

Pilot's Handbook of Aeronautical Knowledge

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Preface

This handbook provides the basic knowledge that is essential for pilots. It introduces pilots to the broad spectrum of knowledge that will be needed as they progress in their pilot training. Except for the Code of Federal Regulations pertinent to civil aviation, most of the knowledge areas applicable to pilot certification are presented. This handbook is useful to beginning pilots, as well as those pursuing more advanced pilot certificates.

Occasionally the word “must” or similar language is used where the desired action is deemed critical. The use of such language is not intended to add to, interpret, or relieve a duty imposed by Title 14 of the Code of Federal Regulations (14 CFR).

It is essential for persons using this handbook to become familiar with and apply the pertinent parts of 14 CFR and the Aeronautical Information Manual (AIM). The AIM is available online at www.faa.gov. The current Flight Standards Service airman training and testing material and learning statements for all airman certificates and ratings can be obtained from www.faa.gov.

This handbook supersedes FAA-H-8083-25B, Pilot’s Handbook of Aeronautical Knowledge, dated 2016; the Pilot’s Handbook of Aeronautical Knowledge Addendum A, dated February 2021; the Pilot’s Handbook of Aeronautical Knowledge Addendum B, dated January 2022; and the Pilot’s Handbook of Aeronautical Knowledge Addendum C, dated March 2023.

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Major Enhancements

This revision of the handbook has only been updated to include the following:

- Pilot's Handbook of Aeronautical Knowledge Addendum A, dated February 2021
- Pilot's Handbook of Aeronautical Knowledge Addendum B, dated January 2022
- Pilot's Handbook of Aeronautical Knowledge Addendum C, dated March 2023
- Included language to answer National Transportation Safety Board (NTSB) Safety Recommendation (SR) A-21-020

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Disclaimer: Information in Chapter 14 pertaining to Runway Incursion Avoidance was created using FAA orders, documents, and Advisory Circulars that were current at the date of publication. Users should not assume that all references are current and should check often for reference updates.

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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 Certified 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.



Information Manual (AIM)
The Information Manual is designed to provide
community with basic flight information.
Flying Handbook

Plane Flying Handbook is designed as a technical
to introduce basic flight information.
Aviation Instructor's Handbook

Aviation Instructor's Handbook provides the foundation
beginning instructors to understand and apply the

Instrument Flying Handbook

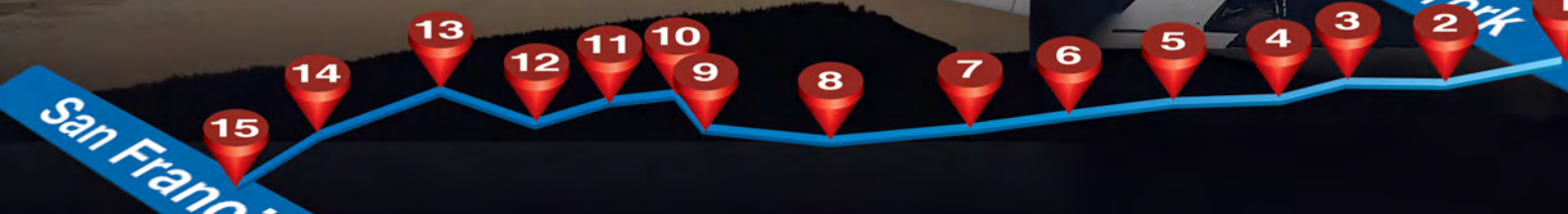
The Instrument Flying Handbook is designed for use by
instrument flight instructors and pilots preparing for

Instrument Procedures Handbook

The Instrument Procedures Handbook is designed as a
technical reference for professional pilots who operate
under IFR in the NAS and expands on information contained
in the Instrument Flying Handbook.



Code of Federal Regulations	
Aeronautics and Space	
Subchapters	Chapter 1. Federal Aviation Administration
A	Definitions (definitions and abbreviations)
B	Procedural rules (rulemaking process, claims, enforcement)
C	Aircraft (Aircraft certification procedures, Airworthiness standards [parts 25 through 39], depending on type of aircraft], airworthiness directives [39], maintenance [43], aircraft registration [47])
D	Airmen (certification of pilots and flight instructors [61], (Medical standards [67])
E	Airspace (designation of airspace, classification [71], special use airspace)
F	Air traffic and general operating and flight rules (general operating and flight rules, general traffic rules)
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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



Figure 1-1. Leonardo da Vinci’s ornithopter wings.

billowing heap of cloth capable of no more than a one-way, downwind journey.

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 Montgolfier 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.

