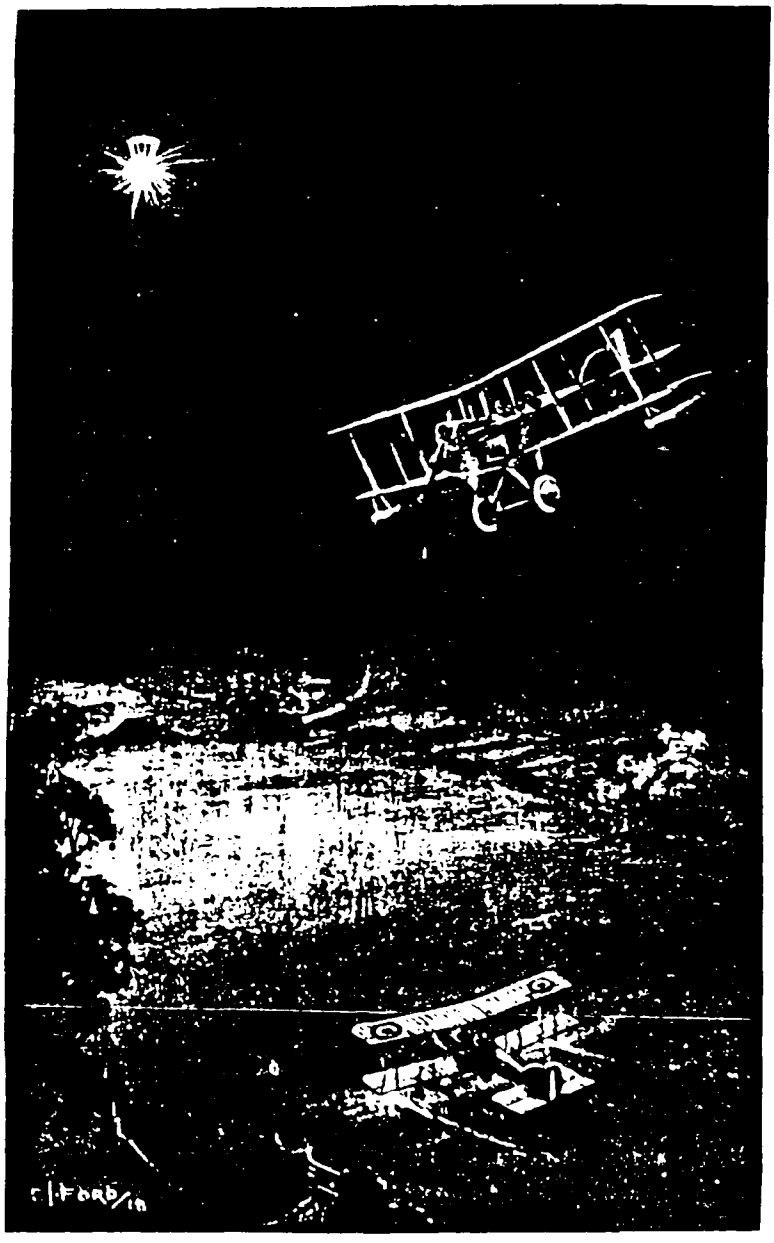

Fig. 3. Sketch showing wingtip and parachute flare use for night landings Drawn by E. L. Ford; included in W. G. McMinnies, *Practical Flying* (London: Temple Press, 1918).

Germany developed similar illuminating flares for night operations. Their *Leuchtbombe mit Fallschirm* was produced in 60cm and 90cm varieties and burned for about two minutes when deployed from a height of 300 to 400 meters. Another flare was much used by naval airships over the North Sea; the flare illuminated only upon contact with water. The use of parachute flares was crucial for exploiting night operations to their fullest; be it bomb-dropping, machine-gunning, reconnaissance, or even forced landings.[36]

Ground-based systems provided necessary assistance for night navigation and landing. One of the most interesting developments was the system of aerial lighthouses on both sides of the Western Front. Germany built the first such lighthouse at Johannistal in October 1913 and later improved on the idea with the creation of intermittent beacons. Individual lighthouses could now emit a unique light sequence which made identification simple. The sequence could be changed as the situation warranted. Lighthouses flashed either Morse code letters or numbers during the war. (see figure 4). Electrical power was found to be the preferred power source for lighthouse operation; many lights were nonetheless powered by acetylene or other gases.[37]

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[36]Stencil #416, IS-AD OCSO, 18 September 1917, entitled "Ordnance," RG 18, Entry 114, box 3, vol. 9, NA; Summary of Air Information No. 22, 2dS GS, 31 May 1918, AUL.

[37]"Lighthouse for Airships," *New York Times*, 12 October 1913, part 4, p. 4. Alfred Gradenwitz, "Lighthouses for the Aerial Navigator: Guiding the Airman at Night," *Scientific American* 110, no. 20 (16 May 1914), 411-412; "German

Light signal known as mark 123. Light signal known as mark 1242.

Fig. 4. Sample German lighthouse signals, 1914. From Alfred Gradenwitz, "Lighthouses for the Aerial Navigator: Guiding the Airman at Night," *Scientific American* 110, no. 20 (16 May 1914), 411.

The French established a string of high-powered light stations located between fifteen and twenty-five kilometers behind the front; the stations were placed thirty kilometers apart. The radiance emitted from these sites was visible for up to one hundred kilometers under optimum atmospheric conditions. Less intense lights (visible for forty kilometers) were located at emergency airfields further behind the lines. These acted as intermediate guides for night fliers, directing them toward the front. Although mobile, the lights were nevertheless cumbersome to move, difficult to install, and fragile. Under poor climatic conditions the ground lights were often "barely visible from ten miles." Yet they were a welcome sight for the aircrews returning from missions behind the lines. One aviator recalled that "France, from the air at night, was . . . a sea of

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Searchlights For Aeronauts," *Flight* (London) 6, no. 41 (9 October 1914), 1030; "La signalisation nocturne des aérodromes," *La Revue Aérienne* 7, no. 134 (10 *mai* 1914), 263-264.

blackness, except for the 'dummies' and the 'lighthouses'."[38]

The German system of navigational aids was much more elaborate. In addition to a series of lighthouses, lights in the shape of stars, crosses, triangles, or the letter "T" were used to steer night bombers toward their objectives. These lights were visible from ten to sixty kilometers depending on weather conditions. However the German system also employed aerial signals. Luminous balls, commonly referred to by Allied aviators as "flaming onions," fired from a twenty-millimeter cannon reached an altitude of up to 2,000 meters. The "onions," or "lovely necklaces of flaming jade" as one RNAS aviator referred to them, could be fired in thick chains or spaced to form Morse code letters; each location was thereby readily identifiable. Furthermore, luminous shells of various color were fired from heavy-caliber guns; they deployed a parachute and were visible from fifty to one hundred kilometers. The Allies lacked a similar aerial scheme.[39]

Any discussion of aids to night aviation during the First World War would be incomplete without commenting upon the use of radio-direction finding (RDF) for long-distance

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[38]"Organisation Lumineuse des Routes Aeriennes de Nuit sur le Front," n.d. [1918?], box A21; "Signalisation de Nuit," *Escadre* 14, 5 *octobre* 1918, box A88, *SHAA*; Montgomery, *Flare Path*, 21-22; Monaghan, *Big Bombers*, 93. See appendix 22 for locations of French lighthouses.

[39]"Signalisation de Nuit," 5 *octobre* 1918, box A88, *SHAA*; Bewsher, *"Green Balls,"* 127.

flying. German prewar radio experimentation with Zeppelins paid off on the night of 15 June 1915 when airship *L 10* used bearings from the RDF stations at Nordholz and Borkum to triangulate its position over England. Curiously, the airship called the stations which then plotted the direction of the signals and radioed them back to the zeppelin. Though the British were also able to intercept the airship transmissions and determine its position, the system remained in effect until 1918. Then the German RDF stations began to send transmissions to the now silent airships. The French had considered a similar system for its bombardment aviation, with ground RDF personnel making calculations from signals emitted by the aircraft, but considered the mode too unreliable. Presumably the French went along with British developments in the field.[40]

In early 1918, the British experimented with RDF systems for night-flying airplanes at Andover Junction and Cranwell. Guiding Allied bombardment aircraft to and from Berlin was to be the main purpose of British RDF. The USAS ordered 550 sets of direction finding apparatus for its night bombers. Additionally students at the bombardment school at Ford Junction were instructed in night navigation

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[40]Robinson, *Zeppelin in Combat*, 72; *Capitaine* Petitalot, "Utilisation de l'Electricité à bord des Avions," *L'Aeronautique Pendant La Guerre Mondiale*, ed. M. Brunoff, 241.

by means of RDF. The armistice prevented widespread Allied use of RDF.[41]

An aviator could now take off at night, fly to his objective with the assistance of ground and aerial navigational aids, illuminate his target with parachute flares, drop his bombs, fly back across the lines, answer challenges from friendly AA batteries, and arrive home. A simple landing was all that remained for successful mission completion. Unfortunately night landings often proved more hazardous than the enemy searchlight and AA barrage. Holt flares were useful but safer airfield lighting was needed.

