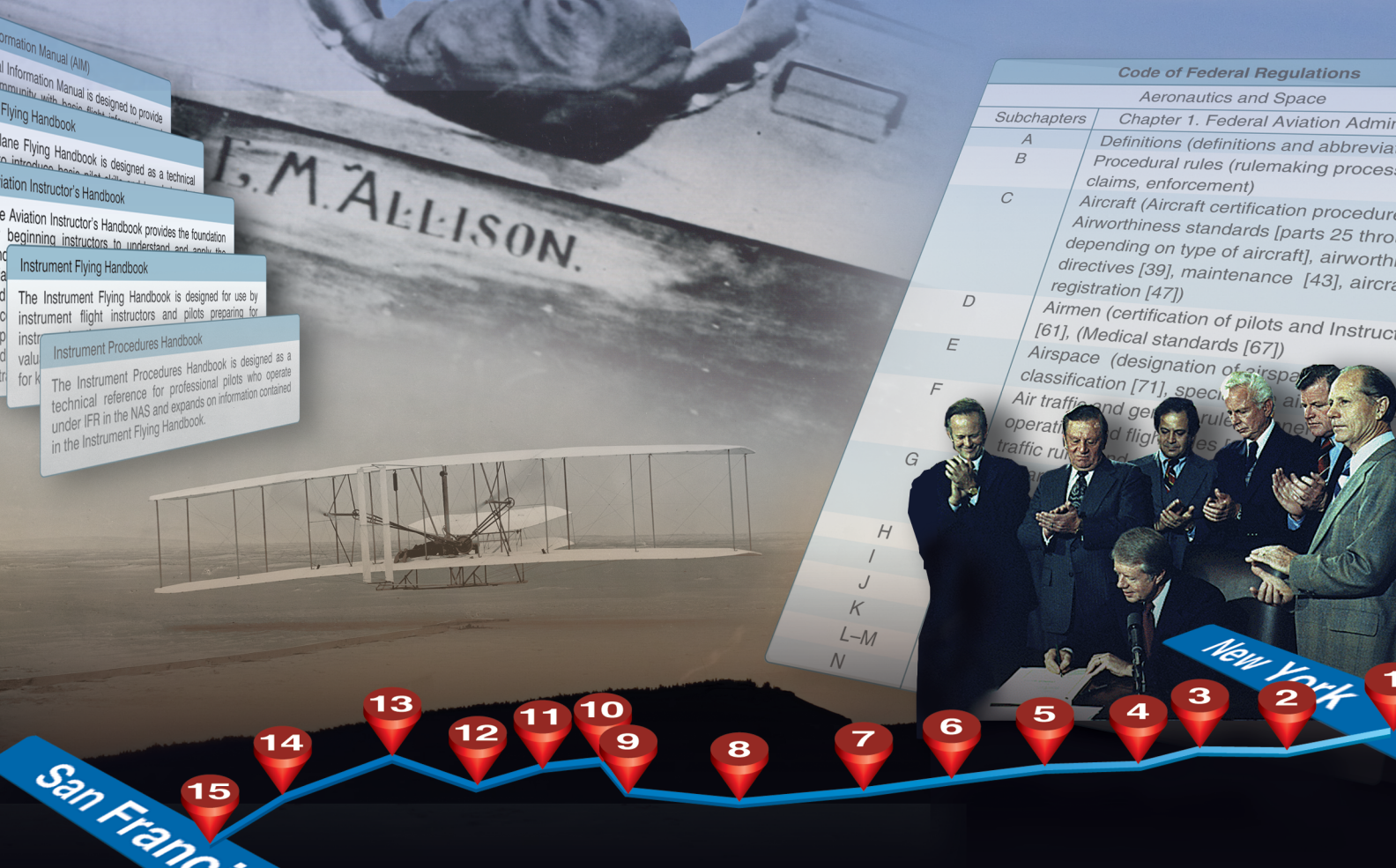
Chapter 1

Introduction To Flying

Introduction

The Pilot's Handbook of Aeronautical Knowledge provides basic knowledge for the student pilot learning to fly, as well as pilots seeking advanced pilot certification. For detailed information on a variety of specialized flight topics, see specific Federal Aviation Administration (FAA) handbooks and Advisory Circulars (ACs).