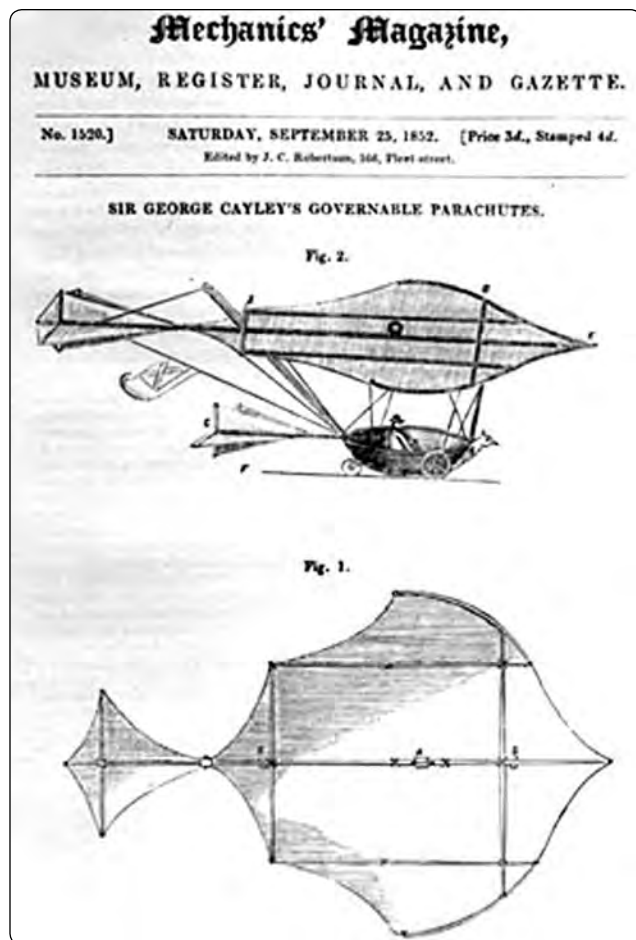


Figure 1-2. Glider from 1852 by Sir George Cayley, British aviator (1773–1857).

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]

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 1-3. First flight by the Wright brothers.



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

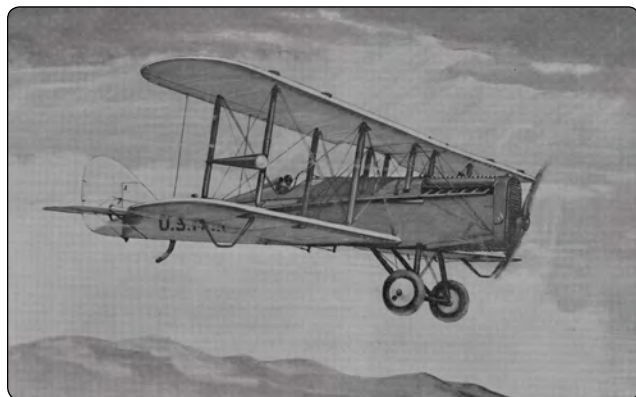


Figure 1-5. The de Havilland DH-4 on the New York to San Francisco inaugural route in 1921.



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

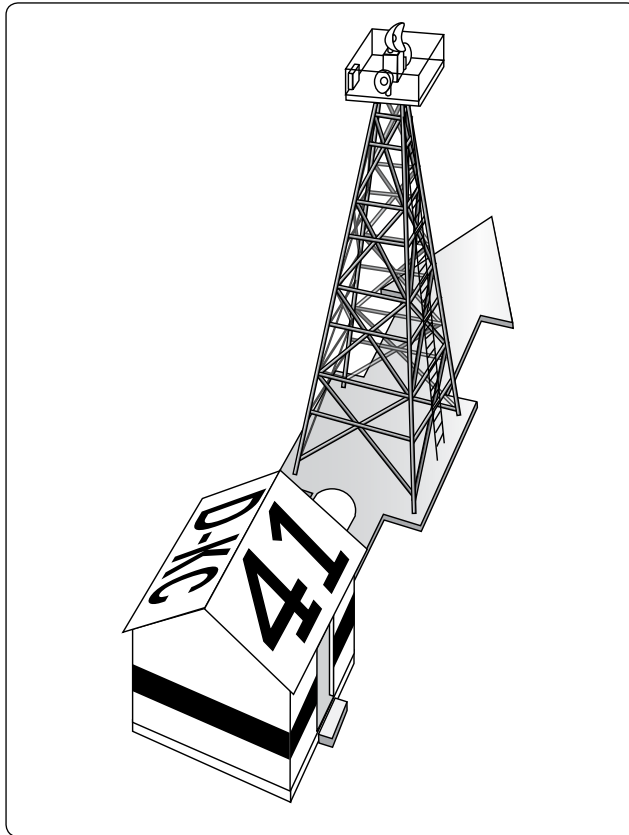


Figure 1-7. A standard airway beacon tower.

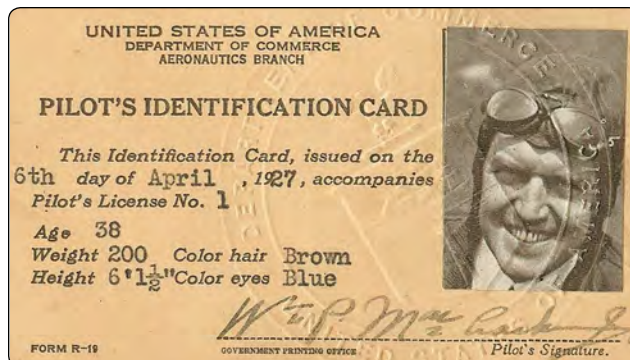


Figure 1-8. The first pilot license was issued to William P. MacCracken, Jr.



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