When Captain Charles DeF. Chandler flew to the U.S. Signal Corps airfield at College Park, Maryland late on 1 June 1912, the ground mechanics, not expecting the aviator to return to the field after dark, resorted to throwing "oil and gasoline on the field" and igniting it to aid in his landing. Clearly, such temporary measures for lighting up landing fields were as common as night flying was rare. The lack of any systematic airfield illumination certainly was a limiting factor in the development of military night aviation. However, experimentation with aerodrome lighting

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[41]"Final Report of Chief of Air Service, AEF," *Gorrell's History*, vol. A-29, 128; Memorandum, 1st Lt Henry N. Wolff to 1st Lt J. Parker Van Zandt, 3 September 1918, *Gorrell's History*, vol. B-6, 258-259, RG 120, NA; Lecture entitled "Navigation to be used in connection with radio direction finding for aircraft," *Gorrell's History*, vol. J-5, "Direction Finding by Radio: Maximum Method Using Two Coils Especially Adapted to Use on Airplanes," Air Service Bulletin 4, vol. 175, *Ibid.*, RG 120, NA.

soon began to pay dividends. Organized airfield illumination rapidly matured in the decade between Wilbur Wright's first night flight and the end of the war.[42]

Remarkably one man, Clément Ader, had foreseen the importance of military night aviation as early as the 1890s and set out to develop a permanent system of airfield illumination. Ader called for outlining an airfield's landing zones with "beacon fires of special color, placed in little holes and covered at ground level by grills" during night operations. Smoke from fires near the landing zone provided a visual indication of the wind direction. Furthermore, electric lamps could replace the fires so the entire field could be illuminated or darkened as "tactical considerations" warranted.[43]

Supplementary beacons located at a distance from the aerodrome and oriented due north, south, east, and west of the field could serve as directional aids for night cross-country flying. Unfortunately, French military leaders failed to take Ader's recommendations seriously since extensive night flying appeared impractical at the time. Undoubtedly to Ader's chagrin, his ideas found expression in a similar scheme enacted by the Germans during the First World War.[44]

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[42]Hennessy, *Army Air Arm*, 61.

[43]Ader, *Military Aviation*, 36-37.

[44]*Ibid.*

An illumination system consisting of a series of sunken electric lamps, providing the night flier with both airfield location and wind direction, was developed at Johannistal aerodrome. At the center of the airfield was positioned a large square glass window, flush with the ground, and sufficiently thick to withstand the impact of an aircraft landing. At night an electric lamp located beneath the glass continuously radiated white light into the darkened sky, acting as a beacon to guide the night flier. Located at a distance of 250 feet from the central lamp were eight smaller submerged red lamps (see figure 5). Connected by underground cable to a weathervane, these outer lamps were automatically switched on or off as the vane turned into the wind, thereby offering a visual indication of the wind direction. For instance if the wind was from the east, in addition to the central white lamp, only the red lamp located to the east would be illuminated. If the wind was blowing in a direction between cardinal points, the two outer lamps closest to the actual wind direction would light up. The fixity of such a system undoubtedly limited its use to permanent aerodromes in the interior of Germany, such as Johannistal.[45]

Petrol flares, cans filled with petrol and waste, later asbestos and parrafin, were the standard fare for

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[45]"Signals For Night Landings," *Aeronautics* (London) 9, no. 91 n.s. (14 July 1915), 19.

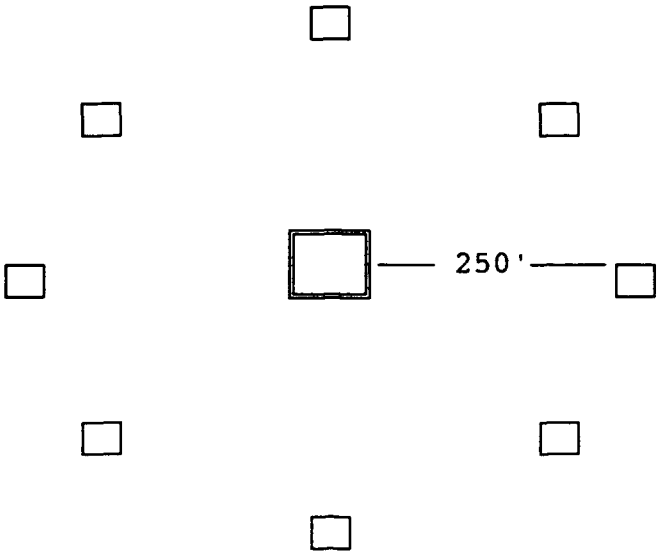

Fig. 5. Plan for German airfield illumination, 1915.

British aerodrome illumination for much of the war. The flares were routinely placed in the shape of a "L," with the long side of the letter positioned parallel to the wind. Takeoffs and landings were then made toward the base of the letter. The scheme provided an inexpensive and mobile system of night airfield lighting.[46]

Various airfield lighting schemes utilizing electric lamps were developed by the Allies. By the end of the war the most widely used system was the electric "TEE" (see figure 6). Approximately 100 meters in length by fifty

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[46]Jones, *War in the Air*, vol. 3, 170-171; Montgomery, *Flare Path*, 10, 20; W. G. McMinnies, *Practical Flying: Complete Course of Flying Instruction* (London: Temple Press, 1918), 203-204; Mahgni-Eltten, "Night Flying - Ancient and Modern," 367.

meters wide, the "TEE" proved quite successful. As in the "L" flare system, the long side of the TEE was situated parallel with the wind with the top of the letter facing into the wind.[47]

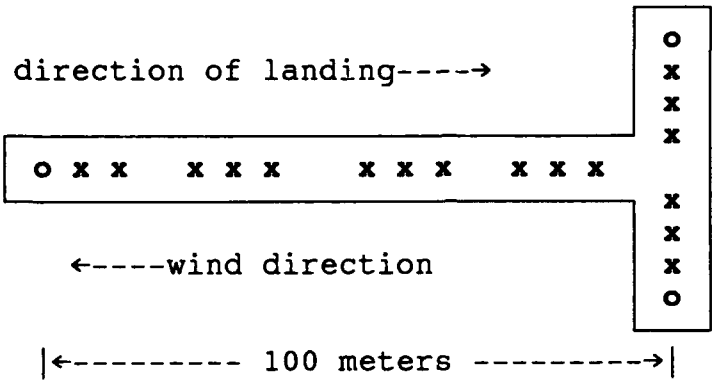

Fig. 6. British "TEE" Electric Airfield Light System: x = lightbulb; o = lightbulb for triangle lighting option. From "Airdrome Field Electrical Equipment For Night-Flying Squadrons," Air Service Bulletin 6, no. 286, 26 September 1918, *Gorrell's History*, vol. L-10, RG 120, NA.

The French regularly used the Crochat Electric Field Illuminating Truck. Obviously the system was completely mobile. In addition to spotlights mounted on the vehicle, six portable 33-cm "Brandt" projectors, placed atop adjustable tripods, provided enough lighting for night

[47]Montgomery, *Flare Path*, 21; "Final Report of the Committee on the Administration and Command of the Royal Flying Corps, &c.," *Flight* (London) 9, no. 2 (no. 420) (11 January 1917), 44; Stencil #66, Airplane Division, OCSO, 8 June 1917, subsection entitled "Landing Lights," RG 18, Entry 114, box 1, vol. 1, NA.

aviation operations. The USAS tested its own prototype of an airfield lighting truck at Ellington Field only months before the armistice. Such mobile lighting systems were important during the "war of movement."[48]

Aviators were now able to safely bring their planes home Improved training requiring hours of night flying gave airmen the experience so necessary for successful military operations under cover of darkness. Advances in ground and airborne aids improved the efficiency and security of such missions. Night military aviation was clearly dependent upon the progress in both technology and training for its mastery during the First World War.

[48]"Catalogue of Radio and Electrical Equipment on Order June, (1918)," *Gorrell's History*, vol. L-3, 34-37, RG 120; "Aviation Field Illuminating Outfit," Air Service Bulletin 7, no. 316 (16 December 1918), *Gorrell's History*, vol. L-10, RG 120, NA.

CONCLUSIONS

Bold individuals first tackled the darkened skies in balloons and dirigibles. Airplane pilots later thrilled crowds with intrepid nighttime exhibitions. Although such demonstrations were considered foolhardy and even eccentric by many segments of society, they nevertheless provided the impetus for military experimentation in night flying. Yet the fragile nature of pre-war aircraft as well as the unsophisticated state of support equipment combined to limit night capabilities. Hence military authorities remained unconvinced of the usefulness of flying airplanes under cover of darkness; only the rigid airship appeared as a practical nocturnal voyager.

The First World War quickly exposed the vulnerability of airships both day and night; even small arms fire proved hazardous to the early low-ceiling dirigibles. Bright moonlit nights offered little refuge to these lumbering giants. While improvements allowed the airships to climb higher into the nighttime skies, bombing accuracy subsequently decreased. The airship, although remaining a terror weapon for much of the war, ultimately proved inferior to the airplane for military use.

Night airplane activity in the early days of the Great War was limited to sporadic bombing raids; these were mainly individual actions with the sole purpose of harassing the enemy. Yet the nighttime skies began to appear as a safe haven for airplanes as improving technology caused rapid obsolescence of aircraft. The synchronized forward-firing machine gun, perhaps the most significant development in aerial armament during the war, banished an entire class of aircraft, the pushers, into the night. For the balance of the war aerial bombardment remained heavily nocturnal.