This chapter offers a brief history of flight, introduces the history and role of the FAA in civil aviation, FAA regulations and standards, government references and publications, eligibility for pilot certificates, available routes to flight instruction, the role of the Certificated Flight Instructor (CFI) and Designated Pilot Examiner (DPE) in flight training, Practical Test Standards (PTS), and new, industry-developed Airman Certification Standards (ACS) framework that will eventually replace the PTS.



History of Flight

From prehistoric times, humans have watched the flight of birds, and longed to imitate them, but lacked the power to do so. Logic dictated that if the small muscles of birds can lift them into the air and sustain them, then the larger muscles of humans should be able to duplicate the feat. No one knew about the intricate mesh of muscles, sinew, heart, breathing system, and devices not unlike wing flaps, variable-camber and spoilers of the modern airplane that enabled a bird to fly. Still, thousands of years and countless lives were lost in attempts to fly like birds.

The identity of the first "bird-men" who fitted themselves with wings and leapt off of cliffs in an effort to fly are lost in time, but each failure gave those who wished to fly questions that needed to be answered. Where had the wing flappers gone wrong? Philosophers, scientists, and inventors offered solutions, but no one could add wings to the human body and soar like a bird. During the 1500s, Leonardo da Vinci filled pages of his notebooks with sketches of proposed flying machines, but most of his ideas were flawed because he clung to the idea of birdlike wings. *[Figure 1-1*] By 1655, mathematician, physicist, and inventor Robert Hooke concluded that the human body does not possess the strength to power artificial wings. He believed human flight would require some form of artificial propulsion.

The quest for human flight led some practitioners in another direction. In 1783, the first manned hot air balloon, crafted by Joseph and Etienne Montgolfier, flew for 23 minutes. Ten days later, Professor Jacques Charles flew the first gas balloon. A madness for balloon flight captivated the public's imagination and for a time flying enthusiasts turned their expertise to the promise of lighter-than-air flight. But for all its majesty in the air, the balloon was little more than a billowing heap of cloth capable of no more than a one-way, downwind journey.

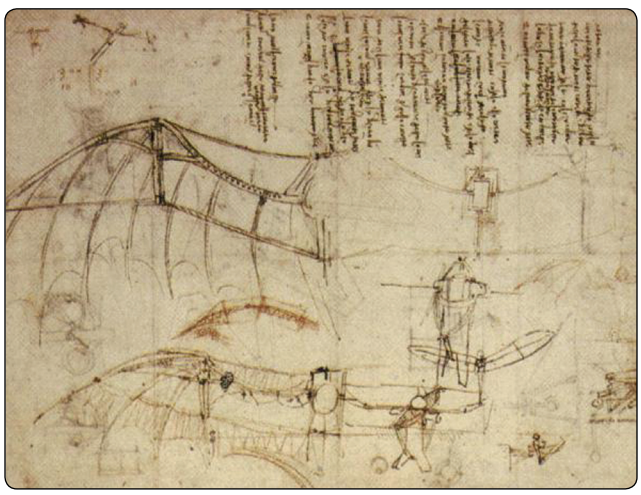
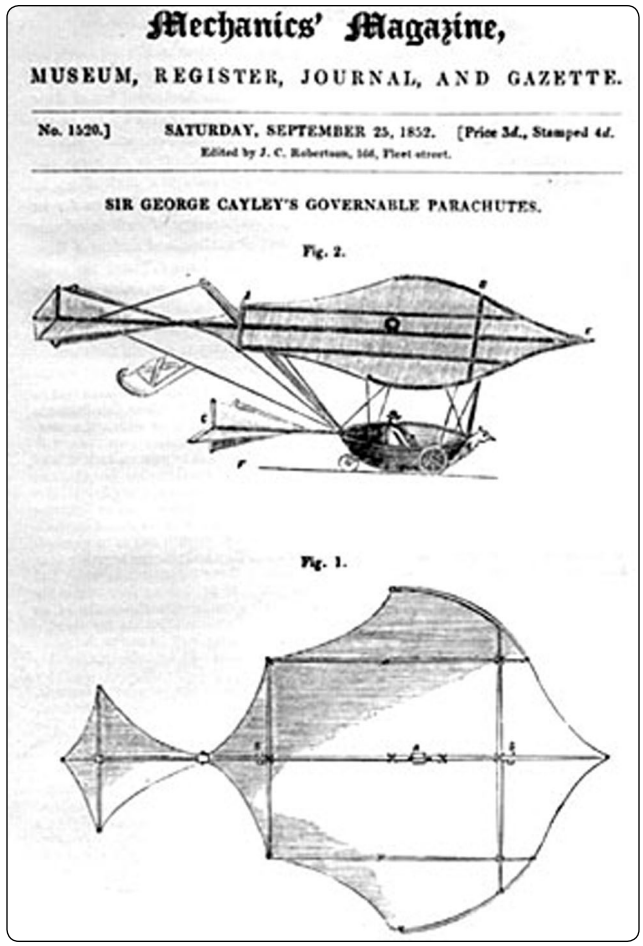


