AIR TRANSPORT ASSOCIATION

ATA Airline Handbook

Description

The Airline Handbook provides a brief history of aviation and an overview of important aviation topics, including: the principles of flight, deregulation, the structure of the industry, airline economics, airports, air traffic control, safety, security and the environment. This publication also includes a glossary of commonly used aviation terms.

Table of Contents

Last Modified: 6/7/2008

Air Transport Association of America, Inc. ata@airlines.org

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 1

Brief History of Aviation

First Flight

On Dec. 17, 1903, Orville and Wilbur Wright capped four years of relentless research and design efforts with a 120-foot, 12-second flight at Kitty Hawk, N.C. – the first powered flight in a heavier-than-air machine. Prior to that, people had flown only in balloons and gliders.

The first person to fly as a passenger was Leon Delagrange, who rode with French pilot Henri Farman from a meadow outside of Paris in 1908. Charles Furnas became the first American airplane passenger when he flew with Orville Wright at Kitty Hawk later that year.

The first scheduled air service began in Florida on Jan. 1, 1914. Glenn Curtiss had designed a plane that could take off and land on water and thus could be built larger than any plane to date, because it did not need the heavy undercarriage required for landing on hard ground. Thomas Benoist, an auto parts maker, decided to build such a flying boat, or seaplane, to initiate air service across Tampa Bay called the St. Petersburg-Tampa Air Boat Line. His first passenger was ex-St. Petersburg Mayor A.C. Pheil, who made the 18-mile trip in 23 minutes, a considerable improvement over the two-hour trip by boat. The single-plane service accommodated one passenger at a time, and the company charged a one-way fare of $5. After operating two flights a day for four months, the company folded with the end of the winter tourist season.

World War I

These and other early flights were headline events, but commercial aviation was very slow to catch on with the general public, most of whom were afraid to ride in the new flying machines. Improvements in aircraft design also were slow. However, with the advent of World War I, the military value of aircraft was quickly recognized and production increased to meet the soaring demand for planes from governments on both sides of the Atlantic. Most significant was the development of more powerful motors, enabling aircraft to reach speeds of up to 130 miles per hour, more than twice the speed of pre-war aircraft. Increased power also made larger aircraft possible.

At the same time, the war was bad for commercial aviation in several respects. It focused all design and production efforts on building military aircraft. In the public's mind, flying became associated with bombing runs, surveillance and aerial dogfights. In addition, there was such a large surplus of planes at the end of the war that the demand for new production was almost nonexistent for several years – and many aircraft builders went bankrupt. Some European countries, such as Great Britain and France, nurtured commercial aviation by starting air service over the English Channel. However, nothing similar occurred in the United States, where there were no such natural obstacles isolating major cities and where railroads could transport people almost as fast as airplanes, and in considerably more comfort. The salvation of U.S. commercial aviation following World War I was a government program, but one that had nothing to do with the transportation of people.

Airmail

By 1917, the U.S. government felt enough progress had been made in the development of planes to warrant something totally new – the transport of mail by air. That year, Congress appropriated $100,000 for an experimental airmail service to be conducted jointly by the Army and the Post Office between Washington, D.C. and New York, with an intermediate stop in Philadelphia. The first flight left Belmont Park, Long Island for Philadelphia on May 14, 1918, and the next day continued on to Washington, where it was met by President Woodrow Wilson.

With a large number of war-surplus aircraft in hand, the Post Office set its sights on a far more ambitious goal – transcontinental air service. It opened the first segment, between Chicago and Cleveland, on May 15, 1919, and completed the air route on Sept. 8, 1920, when the most difficult part of the route, the Rocky Mountains, was spanned. Airplanes still could not fly at night when the service began, so the mail was handed off to trains at the end of each day. Nonetheless, by using airplanes the Post Office was able to shave a remarkable 22 hours off coast-to-coast mail deliveries.

Beacons

In 1921, the Army deployed rotating beacons in a line between Columbus and Dayton, Ohio, a distance of about 80 miles. The beacons, visible to pilots at 10-second intervals, made it possible to fly the route at night.