Yet night military aviation appeared as a "poor relation" to its daytime counterpart. Air service leadership failed to press for development of strictly night-capable aircraft since obsolete airplanes performed "adequately" in such a role. Unfortunately the outdated aircraft often possessed unreliable motors which made forced landings a perennial concern of aviators. Night flying was further hampered by a lack of complementary equipment, such as illuminated cockpit instruments. Finally night bombardment, which was the essential element of night military aviation along the Western Front until 1918, was commonly considered by military authorities as a "dumping ground" for mediocre pilots. Could there be much surprise that morale was often lacking in these units?

Germany suffered from a deficiency of bomber aircraft due to a preference in military circles for airship development; the Zeppelin was an extremely visible symbol of

German ascendancy over the heavens. Yet seventeen airships were lost over England and over sixty more destroyed through hostile and non-hostile action during the course of the war. In the end the night offered the dirigible little protection. Had much of the massive monetary investment drained by airship construction been used for increased research, development, and deployment of heavy bomber aircraft, German night bombardment aviation might well have played a more decisive role in the events of 1914-1918.[1]

France was constrained by geography and aircraft limitations to the strategic bombardment of the Briey basin. The basic problem was that numerous French cities were vulnerable to German reprisals. Hence the railways and industry of the basin were the only strategic options for the night bombers of the French air service; tactically airfields were important targets for their bombers.

Slow to switch to night operations, the RFC was forced to adopt a strategic role for its bombardment aviation due to RNAS successes and the British desire for reprisals against German cities. Only grudgingly did the RFC incorporate the Handley Page heavy bombers; in fact as late as August 1917 General Trenchard opposed the use of the twin-engine bombers. Fully forty percent of Independent Forces RAF bombs (220 of 543 tons) were directed at German airfields. Railway targets constituted a primary objective

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[1]Cole and Cheesman, *Air Defence of Britain*, 446-451.

for the short-range FE2b aircraft. The bombing of industrial targets in German cities was simply not a major activity. Therefore on closer examination, the French and British bombing campaigns were not as disparate as would first appear.[2]

The German bombing campaign against England failed to reduce British war resolve. Sporadic night attacks, which were thought to be especially demoralizing, could not break the will of the people. The German strategic campaign was continually hampered by the need for tactical bombing on the continent; the number of aircraft flying against the British isles remained a minority of the German bomber force. In fact the bombers of *Bogohl* 3 were often used for tactical missions, especially during the spring 1918 offensives.

Nevertheless the British were compelled to invest heavily in home defense (this incidentally gave the British an early background in night interception). One author contends that the equivalent of ten full-strength fighter squadrons and two or three short-range bombardment squadrons (that could have been formed on the Western Front) were tied up in home defense duties. Germany, already outnumbered on the front, could have ill-afforded such an addition to the

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[2]Jones, *War in the Air*, vol. 6, 158-159, 167.

enemy camp. Hence the decision to implement the strategic bombardment of England was not totally in error.[3]

Night reconnaissance and night pursuit both performed important duties during the last year of fighting. The airplane brought about a fundamental change in warfare by forcing armies to make their movements and preparations under cover of darkness. Additionally concealment and deception now had to be carried out far behind the lines in order to mask intentions. Four years after the war a young USAS test pilot, Lieutentant Muir S. Fairchild, argued that "in a future war Night Reconnaissance [would] be of fundamental importance." Such an assessment was supported by the operations of 1918. Yet Fairchild lamented that the USAS did not "seem to regard Night Observation aviation as deserving of the importance" it clearly warranted.[4]

Night pursuit was a logical supplement to searchlight and anti-aircraft artillery defenses. Airplanes illuminated by searchlight were attacked with little difficulty by fighter aircraft. Interception without searchlight assistance was more difficult yet possible. At the time of the armistice night pursuit was evolving rapidly. Unfortunately the hard-earned lessons of night flying along the Western

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[3]Imrie, *German Air Service*, 48; Cole and Cheesman, *Air Defence of Britain*, 446-451. See appendix 23 for comparison of night bomber strengths during 1918.

[4]Fairchild, "Notes on Type VIII Night Observation," 26 October 1922, Fairchild Collection, 168.7001-85, HRC.

Front appear to have been lost with the military force reductions after the Great War.

Strategic bombardment aviation had experienced a much reduced loss rate during night operations, with little apparent difference in bombing accuracy, than during daylight missions. Yet both the British and American air forces insisted on emphasizing daylight strategic bombing operations during the interwar period and into the Second World War. Aircraft losses quickly forced the British to return to the nighttime skies; however the United States steadfastly refused to alter tactics even after it became apparent that the "bomber would *not* always get through." Was this due in part to the fact that the United States had no night bombing (combat) legacy from the Great War? Here perhaps is the great paradox of World War I night flying.

Night fighting received scant attention in the interwar years. The French closed their night fighter instruction center three months after the armistice. The British failed to exploit the advances produced by years of home defense activity; one author contends that the first true night fighter did not enter the RAF inventory until 1956. Both the Germans and Americans made great strides in night fighting during the Second World War. Yet the achievements were *not* due to a systematic study of night fighting during the interwar years. Especially in the case

of Germany night pursuit was once again too little too late.[5]

It should now seem obvious that the Western Front belligerents failed to understand and master the lessons of night flying learned during the First World War. Diminished military budgets in the interwar period inhibited air service development and training, and resulted in a reduction of night flying. Additionally there appeared to be a subtle implication that aerial combat operations under cover of darkness were less chivalrous than in open daylight. For these reasons, and undoubtedly many others, western military aviation entered the Second World War unprepared to exploit the nighttime skies.

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[5]Gunston, *Night Fighters*, 9-11.

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"Wright Flies By Moonlight." *New York Times*, 23 October 1909, 1.

"Zeppelin Craft Badly Wrecked." *New York Times*, 1 June 1909, 2.

"Zeppelin Flies Over 24 Hours." *New York Times*, 31 May 1909, 1.

"Zeppelin's Long Voyage." *New York Times*, 1 June 1909, 8.

APPENDICES

APPENDIX 1

BENNETT CUP INTERNATIONAL BALLOON RACES TO 1914*

YEAR	LOCATION	WINNER	DISTANCE (Miles)
1906	Paris	Frank P. Lahm	402.4
1907	St. Louis	Oscar Erbslöh	872.5
1908	Berlin	M. Schaeck	808.0
1909	Zurich	Edgar W. Mix	696.5
1910	St. Louis	Alan R. Hawley+	1,172.9
1911	Kansas City	Hans Gericke	468.0
1912	Stuttgart	Maurice Bienaimé	1,364.0
1913	Paris	Ralph H. Upson++	383.2
1914	Not held due to outbreak of the First World War		

+Hawley was permanently awarded the Lahm Cup in 1913 for the longest balloon flight by a member of the Aero Club of America exceeding Lahm's distance in the 1906 Bennett Cup race.

++Upson won in the balloon *Goodyear*, the first lighter-than-air vehicle owned by Goodyear Tire and Rubber Co.

*adapted from Tom D. Crouch, *The Eagle Aloft: Two Centuries of the Balloon in America* (Washington, D.C.: Smithsonian Institution Press, 1983), chapter 17.

APPENDIX 2

FAI SPHERICAL BALLOON PILOT REQUIREMENTS, 1909 & 1911*

1909

Applicant must be 21 years of age

10 ascensions

1 at night

1 alone

2 conducted by applicant under supervision of licensed pilots (with no interference) who report on handling to board

1911

Applicant must pass the following tests:

(A) Five ascensions without any conditions

(B) An ascension of one hour's minimum duration undertaken by the candidate alone

(C) A night ascension of two hours' minimum duration, completed between the setting and the rising of the sun

The issue of a certificate is always discretionary

*from Juliette A. Hennessy, *The United States Army Air Arm, April 1861 to April 1917* (Washington, D.C.: Government Printing Office, 1958), 218.

APPENDIX 3

DISTRIBUTION OF FRENCH BOMBARDMENT ON 19 JANUARY 1916*

GROUP	LOCATION	ESCADRILLES	ASSIGNMENT
GB 1	Malzéville	VB 101	G.A.E.+
		VB 102	
		VB 103	
		VB 112	
		VB 114	
GB 2	Malzéville	VB 104	G.A.E.
		VB 105	
		VB 106	
		N 65	
		C 66	
GB 3	Breteuil	VB 107	G.A.N.++
		VB 108	
		VB 109	
		VB 111	
GB 4	Belfort	MF 29	G.A.E.
		C 61	
	Luxeuil	MF 25?	
		C ?	
GB 5	Ochey	BM ?	G.A.E.
(Not formed until February 1916)			

+ *Group d'Armee de l'Est* (Army Group of the East)
++*Group d'Armee du Nord* (Army Group of the North)

*adapted from ORDER NO. 1302, G.Q.G. DES ARMEES DE L'EST, found in *Les Armees Francaises Dans La Grande Guerre, Tome 111*, 4e Volume (Paris: ?, 1926), 656, annex 3276, quoted in *"Wind Soc," Cross and Cockade Journal* (U.S.) 12, no. 4 (Winter 1971), 380.