Figure 1-1. *Leonardo da Vinci's ornithopter wings.*

Balloons solved the problem of lift, but that was only one of the problems of human flight. The ability to control speed and direction eluded balloonists. The solution to that problem lay in a child's toy familiar to the East for 2,000 years, but not introduced to the West until the 13th century—the kite. The kites used by the Chinese for aerial observation, to test winds for sailing, as a signaling device, and as a toy, held many of the answers to lifting a heavier-than-air device into the air.

One of the men who believed the study of kites unlocked the secrets of winged flight was Sir George Cayley. Born in England 10 years before the Mongolfier balloon flight, Cayley spent his 84 years seeking to develop a heavier-than-air vehicle supported by kite-shaped wings. *[Figure 1-2]* The "Father of Aerial Navigation," Cayley discovered the basic principles on which the modern science of aeronautics is founded; built what is recognized as the first successful flying model; and tested the first full-size man-carrying airplane.



Mechanics' Magazine,

MUSEUM, REGISTER, JOURNAL, AND GAZETTE.

No. 1520.] SATURDAY, SEPTEMBER 25, 1852. [Price 3d., Stamped 4d.

Edited by J. C. Robertson, 166, Fleet street.

SIR GEORGE CAYLEY'S GOVERNABLE PARACHUTES.

Fig. 2.

Fig. 1.

Figure 1-2. *Glider from 1852 by Sir George Cayley, British aviator (1773–1857).*

For the half-century after Cayley's death, countless scientists, flying enthusiasts, and inventors worked toward building a powered flying machine. Men, such as William Samuel Henson, who designed a huge monoplane that was propelled by a steam engine housed inside the fuselage, and Otto Lilienthal, who proved human flight in aircraft heavier than air was practical, worked toward the dream of powered flight. A dream turned into reality by Wilbur and Orville Wright at Kitty Hawk, North Carolina, on December 17, 1903.

The bicycle-building Wright brothers of Dayton, Ohio, had experimented for 4 years with kites, their own homemade wind tunnel, and different engines to power their biplane. One of their great achievements in flight was proving the value of the scientific, rather than a build-it-and-see approach. Their biplane, The Flyer, combined inspired design and engineering with superior craftsmanship. *[Figure 1-3]* By the afternoon of December 17th, the Wright brothers had flown a total of 98 seconds on four flights. The age of flight had arrived.

History of the Federal Aviation Administration (FAA)

During the early years of manned flight, aviation was a free for all because no government body was in place to establish policies or regulate and enforce safety standards. Individuals were free to conduct flights and operate aircraft with no government oversight. Most of the early flights were conducted for sport. Aviation was expensive and became the playground of the wealthy. Since these early airplanes were small, many people doubted their commercial value. One group of individuals believed otherwise and they became the genesis for modern airline travel.

P. E. Fansler, a Florida businessman living in St. Petersburg, approached Tom Benoist of the Benoist Aircraft Company in St. Louis, Missouri, about starting a flight route from St. Petersburg across the waterway to Tampa. Benoist suggested using his "Safety First" airboat and the two men signed an agreement for what would become the first scheduled airline in the United States. The first aircraft was delivered to St. Petersburg and made the first test flight on December 31, 1913. *[Figure 1-4]*

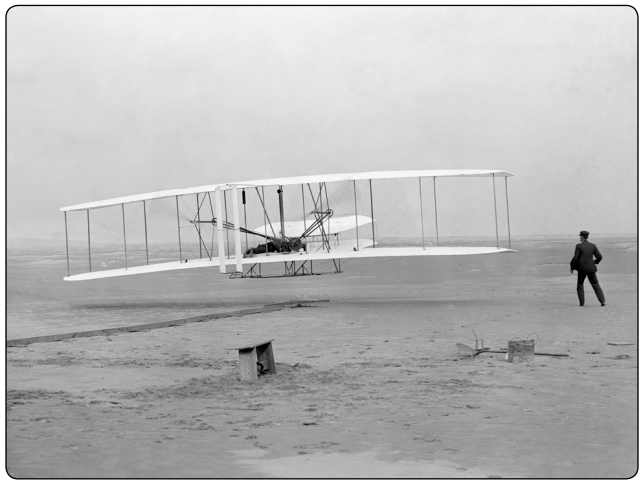


Figure 1-3. *First flight by the Wright brothers.*

A public auction decided who would win the honor of becoming the first paying airline customer. The former mayor of St. Petersburg, A. C. Pheil, made the winning bid of $400.00, which secured his place in history as the first paying airline passenger.

On January 1, 1914, the first scheduled airline flight was conducted. The flight length was 21 miles and lasted 23 minutes due to a headwind. The return trip took 20 minutes. The line, which was subsidized by Florida businessmen, continued for 4 months and offered regular passage for $5.00 per person or $5.00 per 100 pounds of cargo. Shortly after the opening of the line, Benoist added a new airboat that afforded more protection from spray during takeoff and landing. The routes were also extended to Manatee, Bradenton, and Sarasota giving further credence to the idea of a profitable commercial airline.

The St. Petersburg-Tampa Airboat Line continued throughout the winter months with flights finally being suspended when the winter tourist industry began to dry up. The airline operated for only 4 months, but 1,205 passengers were carried without injury. This experiment proved commercial passenger airline travel was viable.

The advent of World War I offered the airplane a chance to demonstrate its varied capabilities. It began the war as a reconnaissance platform, but by 1918, airplanes were being

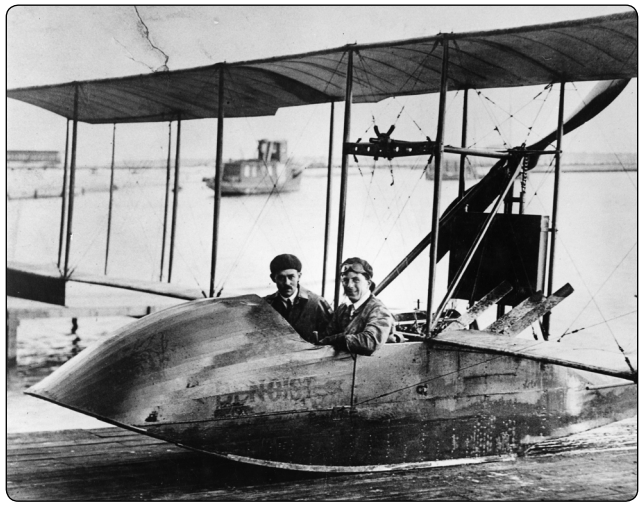


Figure 1-4. *Benoist airboat.*

mass produced to serve as fighters, bombers, trainers, as well as reconnaissance platforms.

Aviation advocates continued to look for ways to use airplanes. Airmail service was a popular idea, but the war prevented the Postal Service from having access to airplanes. The War Department and Postal Service reached an agreement in 1918. The Army would use the mail service to train its pilots in flying cross-country. The first airmail flight was conducted on May 15, 1918, between New York and Washington, DC. The flight was not considered spectacular; the pilot became lost and landed at the wrong airfield. In August of 1918, the United States Postal Service took control of the airmail routes and brought the existing Army airmail pilots and their planes into the program as postal employees.

Transcontinental Air Mail Route

Airmail routes continued to expand until the Transcontinental Mail Route was inaugurated. *[Figure 1-5]* This route spanned from San Francisco to New York for a total distance of 2,612 miles with 13 intermediate stops along the way. *[Figure 1-6]* On May 20, 1926, Congress passed the Air Commerce Act, which served as the cornerstone for aviation within the United States. This legislation was supported by leaders in the aviation industry who felt that the airplane could not reach its full potential without assistance from the Federal Government in improving safety.