APPENDIX 4

DISTRIBUTION OF FRENCH BOMBARDMENT IN SEPTEMBER 1917*

GROUP	LOCATION	ESCADRILLES	
		DAY	NIGHT
GB 1	Sénard	Sop 66	VB 110
		Sop 111	VB 114
GB 2	Malzéville		VB 101
			CEP 115
			MF 130
GB 3	Champion	Sop 128	Sop 107
			VB 113?
			VB 125
			PS 126
			PS 127
GB 4	Luxeuil	Sop 29	
		Sop 123	
		Sop 129	
		Sop 131	
GB 5+	Ochey		BR 117
			BR 118
			BR 119
			BR 120
			BR 121
INDEPENDENT UNITS			
	Vadelaincourt		MF 25
	Dunkirk		V 116

+*GB* 5 increasingly was used for day operations as the transition to the Bréguet 14 B 2 neared completion.

*adapted from translation of "Chaalis's Classes For Advance Students," by *Capitiane* Bouchet, n.d. [but pre-1 October 1917], 25-26, RG 120, Entry 806, box 8504, NA.

Captain Bouchet commanded GB 1 in 1917.

APPENDIX 5

ORDER OF ARRIVAL FOR BRITISH NIGHT BOMBARDMENT SQUADRONS IN FRANCE

DATE	SQUADRON	AIRCRAFT
1916		
? (night bomb by 10 Nov 1916)	5 (Naval)	Sop 11/2
?	3 (N) Wing	Sop 11/2
1917		
28 March	100	FE2b, BE2e, HP
25 July	101	FE2b, BE12
24 September	102	FE2b
17 October	'A' (Naval) later 216	HP
1918		
10 January	58	FE2b, HP
3 March	207	HP
4 March	83	FE2b
1 April	214	HP
26 April	148	FE2b
31 May	38	FE2b
2 June	149	FE2b
4 July	215	HP
4 August	97	HP
31 August	115	HP

*adapted from Jones, *War in the Air*, Appendices, appendix XXIX; Bartlett, *Bomber Pilot*, 29, 53; Burge, *100 Squadron*, 3.

APPENDIX 6

DISTRIBUTION OF GERMAN BOMBARDMENT AVIATION ON 28 JULY 1918*

BOGOHL	*Staffeln*	REGION	AIRFIELDS
1	1-3	Sedan	Malmy
2	10-12	Laon	Clermont-les-Fermes, Boncourt
3	13-18	Ghent	Gontrode, Mariakerke, Oostacker
4	19-21	Somme	Giizancourt
5	4-6	Rethel	Seraincourt
6	7-9	Tournai	Froidmont, Marquain, Templeuve
7	22-24	Somme	Estrees-en-Chaussee
8	25-27	Lorraine	Boulay (Bavarian unit)
Rfa			
500	-	Ghent	Scheldewindeke
501	-	Dinant	Morville

*from Summary of Air Information No. 37, 2dS GS, 4 August 1918, AUL; "*Vizefeldwebel* Kurt Weil," *Cross and Cockade Journal* (U.S.) 3, no. 4 (Winter 1962), 327.

APPENDIX 7

EXCERPTS FROM "PLAN FOR BOMBARDMENT AVIATION"
ST. MIHIEL OFFENSIVE

Four phases are to be considered:

1. *Preparation* - Before the attack until the time of Artillery preparation.

2. *During the Artillery preparation*

3. *Day of the Attack* - On the day of the attack from the hour of the attack.

4. *Exploitation*

1. *Preparation*

Object: To hinder enemy concentration by railroads (arrival of reinforcements and supplies of any nature). Destruction of enemy aviation on its flying fields.

In order to avoid giving the enemy any intimation of the coming attack it is desired that the bombing operations be continued with their present normal activity simply selecting the objectives named below.

Means to employ: Bombardment of the principal railroad centers, points of forced passages leading to the zone of operations *at great distances*. Bombardment of enemy airdromes occupied by bombardment and pursuit aviation. In concentrating on these objectives the Bombardment Aviation to be employed is indicated below:

Objectives	To be Bombarded by	Orders of missions to be given by
Railroads		
Metz-Sablon Stations Thionville	Day and Night British Squadrons	General Trenchard

Bettemburg Ehrange Teterchen *Airdromes* *Frescaty* *Boulay* *Montoy* *Buhl*		
Railroads Longuyon Conflans Audun-le-Roman Arlon Baroncourt *Airdromes* Mars-la-Tour Puxieux	French *Groupes de Bombardement* 2 and 18	Chief of Air Svc 1st American Army
Railroads Sedan Mezieres Stenay Vouziers *Airdromes* Mouzon Malny	3 Night Bombing Groups of the *G.A.C.* [apparently these groups never arrived and were replaced with day units]	*Groupe d'Armées* du Centre
Same targets as for the above French Night Bombing Groups of the *G.A.C.*	The Day Bombing Groups from the Brigade of the French Aerial Division as soon as they are ready. These Groups will go over the lines W. of Verdun	Chief of French Aerial Division (or Brigade)

2. *During the Artillery Preparation*

Object: To hinder transportation and detraining of troops in zone of operations. Destruction of enemy aviation on its flying fields. But the present normal bombing activity will be continued through this phase, in order to adhere to the surprise element in the coming attack.

Means to employ: Destruction of railroad centers and other points of forced passage (bridges on the Meuse and Moselle), around the zone of operations at *average distances*, and at the same time the concentration of troops and supplies of all kinds.

To attack the principle airdromes as indicated below:

Objectives	To be bombarded by	Orders of mission to be given by
Railroads		
Metz-Sablon Stations Thionville Courcelles	British Day and Night Squadrons (4 night and 3 day)	General Trenchard
Airdromes		
Frescaty Boulay Montoy		
Railroads		
Longuyon Mars-la-Tour Conflans Dommary-Baroncourt Vallercy dump	French *GBs* 2 and 18 (night) *GBs* 3 and 4 (day)	General Commanding 1st American Army, through Chief of Air Svc, 1st Army
Airdromes		
Malny Mouzon Mars-la-Tour Puxieux		
Railroads		
Sedan Vouziers Bridges from Dun to Sedan	French *GBs* 5, 6, and 9?	*G.A.C.*

3. *Day of the Attack - On the day of the attack from the hour of the attack*

In general, the targets indicated hereafter, including any important objectives such as troop concentrations or dumps of material (concentration of troops, columns, bivouacs, etc.), reported by aerial reconnaissances, by observation posts or seen by the bombers themselves. But the greatest emphasis should be given to the part relating to the bombing of enemy P.C.'s and also to aerial bombing and fighting in close liaison with our own infantry.

Objectives	To be bombarded by	Orders of mission to be given by
Railroads		
Metz-Sablon Stations Courcelles	3 British Day Bombing Squadrons	General Trenchard
Dumps and troop concentrations		
Pagny-sur-Moselle Mars-la-Tour		
Dumps		
Thiacourt St. Jean-les-Buzy Chambley Landres Dommary-Baroncourt Muzery Loison: also any troop concentrations and posts of command or communication centers that can be located	French *GBs* 3 and 4 (day)	Chief of French Aerial Division

Night Squadrons same general targets as Day Squadrons, also railroad centers where reserves detrain.

4. *Exploitation*

After the days of the attack, exploitation and continuation of attack.

Observations - Here too, special emphasis should be given to the part relating to the bombing of enemy P.C., gathering of troops, columns, etc., in close liaison with our infantry. Objectives will be determined according to situation at the time being.

The targets in each case are given in order of their relative importance and in general should be bombed in that order.

The French Bombing Units will be furnished by the 1st American Army with all the documents, maps, information and objectives, etc., which may be necessary for them and which they may not have in their possession for the execution of their missions.

*adapted from "The Plan of Bombardment Aviation," Appendix No. 2 to Annex No. 3 (Field Orders No. 9), Plan of Employment of Air Service Units, 1st American Army, 7 September 1918, HQ, First Army, AEF, RG 120, Entry 806, box 8501, NA.

APPENDIX 8

THE NIGHT BOMBERS*

Dusk is our dawn, and midnight is our noon;
And for the sun we have the silver moon:
We love the darkness, and we hate the light;
For we are wedded to the gloomy night.

When in the East the evening stars burn clear
We know our time of toil is drawing near;
For as the evening deepens in the West
It brings an ending to our day-long rest.

One after one we slip into the gloom,
And through the dusk like great cockchafers boom:
High in the stars you hear our mournful cry,
As we sail onward through the sapphire sky.

The twilight shadows welcome in our day:
The silver dawn will hurry it away.
The golden stars act as a changeless guide--
The gloomy skies our wanderings will hide.

The Rhenish cities hear our throbbing hum,
And o'er the Belgian coast we go and come.
From Zeebrugge to Metz our name is cursed,
At every township where our bombs have burst.

The cunning searchlights haunt the midnight skies,
Where chains of emerald balls of fire rise,
To mingle with the spark of bursting shells--
High in the darkness where the bomber dwells!

Across whole countries we move to and fro
As on our restless pilgrimage we go:
With tanks filled up with petrol and with oil,
With loaded bomb-racks--all the night we toil.

We know the meaning of the lights which shine
Upon the world beneath--each is a sign,
Which tells us of some dim and frightened town,
Which dreads to hear our bombs fall whistling down:

Or of some railway junction full of dread
Whose workers hear us thunder overhead,
And darken every lamp--that we may pass
And leave no twisted rails and shattered glass.