The Air Commerce Act charged the Secretary of Commerce with fostering air commerce, issuing and enforcing air traffic rules, licensing pilots, certificating aircraft, establishing airways, and operating and maintaining aids to air navigation. The Department of Commerce created a new Aeronautics Branch whose primary mission was to provide oversight for the aviation industry. In addition, the Aeronautics Branch took over the construction and operation of the nation's system of lighted airways. The Postal Service, as part of the Transcontinental Air Mail Route system, had initiated this system. The

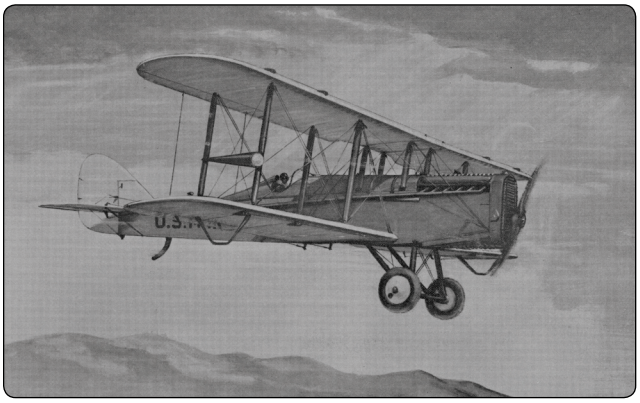


Figure 1-5. *The de Haviland DH-4 on the New York to San Francisco inaugural route in 1921.*

Figure 1-6. *The transcontinental airmail route ran from New York to San Francisco.*

Department of Commerce made significant advances in aviation communications, including the introduction of radio beacons as an effective means of navigation.

Built at intervals of approximately 10 miles apart, the standard beacon tower was 51 feet high, and was topped with a powerful rotating light. Below the rotating light, two course lights pointed forward and back along the airway. The course lights flashed a code to identify the beacon's number. The tower usually stood in the center of a concrete arrow 70 feet long. A generator shed, where required, stood at the "feather" end of the arrow. *[Figure 1-7]*

Federal Certification of Pilots and Mechanics

The Aeronautics Branch of the Department of Commerce began pilot certification with the first license issued on April 6, 1927. The recipient was the Chief of the Aeronautics Branch, William P. MacCracken, Jr. *[Figure 1-8]* (Orville Wright, who was no longer an active flier, had declined the honor.) MacCracken's license was the first issued to a pilot by a civilian agency of the Federal Government. Some 3 months later, the Aeronautics Branch issued the first Federal aircraft mechanic license.

Equally important for safety was the establishment of a system of certification for aircraft. On March 29, 1927, the Aeronautics Branch issued the first airworthiness type certificate to the Buhl Airster CA-3, a three-place open biplane.

In 1934, to recognize the tremendous strides made in aviation and to display the enhanced status within the department, the Aeronautics Branch was renamed the Bureau of Air Commerce. *[Figure 1-9]* Within this time frame, the Bureau of Air Commerce brought together a group of airlines

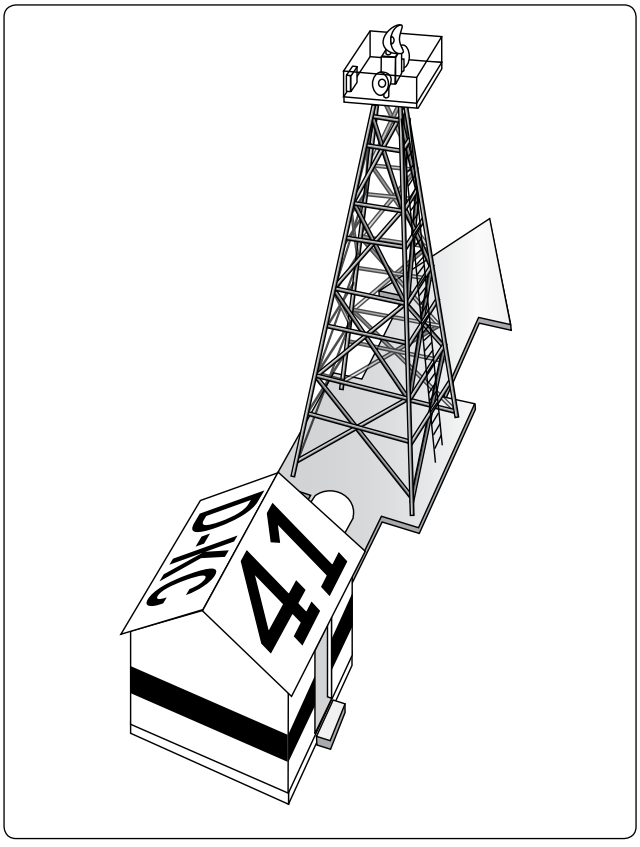
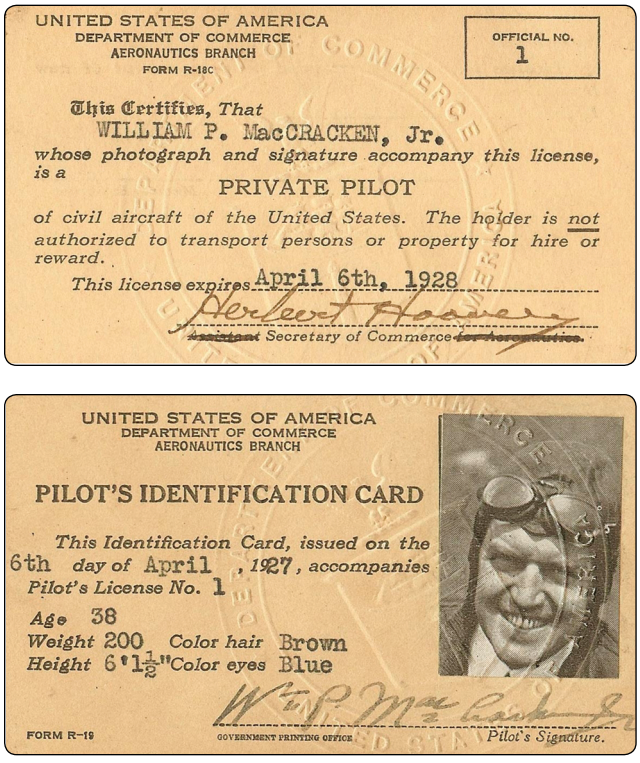


Figure 1-7. *A standard airway beacon tower.*


UNITED STATES OF AMERICA
DEPARTMENT OF COMMERCE
AERONAUTICS BRANCH
FORM R-18C

OFFICIAL NO. 1

This Certifies, That
WILLIAM P. MacCRACKEN, Jr.
whose photograph and signature accompany this license, is a
PRIVATE PILOT
of civil aircraft of the United States. The holder is not authorized to transport persons or property for hire or reward.
This license expires April 6th, 1928
Herbert Hoover
~~Assistant~~ Secretary of Commerce ~~for Aeronautics~~.

UNITED STATES OF AMERICA
DEPARTMENT OF COMMERCE
AERONAUTICS BRANCH

PILOT'S IDENTIFICATION CARD

This Identification Card, issued on the 6th day of April, 1927, accompanies Pilot's License No. 1

Age 38
Weight 200 Color hair Brown
Height 6' 1½" Color eyes Blue

W. P. MacCracken Jr.
Pilot's Signature.

FORM R-19
GOVERNMENT PRINTING OFFICE

Figure 1-8. *The first pilot license was issued to William P. MacCracken, Jr.*

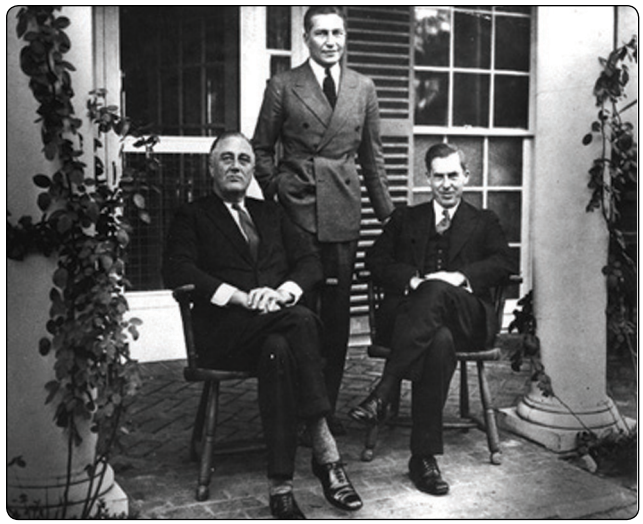


Figure 1-9. *The third head of the Aeronautics Branch, Eugene L. Vidal, is flanked by President Franklin D. Roosevelt (left) and Secretary of Agriculture Henry A. Wallace (right). The photograph was taken in 1933. During Vidal's tenure, the Aeronautics Branch was renamed the Bureau of Air Commerce on July 1, 1934. The new name more accurately reflected the status of the organization within the Department of Commerce.*