We know the meaning of the sudden glare
Of dazzling light which blossoms in the air.
For us the green and scarlet rockets blaze
And whisper urgent secrets through the haze.

The dials with their phosphorescent face
Record our passage through the star-lit space;
Our height, our speed, the lapse of time is told
By steady fingers, calculating, cold.

Above a strange and darkened world we ride
And over dim mysterious forests glide:
When we are silent we can move unknown,
Our only warning is our engines' drone.

Dusk is our dawn, and midnight is our noon;
And for the sun we have the silver moon:
We love the darkness, and we hate the light;
For we are wedded to the gloomy night.

*from Paul Bewsher, *The Bombing of Bruges* (London: Hodder and Stoughton, 1918), 27-29.

APPENDIX 9

ROYAL AIR FORCE NIGHT BOMBARDMENT, WESTERN FRONT ON 11 NOVEMBER 1918*

BRIGADE	WING	SQUADRON	LOCATION	AIRCRAFT TYPE
IX (HQ)	54th	83	Estrée-en-Chaussée	FE2b
		207	"	HP+
	82d	58	Provin	HP
		214	Chemy	HP
I	10th (Army)	148	Erre	FE2b
II	11th (Army)	149	St. Marguerite	FE2b
	65th	38	Harlebeke	FE2b
III	90th	102	Bevillers	FE2b
V	22d (Army)	101	Hancourt	FE2b
VIII++	83d	97	Xaffrévillers	HP
		100	"	HP
		115	Roville	HP
		215	Xaffrévillers	HP
		216	Autreville	HP

TOTAL of 14 squadrons and 1 flight (RAF had 19 day sqdns).

FE2b used for short-range night bombing. Each sqdn had average of 18.5 aircraft assigned.

HP used for long-range night bombing. Each squadron had 10 aircraft assigned.

+Handley Page 0/100 or 0/400 ++Independent Force, RAF

*adapted from Jones, *War in the Air*, Appendices, appendix XXVI, 125-129.

APPENDIX 10

BOMBARDMENT OBJECTIVES OF THE INTER-ALLIED INDEPENDENT AIR FORCE, OCTOBER 1918

I. The Lorraine-Luxembourg iron basin.

   a. Mines and Works -- industrial agglomerations.
   b. Stations controlling the traffic in ore, chiefly Metz, Thionville, Bettembourg, and Ehrang and Karthaus near Treves.

2. Centers for the manufacture of chemical products.

   Ludwigshafen-Oppau, Höchst, Leverkussen.

3. Large industrial and commercial centers.

   a. Mannheim, Stuttgart, Frankfurt, Cologne, Düsseldorf.
   b. Mainz, Karlsruhe, Freiburg, Coblenz, Saarbrucken, Friedrichshafen, Aix-la-Chappelle.

   The railway stations supplying these towns would be attacked at the same time.

4. Large sorting stations of Western Germany.

   Hausbergen near Strassburg.
   Kalk Nord near Cologne.
   Düsseldorf-Derendorf.
   Saarbrucken.
   Remelfingen near Sarrequemines.
   Ehrang and Karthaus near Treves.
   Aix-la-Chappelle.
   Offenburg near Strassburg.

5. The principal metallurgical works of the Rhenish-Westphalian basin (particularly Essen) and of the Sarre basin.

Additional secondary targets (Röttweil, Oberndorf, etc).

*adapted from Memorandum No. 3875, Marshal Foch to M. Clemenceau, 13 September 1918, quoted in H. A. Jones, *The War in the Air*, Appendices, appendix 10, 38-39.

APPENDIX 11

EXCERPTS FROM U.S. AIR SERVICE "NOTES ON BOMBARDMENT"*

Specialization Needed

The day is passed when one machine serves for many purposes. To get maximum effect, our machines must be designed for specific ends. . . . Considering the principal Rhine objectives as Düsseldorf [sic], Cologne, Mannheim and Frankfurt, . . . [o]ne type should be designed for these points, another for the shorter distances of the mineral region of the Saar [sic] basin, and if attacks on Berlin are contemplated a third type should be designed.

Present Machines Out of Date

British

Handley Page [0/100]: Though out of date, it is the best the British have.

French

Voisin [10?]: Has certain good qualities, but was out of date early in the war.

Caproni [Ca.33]: Is slow, unwieldy, and quite out of date.

Sopwith [1½ Strutter]: Not in any sense a bombardment machine and entirely unsuited for this work.

Farman [FE2b]: Not a bombardment machine and unsuited for weight carrying, but has an exceedingly reliable and silent motor and is easy to fly and land at night. . . As a makeshift, it is good.

Italian

Caproni Triplane: An up-to-date night bomber. From all accounts a thoroughly good machine, and the kind we ought to have.

RECOMMENDATIONS

1. That the importance of perfecting an incendiary bomb should be brought to the immediate notice of those concerned.

2. That for night work the largest and most advanced successful type of airplane be ordered, and no other; and that the speedy development of much larger machines (1500 H. P. and over) be encouraged.

3. That for day work a very fast (130 m. per h.) bi-motor, three-seater be produced.

4. That reliability and silence be insisted upon for motors used for night flying.

5. That safety devices such as parachute and fire extinguishers be considered for big machines.

6. That body armor be tested and considered for pilots and crews of big machines.

*adapted from Air Service, Information Department, "Air Service Bulletin No. 2," Notes on Bombardment, 20 October 1917, *Gorrell's History*, vol. L-3, RG 120, NA.

APPENDIX 12

U.S. AIR SERVICE SQUADRON PLANS AND PROGRAMS 1917-1918*

DATE	TOTAL SQDNS	NIGHT BOMB SQ	#SQDNS BY DEC 1918	COMPLETION DATE
10 Jul 1917	59	5+		Dec 1918
18 Sep 1917	260	60+		Dec 1918
1 Jan 1918	100	11+		Dec 1918
6 Feb 1918	120	31+		Dec 1918
5 Jun 1918	260	60++	36	Jun 1919
29 Jul 1918	358	55	25	Jun 1919
16 Aug 1918	202	27+++	2	Jun 1919

+represents total number of bomber squadrons for USAS.

++The following number of night bombardment aircraft were estimated to be required for the program:

For training in the United States 96
For service in France 1620 total 1716

[from Memorandum, B/G W. L. Kenly to Chief of Staff, 14 May 1918, *Henry H. Arnold MSS*, box 222, LC

+++17 Handley Page squadrons, 10 Caproni squadrons

[from "History of the Night Bombardment Section in France," *Gorrell's History*, vol. B-6, 4, RG 120, NA.]

*adapted from Maurer, *U.S. Air Service*, vol. 2, 196, 220, 228, 412.

APPENDIX 13

U.S. AIR SERVICE NIGHT BOMBARDMENT SQUADRONS, 1918*

SQDN #	ORGANIZED	TRAINING LOCATION	ARRIVED FRONT
92	1 Sep 1917	Ford Junction, England	-
140	1 Nov 1917	Ford Junction, England	-
155	1 Dec 1917	RAF Lake Down, England	9 Nov 1918
326	7 Jul 1918	Ford Junction, England	-

The 92d and 140th Aero Squadrons did not begin training for night bombardment until mid-August 1918.

The 155th Aero Squadron originally trained as day bombardment squadron. Ordered to report to Colombey-les-Belles on 11 Nov 1918 to search for missing planes.+

+Lucien H. Thayer, *America's First Eagles: The Official History of the U.S. Air Service, A.E.F. (1917-1918)*, ed. *Donald G. McGee and R. James Bender (San Jose, California:* R. James Bender; co-published Mesa, Arizona: Champlin Fighter Museum Press, 1983), 243.

*from A.E.F. Progress Report, 9 April 1919,[need vol. #], Memorandum from Capt J. Stuart to Col A. Monell, 20 November 1918, *Gorrell's History*, vol. B-9, 97-101.; "American Air Service In Training With R.A.F., British Isles," *Gorrell's History*, vol. B-5, 45-46, 60, RG 120, NA.

APPENDIX 14

PLANNED ARRIVAL OF U.S. HANDLEY PAGE NIGHT BOMBARDMENT SQUADRONS AND ANTICIPATED AERODROMES IN FRANCE*

DATE	#SQUADRONS	DATE	AIRDROME
1 Sep 1918	3	31 Oct 1918	Trampot
1 Oct 1918	3	31 Dec 1918	St. Blin (east)
1 Nov 1918	3	31 Jan 1919	Grand
1 Dec 1918	3	31 Jan 1919	Leurville
1 Jan 1919	2	28 Feb 1919	St. Blin (west)
1 Feb 1919	4	28 Feb 1919	Bressoncourt
1 Mar 1919	4		
1 Apr 1919	4		
1 May 1919	4		
TOTAL	30		

*from *An agreement, made this ?5th day of February 1918, between the Air Ministry of the British Government, represented by Harold Lord ROTHERMERE and the United States Government represented by* [no name listed], Article 8, in "Appendix to History of the Night Bombing Section in France," *Gorrell's History*, vol. B-6, 30; Memorandum, 3 September 1918, in *ibid.*, 62, RG 120, NA.

APPENDIX 15

UNITED STATES NAVAL AVIATION FORCES IN EUROPE, NORTHERN BOMBING GROUP, NIGHT WING*

Squadron	Estimated Date of Operation	Proposed Location
1	15 Jul 1918	St. Ingelverts
2	1 Aug 1918	St. Ingelverts
3	15 Aug 1918	Champagne
4	1 Sep 1918	Champagne
5	1 Sep 1918	+
6	15 Sep 1918	+

Nos. 3 and 4 Squadrons were never organized before the armistice.

+ Nos. 5 and 6 Squadrons were eliminated by the Department of the Navy after the original projections.

* adapted from Memorandum to Captain Cone, 21 May 1918, quoted in report by Lt Col Christe (for Joint Army and Navy Board on Aeronautic Cognizance?), 17 August 1919, 8, RG 18, NA; Roger M. Emmons, "The First Marine Aviation Force, Part Two," *Cross and Cockade Journal* (U.S.) 6, no. 3, 272.

APPENDIX 16

SPECIFICATIONS FOR NIGHT RECONNAISSANCE PLANE*

1. Two Compasses - luminous dials, one for each cockpit.
2. Two Clocks - luminous dials, one for each cockpit.
3. One Tachometer.
4. One Airspeed Indicator
5. Two Altimeters - one for each cockpit
6. Four Holt flare brackets on each lower wing underneath, and completely wired to pilot's cockpit and connected to Holt flare push button. These brackets to be placed as near the extreme side of lower wing as possible.
7. Two Landing Search Lights - midway between fuselage and wingtip on upper side of lower planes. - type of light used on D.H. and Breguet (Cibie) completely wired and equipped with storage batteries.
8. Navigation lights - one red and one green - mounted in proper receptacle on wingtip struts and completely wired to pilot's cockpit.
9. One Intercommunicating electric telephone set.
10. One Incidence indicator - pilot's cockpit.
11. One Banking indicator - pilot's cockpit.
12. One Inclinometer - pilot's cockpit.
13. Dash lights for gauges in front.
14. Two portable socket lights for rear.
15. Full wireless equipment for two keys in rear cockpit.
16. Machine guns - one fixed synchronizing on nose - two on turrel - observer.
17. For A.R.2 planes, speaking tubes instead of electric telephone. Guns - one top plane mount and two on turrel.

In case of necessity on rush order, these planes will be equipped only with items 3, 4, 7, 8, 10, 13, 14, and 16.

*adapted from "Specification for Night Reconnaissance Plane," Production and Maintenance Division, Inspection Department, A.S.P.C.#2, n.d. [after 12 August 1918], *Gorrell's History*, vol. I-15, 123, RG 120, NA.

APPENDIX 17

GUIDE FOR FRENCH NIGHT BOMBING SCHOOL AT CERNON*

INSTRUCTION OF THE PILOT.

Pilots who have never made night flights are generally rather afraid of them at first. But experience shows that night piloting is comparatively quite easy, that even mediocre pilots can manage it, and that, after sufficient training, they can even go out at night in bad weather.

TO GIVE THE PILOT CONFIDENCE.

In order to gain [confidence], he should make one or two flights as passenger with a French instructor, preferably by moonlight or at nightfall.

The pilot, having thus got some idea of night flying will be able to make some flights alone, beginning at twilight.

LANDING.

Choose the landing-ground from a distance, fly down to 100 meters altitude with the engine still working, until just above the landing-ground; then shut off the engine altogether. As the first night flights are rather trying, too many should not be made in one evening.

TRAINING.

When the pilot has made 4 or 5 night landings, he will have gained sufficient experience to carry a passenger. From this time forward, his training can be continued without difficulty, at the same time as that of the observer, by means of night flights over the country at varying altitudes, and in more or less misty weather.

TRAINING OF THE OBSERVER.

The training of the observer is much more complicated than that of the pilot; he requires a long course of night flying before he can learn to take his bearings easily, and

besides this, in carrying out bombing operations, he has only very few landmarks by which to guide himself.

VISIBILITY.

Night visibility varies considerably, according to the atmospheric conditions, the season, and the place.

In clear moon-light one can see almost as clearly as by day; in foggy weather, on the contrary, the pilot can distinguish nothing but the stars at the zenith, and the observer cannot make out very much from the vertical point of view.

In Spring and at the beginning of Summer, the woods and fields still green often look exactly alike, but the dusty roads which are not bordered with trees can be seen even on the darkest night. In winter, on the other hand, the roads are not often visible, but woods can be distinguished quite clearly. In snowy weather, the visibility is always excellent.

In conclusion, the visibility varies according to the altitude. It is generally better at 1000 meters than at 2000 meters, but it frequently happens that it diminishes at low altitudes.

USE OF FIELD-GLASSES.

Observers do not generally care to use field-glasses at night. They must be convinced that field-glasses are very useful at night in order to distinguish luminous points a long way off, which cannot be seen with the naked eye.

TRAINING.

1. - Flights over the country at a short distance from the Aviation ground. The ground being lighted up, serves as a land-mark. The observer who has flown over the district several times by day will recognize the most important details.

2. - Flights over the country by an easy route: straight road, canal, or river. These flights will be made by moonlight, on dark nights, and in foggy weather, alternately.

BOMBING.

The following are the conditions necessary for accurate fire:

1. - Fly in a straight line. This is easy if the pilot takes care to steer at night by the star which the observer points out to him.

2. - Fly head to the wind.

3. - Fly level. This is one of the most difficult tasks for a pilot.

4. - Fly at a given angle, to enable the observer to adjust the sighting apparatus.

[Crews] carry out firing practice on the bombing target at an altitude of between 1000 and 2000 meters. During each flight above the objective, the crew fires a single shell; the observer takes note of the error, and corrects his fire accordingly.

Not more than 5 flights should be made over the objective.

The first firing practice should be carried out in very fine weather.

A fairly capable crew, after 2 or 3 exercises, should be able to place their bombs not more than 100 meters from the center of the target.

THEORETICAL INSTRUCTION.

I - The detailed study of topography will be the subject of the first lectures.

II - As each bombing expedition is accompanied by a reconnaissance the observer should know how to collect information.

III - The observer should also have a good knowledge of the principles of bombing.

IV - He will study the bombs in use.

V - The crews should have a general idea of tactics.

VI - The observers should be trained in the study and interpretation of photographs.

VII - Study of the engine.

VIII - The course of instruction will be concluded by the study of meteorology.

* adapted from translation of *Guide Pour L'instruction des Pilotes et Observatuers a L'ecole de Bombardement de Jour de Villeneuve et L'ecole de Bombardement de Nuit de Cernon*, n.d. [1917?], RG 120, Entry 806, NA.

APPENDIX 18

FRENCH TRAINING PROGRAM AT LE CROTOY IN SPRING 1918*

Duration of Instruction:

Day and Night Pilots 20 days

Night Bombarders 45 days (includes 15 days of gunnery instruction)

PRIMARY INSTRUCTION (10 days)

Theoretical Instruction for night bombarders (lectures):

1. General overview of program of instruction.
2. General overview of bombardment aviation.
3. Elementary ballistics and use of Michelin sight.
4. Shooting methods and sights other than Michelin sight.
5. Bomb dropping.
6. Communication between pilot and bombardier.
7. Errors and their causes.
8. Preparation and execution of a bombing expedition.

Practical Instruction (in groups of five to eight students):

1. Bomb sights.
2. Bomb carriers and bomb droppers.
3. Bombs, projectiles, fuses.
4. Rolling carpet.

Examinations after theoretical and practical instruction.

FLIGHT TRAINING (20 days)

Technical Instruction for pilots (lectures):

1. Work of the bombing pilot.
2. Group flying [for day bombers].
3. Use and care of motors.
4. Cross country flights and landings.
5. Geography of the Western Front.
6. Elements of cosmography [astronomy?] and meteorology.
7. Elements of machine gun shooting.
8. Recognition of Allied and German aircraft.

9. Review of the monthly bulletins issued by the French air service and the aviation school.
10. Lesson to be learned from flying accidents.

Practical Instruction for pilots and bombarders (flying):

(1) Day instruction.

a. Transformation flying	1 hour
b. One flight (three passes) over camera obscura	3/4 hour
c. Two bombings with smoke bombs	1 hour
d. One bombing with explosive bombs	3/4 hour
e. Cross country flying	none

(2) Night instruction.

a. Transformation night flying, pilot alone	1 hour
b. Transformation night flying, passenger	½ hour
c. Two flights (four passes) over camera obscura	2 hours
d. Four Very's pistol shootings	3 hours
e. Bombings with explosive bombs	none
f. Cross country flying	none

Special Instruction:

For night bombardment pilots -

1. Shooting methods and sights
2. Maps and trips
3. Use of the compass
4. Bombs, bomb carriers, bomb droppers
5. Rolling carpet
6. Study of motors, mechanics

Aerial gunnery training for bombarders -

1. Study of armament and aerial machine guns
2. Study of shooting, regulating the machine gun
3. Ground shooting of fixed and moving targets
4. Machine gun turret training and aerial shooting to be organized later.

The school anticipated graduating 180 day and night pilots, and 80 night bombarders in April 1918.