and encouraged them to form the first three Air Traffic Control (ATC) facilities along the established air routes. Then in 1936, the Bureau of Air Commerce took over the responsibilities of operating the centers and continued to advance the ATC facilities. ATC has come a long way from the early controllers using maps, chalkboards, and performing mental math calculations in order to separate aircraft along flight routes.

The Civil Aeronautics Act of 1938

In 1938, the Civil Aeronautics Act transferred the civil aviation responsibilities to a newly created, independent body, named the Civil Aeronautics Authority (CAA). This Act empowered the CAA to regulate airfares and establish new routes for the airlines to service.

President Franklin Roosevelt split the CAA into two agencies—the Civil Aeronautics Administration (CAA) and the Civil Aeronautics Board (CAB). Both agencies were still part of the Department of Commerce but the CAB functioned independently of the Secretary of Commerce. The role of the CAA was to facilitate ATC, certification of airmen and aircraft, rule enforcement, and the development of new airways. The CAB was charged with rule making to enhance safety, accident investigation, and the economic regulation of the airlines. Then in 1946, Congress gave the CAA the responsibility of administering the Federal Aid

Airport Program. This program was designed to promote the establishment of civil airports throughout the country.

The Federal Aviation Act of 1958

By mid-century, air traffic had increased and jet aircraft had been introduced into the civil aviation arena. A series of mid-air collisions underlined the need for more regulation of the aviation industry. Aircraft were not only increasing in numbers, but were now streaking across the skies at much higher speeds. The Federal Aviation Act of 1958 established a new independent body that assumed the roles of the CAA and transferred the rule making authority of the CAB to the newly created Federal Aviation Agency (FAA). In addition, the FAA was given complete control of the common civil-military system of air navigation and ATC. The man who was given the honor of being the first Administrator of the FAA was former Air Force General Elwood Richard "Pete" Quesada. He served as the administrator from 1959–1961. *[Figure 1-10]*

Department of Transportation (DOT)

On October 15, 1966, Congress established the Department of Transportation (DOT), which was given oversight of the transportation industry within the United States. The result was a combination of both air and surface transportation. Its mission was and is to serve the United States by ensuring a fast, safe, efficient, accessible, and convenient transportation system meeting vital national interests and enhancing the quality of life of the American people, then, now, and into the future. The DOT began operation on April 1, 1967. At this same time, the Federal Aviation Agency was renamed to the Federal Aviation Administration (FAA).

Figure 1-10. *First Administrator of the FAA was General Elwood Richard "Pete" Quesada, 1959–1961.*

The role of the CAB was assumed by the newly created National Transportation Safety Board (NTSB), which was charged with the investigation of all transportation accidents within the United States.

As aviation continued to grow, the FAA took on additional duties and responsibilities. With the highjacking epidemic of the 1960s, the FAA was responsible for increasing the security duties of aviation both on the ground and in the air. After September 11, 2001, the duties were transferred to a newly created body called the Department of Homeland Security (DHS).

With numerous aircraft flying in and out of larger cities, the FAA began to concentrate on the environmental aspect of aviation by establishing and regulating the noise standards of aircraft. Additionally, in the 1960s and 1970s, the FAA began to regulate high altitude (over 500 feet) kite and balloon flying. In 1970, more duties were assumed by the FAA in the addition of a new federal airport aid program and increased responsibility for airport safety.

ATC Automation

By the mid-1970s, the FAA had achieved a semi-automated ATC system based on a marriage of radar and computer technology. By automating certain routine tasks, the system allowed controllers to concentrate more efficiently on the vital task of providing aircraft separation. Data appearing directly on the controllers' scopes provided the identity, altitude, and groundspeed of aircraft carrying radar beacons. Despite its effectiveness, this system required enhancement to keep pace with the increased air traffic of the late 1970s. The increase was due in part to the competitive environment created by the Airline Deregulation Act of 1978. This law phased out CAB's economic regulation of the airlines, and CAB ceased to exist at the end of 1984.