The school had on hand on 25 March 1918 the following machines for day and night instruction:

A.R. - 3	Farman - 8	Voisin - 28
Breguet 14 B 2 - 10	Sopwith [1½] - 69	

*adapted from report entitled "Organization of the French School of Aerial Bombardment at Le Crotoy," n.d. [late March 1918?], RG 120, Entry 656, box 7309, report file C-O, NA.

APPENDIX 19

EXCERPTS OF SYLLABUS OF USAS NIGHT BOMBARDMENT SCHOOL FORD JUNCTION, ENGLAND*

I. PURPOSE OF COURSE

Pilots, Navigation Officers and Gun Layers are ordered to report to this school for their finishing training, prior to proceeding to the Expeditionary Force, with the assumption that they are able to start work on the day of their arrival at a Squadron in France, and not have to continue their training at that Squadron. . . .

II. STANDING ORDERS

[Fifty-three standing orders are listed]

(12) All machines will give way to Handley Pages landing except in the case of forced landings.

(13) In rough weather taxi out with the mechanics on the wing tips and in landing in rough weather keep the machine dead into the wind until the mechanics take charge of the wing tips. The pilot will be responsible if the machine is damaged.

(21) All pilots are warned that "Stunting" over hangars, diving over troops, transports, camps, villages or towns is expressly forbidden. . . .

(22) When a crash occurs, whether fatal or otherwise, it is strictly forbidden for anyone, except those concerned, to rush across to the scene of the accident.

(26) Observers will always remain seated in their machines when taxying, taking off or landing.

(34) Before commencing night flying, pupils must read night flying orders and aerodrome control signals for night flying and ensure that they thoroughly understand them.

(41) A Red Flag will indicate Right Hand turn, a Blue Flag, left hand turn.

III. FLYING SYLLABUS AND FLYING TESTS

A-FLIGHT DAY FLYING:	TIME
1. Dual and solo on either B.E.'s or Farmans	2 hrs
2. Cross country to X - by compass only, and return on reciprocal bearing, X not to be less than 30 miles distant.	1½hrs
3. Cross country to Winchester - by compass and map - 70 miles.	1½hrs
4. Cross country to Oxford - by compass and map - 120 miles.	2½hrs
5. Bombing - four bombs from 1000 feet	1 hr
6. Bombing - four bombs from 500 feet	3/4 hr
7. Bombing - four bombs from 4000 feet (on glide)	1 hr

In each test the worst 50% of shots are rejected; the average distance (in yards) of the remainder is divided by the height in thousands of feet and the resulting numbers taken as the score; 20 and under constitutes a pass.

Total time	9½hrs

B-FLIGHT HANDLEY PAGE, DAY:	
1. H. P. Dual and Solo	1½hrs
2. Cross country to Andover - by compass and map - 70 miles.	1½hrs
3. Bombing - four bombs from 1000 feet	1 hr
5. Bombing - four bombs from 500 feet	3/4 hr
6. Bombing - four bombs from 4000 feet (on glide)	1 hr
Total time	53/4 hrs

C-FLIGHT NIGHT FLYING:	
1. Dual and Solo on B.E.'s	1½hrs
2. Cross country to Winchester - by compass and map - 70 miles.	1½hrs

3.	Cross country to Salisbury - by compass and and map - 110 miles.	2 hrs
4.	Bombing - four bombs from 1000 feet	1 hr
5.	Bombing - four bombs from 500 feet	3/4 hr
6.	Bombing - four bombs from 4000 feet (on glide)	1 hr
	Total time	73/4 hrs

D-FLIGHT NIGHT FLYING:

1.	H. P. Dual and Solo	1½hrs
2.	Sham Raid on Gosport - by compass and map - 50 miles. Coastal defence searching lights and Home Defence machines will cooperate.	1 hr
3.	Sham Raid on Salisbury - by compass and map- 110 miles.	2 hrs
4.	Bombing - four bombs from 1000 feet	1 hr
5.	Bombing - four bombs from 500 feet	3/4 hr
6.	Bombing - four bombs from 4000 feet (on glide)	1 hr
	Total time	73/4 hrs
	GRAND TOTAL TIME	30½hrs

IV. LECTURES

a- NAVIGATION:

Seven lectures and practical exercises, followed by an examination.

b- BOMBING:

Six lectures followed by an examination.

c- MAP READING:

Five lectures and practical exercises, including a lecture on the Rhine Valley, followed by an examination.

d- GUNNERY: (Ground range)

Eight lectures and practical exercises.
(Aerial range)

Firing from 500 feet.

e- METEOROLOGY:

Three lectures.

f- RADIO DIRECTION FINDING:

[Unknown curriculum]

Miscellaneous information regarding training:

Total hours flown at Ford Junction - 936; at night - 113.

Only the BE2e was used for night flying.

Only advanced night training carried out was the sham raids on Gosport, where planes were required to give the signal of the night to the ground searchlight batteries.

*adapted from *Training Report, Ford Junction Aerodrome*, in "Report of the Activities of the Mobilization and Training Department of the Night Bombardment Section, AS, AEF," *Gorrell's History*, vol. B-9, 23-35, RG 120, NA.

APPENDIX 20

INTRODUCTION TO IDEAL NIGHT BOMBARDMENT TRAINING*

Night Bombardment Planes & Crews.

1. There are two distinct kinds of Night Bombardment Airplanes, each requiring a differently trained and number of crew.

(a) Single Engine.
(b) Multi Engine.

(a) A single engine crew consists of a team - 1 pilot and 1 observer (Bomber).

(b) A Multi Engine crew varies somewhat with the type of ship, the distance from and facilities, i.e.- Radio.

The ordinary crew carried, however, will be three:

1 Pilot.
1 Observer, Navigation Officer, Bomber and Gunner.
1 Observer, Radio Direction Finder, Navigation Officer and Gunner.

At times an extra pilot is carried for very long distance work where weight can be spared, or where green pilots are being trained at the Front.

Previous practice in training has been to train the second pilot to drop the bombs and be the front Observer and Gunner, but this is not considered wise. A pilot needs all possible training in piloting and cannot be taught to be an expert bomber, and gunner as well, without serious delay and duplication in training. Under the above system the crew would consist of:

2 Pilots - Also Bomber and Gunner.
1 Observer - Navigation Officer.
1 Observer - Radio Direction Finder and Gunner.

It will be seen that this type of crew is very uneconomical in point of training and is a most difficult one to maintain at the Front.

II. School Training.

All personnel have passed through Ground School or equivalent.

A. Pilots.

All pilots arrive at the Night Bombing School with R.M.A. and Aerial Gunnery, or an approximate total of 50 hours on Curtis or other type Airplanes.

It is planned to send the pilots to the Front in Single Engine Squadrons with approximately 75 hours flying, and those to Multi Engine Squadrons with approximately 100 hours flying.

B. Observers.

All Observers arrive at the School with complete Aerial Gunnery. they are divided into two classes after finishing Ground School.

Class 1 - Bomber, Navigation Officer and Gunners.
(For Single Engine and Multi Engine Squadrons).

Class 2 - Radio Direction Finders, Navigation Officers Gunners.
(For Multi Engine Squadrons only).

NOTE:- Class 1 Observers (Bombers) need not pass through Radio School.

C. All personnel passes through the Single Engine School and at the end of that course the pilots and bombing observers (Class 1) are selected for Multi Engine School, the remaining pilots and bombing observers are sent to the Front as Single Engine Night Bombing Teams.

It may be found impractical to give any training to Radio Direction Finders at the Single Engine School. In this case they can be given a special course in Navigation and pass only through the Multi Engine School.

The type of plane to be used at the School should be similar to the following:

Single Engine: FE2b (pusher British).
Multi Engine: Caproni and Handley Page.

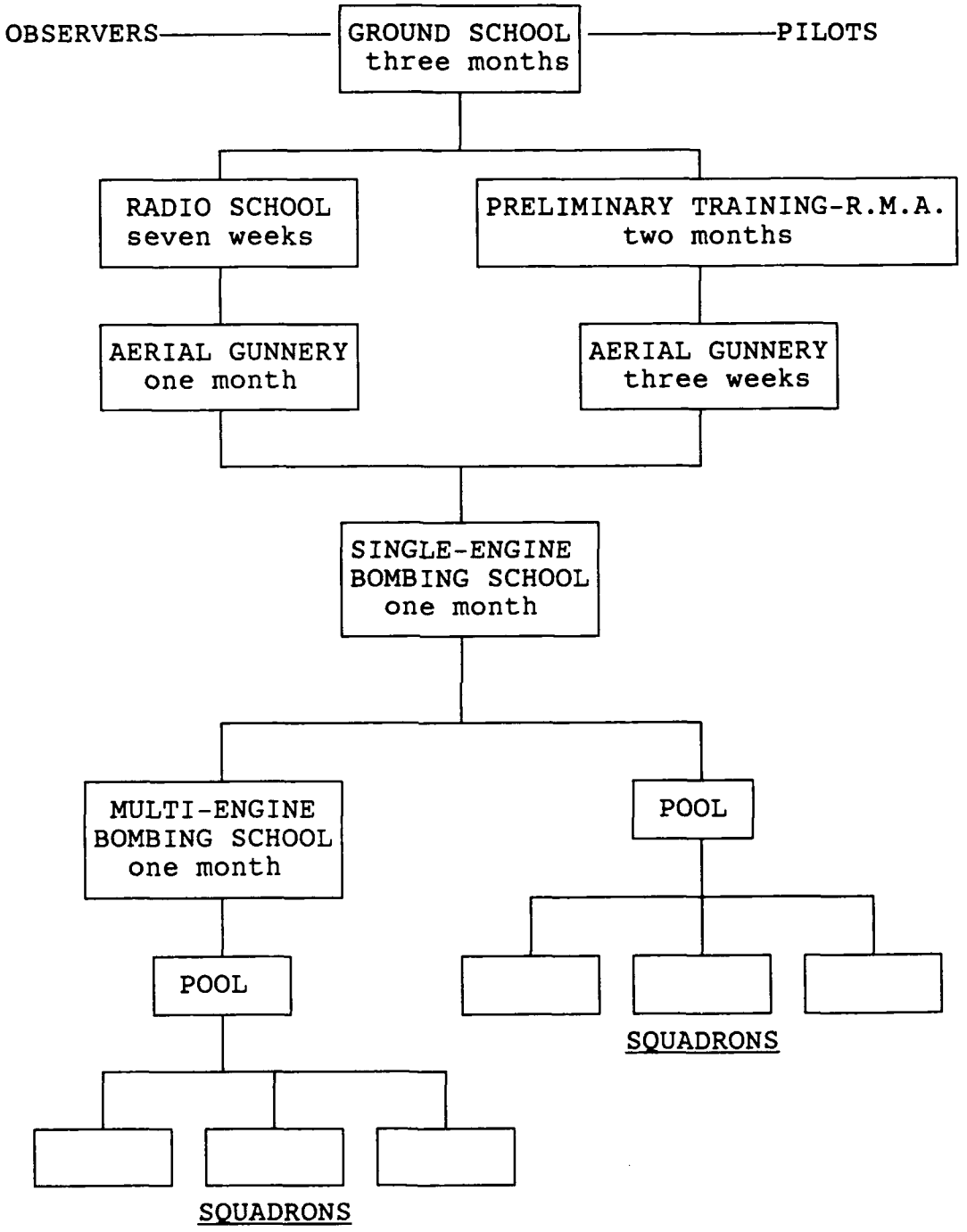
The planes used in training must be of the same type as in Service Squadrons.

The training given at the Single Engine School should fit pilots and observer to make low altitude raids of 20 to 25 miles behind the lines in all weather. These raids should be made with a great deal of dash and daring. The personnel must be taught precision bombing under all conditions, and bombers must be most expert in order to hit targets, such as trains, etc. Observers are also called upon to do a great deal of Night Reconnaissance and strafing with machine guns. Team work is invaluable in these operations in order to obtain good results.

The training at the Multi Engine School should fit crews to execute raids of very long distance in almost any weather. The crews must have uppermost in their minds precision bombing, and must circle the objective several times, if necessary in order to obtain the desired results. Their training must impress on them the futility of foolhardiness, and realize their responsibility in equipment and value of crews.

(signed)
W. G. KILNER
Col. A.S.A.,
C.T.S.
[Chief of Training Section]

IDEAL NIGHT BOMBARDMENT TRAINING



IDEAL NIGHT BOMBARDMENT TRAINING

Tabular schedule showing number of hours in each of the eight weeks of instruction devoted to each of the subjects taught, . . . in the Single and Multi Engine Schools.

Week number -	1	2	3	4	5	6	7	8	T	REMARKS
1. FLYING.										
PART I. Single Engine School										
Stage I -Day- 2 weeks										
Transformation -										
Dual & Solo	2	-	-	-	-	-	-	-	2	Pilots
Camera Obscura	2	-	-	-	-	-	-	-	2	
Individual Bombing	3	-	-	-	-	-	-	-	3	
Aerial Gunnery	1	1	-	-	-	-	-	-	2	
Cross Country	-	6	-	-	-	-	-	-	6	
Stage II - Night- 2 weeks										
Transformation -										
Dual & Solo	-	-	1	-	-	-	-	-	1	Pilots
Individual Bombing	-	-	3	-	-	-	-	-	3	
Aerial Gunnery	-	-	2	-	-	-	-	-	2	
Cross Country	-	-	-	7	-	-	-	-	7	
								Pilots	28	hours
								Observers	25	"
PART II. Multi Engine School										
Stage III -Day- 2 weeks										
Transformation -										
Dual & Solo	-	-	-	-	1	-	-	-	1	Pilots
Camera Obscura	-	-	-	-	2	-	-	-	2	
Individual Bombing	-	-	-	-	3	-	-	-	3	
Aerial Gunnery	-	-	-	-	-	1	-	-	1	
Cross Country	-	-	-	-	-	3	-	-	3	
Stage IV -Night- 2 weeks										
Transformation -										
Dual & Solo	-	-	-	-	-	-	1	-	1	Pilots
Individual Bombing	-	-	-	-	-	-	3	-	3	
Aerial Gunnery	-	-	-	-	-	-	1	-	1	
Cross Country	-	-	-	-	-	-	-	7	7	
								Pilots	22	hours
								Observers	20	"

Week number -	1	2	3	4	5	6	7	8	T	REMARKS
2. GROUND WORK.										
Lectures on bombardment theory, purposes, etc.	7	3	-	-	-	-	-	-	10	
Rolling Carpet, sights										
Observers	7	-	-	-	-	-	-	-	7	
Pilots	3	-	-	-	-	-	-	-	3	
Bombs, fuses	-	-	3	-	2	-	-	-	5	
Gunnery	-	2	-	-	-	2	3	3	10	
Map reading	-	4	2	-	2	2	2	-	12	
Navigation	-	6	2	2	2	-	-	-	12	
Radio	-	-	2	4	4	4	4	3	21	
							Pilots		47	hours
							Observers		80	

It is presumed that, as preparation for this course, all Pilots and Observers will have completed the following minimum work:

PILOTS:

1 - Ground School — 3 months

2 - Preliminary Flying School with following minimum hours:

Dual Control & Solo	15 hours
Cross Country	10 "
Acrobatics	4 "
Formation	5 "
Total flying hours	34

3 - Aerial Gunnery School, taking up both Ground & Aerial work — 3 weeks

OBSERVERS:

1 - Ground School — 3 months

2 - Radio School (for those going to Multi Engine Bombing Planes — 7 weeks

3 - Aerial Gunnery School, taking up both Ground & Aerial work — 1 month

*"Training Section - Report On Night Bombardment Training," *Gorrell's History*, vol. J-5, 2-3, 5, 7-8, RG 120, NA.

APPENDIX 21

SUMMARY OF LANDING SIGNALS FOR HANDLEY PAGE SQUADRON*

From aircraft

Requesting permission to land. . . .	one WHITE light+
Returning with engine trouble	one RED light
Forced landing	one RED and one WHITE light

From ground

Permission to land	one WHITE light
Refusing permission to land	one RED light
Aerodrome temporarily blocked	two RED lights
Cancel permission to land	three RED lights
Recall of all machines	GREEN rockets or lights at intervals

*adapted from "Summary of Landing Signals," in Instruction Book for Handley Page squadrons, *Gorrell's History*, vol. B-6, 184; "Aerodrome Control Signals: Night Flying," Bulletin of the Information Section, AS, AEF, 6, no. 169 (4 June 1918), *Gorrell's History*, vol. B-6, 104-105, RG 120, NA.

APPENDIX 22

LOCATION OF FRENCH AERIAL LIGHTHOUSES, 10 JUNE 1918*

No.	LOCATION OF LIGHTHOUSE	HILL No.	ORIENTATION	TO FRONT
1	Mont des Récoltes	167	N.78.E.	20km
2	5km S.20.W. of Houdain	191	N.85.E.	20km
3	8km S.20.W. of Doullens	170	S.69.E.	22km
4	4km W. of St. Just-en-Chaussée	178	N.51.E.	18km
5	9km N.60.W. of Villers-Cotterets	238	N.61.E.	16km
6	4km E. of Montmirail	235	North	24km
7	11km N. of Chalons	152	N.18.W.	20km
8	1km S. of Clermont-en-Argonne	308	N.12.W.	15km
9	12km N. of Bar-le-Duc	375	N.34.E.	20km
10	12km S. of Nancy	402	N.16.E.	20km
11	Mount d'Essey	420	N.43.E.	15km
12	4km S.20.W. of St. Dié	768	N.60.E.	20km
13	Balloon *Alsace* ?	1248	N.76.E.	25km
14	4km E. of Hérimoncourt	614	N.66.E.	18km

* adapted from Emplacements des Phares de 100 Kilomètres, à la date du 10 juin 1918, Balisage de Nuit du Front, 12, box A88, *SHAA*.

APPENDIX 23

COMPARISON OF ALLIED AND ENEMY NIGHT BOMBARDMENT AVIATION AIRCRAFT STRENGTHS*

30 JULY 1918

AMERICAN	BELGIAN	BRITISH	FRENCH	ITALIAN	GERMAN	AUSTRIAN
0	10	169	210	47	222	67
	Total	436			289	

11 NOVEMBER 1918

AMERICAN	BELGIAN	BRITISH	FRENCH	ITALIAN	GERMAN	AUSTRIAN
0	8	190	247	80	268	11
	Total	525			279	

*A.E.F. Progress Report, 7 May 1919, RG 18, NA