To meet the challenge of traffic growth, the FAA unveiled the National Airspace System (NAS) Plan in January 1982. The new plan called for more advanced systems for en route and terminal ATC, modernized flight service stations, and improvements in ground-to-air surveillance and communication.

The Professional Air Traffic Controllers Organization (PATCO) Strike

While preparing the NAS Plan, the FAA faced a strike by key members of its workforce. An earlier period of discord between management and the Professional Air

Traffic Controllers Organization (PATCO) culminated in a 1970 "sickout" by 3,000 controllers. Although controllers subsequently gained additional wage and retirement benefits, another period of tension led to an illegal strike in August 1981. The government dismissed over 11,000 strike participants and decertified PATCO. By the spring of 1984, the FAA ended the last of the special restrictions imposed to keep the airspace system operating safely during the strike.

The Airline Deregulation Act of 1978

Until 1978, the CAB regulated many areas of commercial aviation such as fares, routes, and schedules. The Airline Deregulation Act of 1978, however, removed many of these controls, thus changing the face of civil aviation in the United States. After deregulation, unfettered free competition ushered in a new era in passenger air travel.

The CAB had three main functions: to award routes to airlines, to limit the entry of air carriers into new markets, and to regulate fares for passengers. Much of the established practices of commercial passenger travel within the United States went back to the policies of Walter Folger Brown, the United States Postmaster General during the administration of President Herbert Hoover. Brown had changed the mail payments system to encourage the manufacture of passenger aircraft instead of mail-carrying aircraft. His influence was crucial in awarding contracts and helped create four major domestic airlines: United, American, Eastern, and Transcontinental and Western Air (TWA). Similarly, Brown had also helped give Pan American a monopoly on international routes.

The push to deregulate, or at least to reform the existing laws governing passenger carriers, was accelerated by President Jimmy Carter, who appointed economist and former professor Alfred Kahn, a vocal supporter of deregulation, to head the CAB. A second force to deregulate emerged from abroad. In 1977, Freddie Laker, a British entrepreneur who owned Laker Airways, created the Skytrain service, which offered extraordinarily cheap fares for transatlantic flights. Laker's offerings coincided with a boom in low-cost domestic flights as the CAB eased some limitations on charter flights (i.e., flights offered by companies that do not actually own planes but leased them from the major airlines). The big air carriers responded by proposing their own lower fares. For example, American Airlines, the country's second largest airline, obtained CAB approval for "SuperSaver" tickets.

All of these events proved to be favorable for large-scale deregulation. In November 1977, Congress formally deregulated air cargo. In late 1978, Congress passed the Airline Deregulation Act of 1978, legislation that had been principally authored by Senators Edward Kennedy and Howard Cannon. *[Figure 1-11]* There was stiff opposition to the bill—from the major airlines who feared free competition, from labor unions who feared non-union employees, and from safety advocates who feared that safety would be sacrificed. Public support was, however, strong enough to pass the act. The act appeased the major airlines by offering generous subsidies and pleased workers by offering high unemployment benefits if they lost their jobs as a result. The most important effect of the act, whose laws were slowly phased in, was on the passenger market. For the first time in 40 years, airlines could enter the market or (from 1981) expand their routes as they saw fit. Airlines (from 1982) also had full freedom to set their fares. In 1984, the CAB was finally abolished since its primary duty of regulating the airline industry was no longer necessary.

The Role of the FAA

The Code of Federal Regulations (CFR)

The FAA is empowered by regulations to promote aviation safety and establish safety standards for civil aviation. The FAA achieves these objectives under the Code of Federal Regulations (CFR), which is the codification of the general and permanent rules published by the executive departments and agencies of the United States Government. The regulations are divided into 50 different codes, called Titles, that represent broad areas subject to Federal regulation. FAA regulations are listed under Title 14, "Aeronautics and Space," which encompasses all aspects of civil aviation from how to earn a pilot's certificate to maintenance of an aircraft. Title 14 CFR Chapter 1, Federal Aviation Administration, is broken down into subchapters A through N as illustrated in *Figure 1-12.*

For the pilot, certain parts of 14 CFR are more relevant than others. During flight training, it is helpful for the pilot to become familiar with the parts and subparts that relate

Figure 1-11. *President Jimmy Carter signs the Airline Deregulation Act in late 1978.*