The Post Office took over the operation of the guidance system the following year and, by the end of 1923, constructed similar beacons between Chicago and Cheyenne, Wyo., a line later extended coast to coast at a cost of $550,000. Mail then could be delivered across the continent in as little as 29 hours eastbound and 34 hours westbound, shaving two days off the time the trip took by train. Prevailing winds from west to east accounted for the directional difference.

The Contract Air Mail Act of 1925

By the mid-1920s, the Post Office mail fleet was flying 2.5 million miles and delivering 14 million letters annually. However, the government had no intention of continuing airmail service on its own. Traditionally, the Post Office had used private companies to transport mail. Once the feasibility of airmail was firmly established and airline facilities were in place, the government moved to transfer airmail service to the private sector by way of competitive bids. The legislative authority for the move was granted by the *Contract Air Mail Act of 1925*, commonly referred to as the Kelly Act after its chief sponsor, Rep. Clyde Kelly of Pennsylvania. This was the first major step toward the creation of a private U.S. airline industry. The initial five contracts were awarded to: National Air Transport (owned by the Curtiss Aeroplane Co.), Varney Air Lines, Western Air Express, Colonial Air Transport and Robertson Aircraft Corporation. National and Varney would later become important parts of United Air Lines (originally a joint venture of the Boeing Airplane Company and Pratt & Whitney). Western would merge with Transcontinental Air Transport (TAT), another Curtiss subsidiary, to form Transcontinental and Western Air (TWA). Robertson would become part of the Universal Aviation Corporation, which in turn would merge with Colonial, Southern Air Transport and others, to form American Airways, the predecessor of American Airlines. Juan Trippe, one of the original partners in Colonial, later pioneered international air travel with Pan Am – a carrier he founded in 1927 to transport mail between Key West, Fla., and Havana, Cuba. Pitcairn Aviation, yet another Curtiss subsidiary that got its start transporting mail, would become Eastern Air Transport, the predecessor of Eastern Air Lines.

The Morrow Board

The same year Congress passed the *Contract Air Mail Act*, President Calvin Coolidge appointed a board to recommend a national aviation policy (a much-sought-after goal of then Secretary of Commerce Herbert Hoover). Dwight Morrow, a senior partner in J.P. Morgan’s bank, and later the father-in-law of Charles Lindbergh, was named chairman. The board, popularly known as the Morrow Board, heard testimony from 99 people and, on Nov. 30, 1925, submitted its report to President Coolidge. The report was wide-ranging, but its key recommendation was that the government should set standards for civil aviation and that the standards should be set outside of the military.

The Air Commerce Act of 1926

Congress adopted the recommendations of the Morrow Board almost to the letter in the *Air Commerce*

Act of 1926. The legislation authorized the Secretary of Commerce to designate air routes, to develop air navigation systems, to license pilots and aircraft and to investigate accidents. The act brought the government into commercial aviation as regulator of the private airlines that the Kelly Act of the previous year had spawned.

Congress also adopted the Board’s recommendation for airmail contracting by amending the Kelly Act to change the method of compensation for airmail services. Instead of paying carriers a percentage of the postage paid, the government would pay them according to the weight of the mail. This simplified payments and proved highly advantageous to the carriers, which collected $48 million from the government for the carriage of mail between 1926 and 1931.

Ford's Tin Goose

Henry Ford, the automobile manufacturer, was also among the early successful bidders for airmail contracts, winning the right, in 1925, to carry mail from Chicago to Detroit and Cleveland aboard planes his company already was using to transport parts for his automobile assembly plants. More importantly, he jumped into aircraft manufacturing and, in 1927, produced the Ford Trimotor, commonly referred to as the Tin Goose. It was one of the first all-metal planes, made of a new material, duralumin, which was almost as light as aluminum but twice as strong. It also was the first plane designed primarily to carry passengers rather than mail. The Ford Trimotor had 12 passenger seats, a cabin high enough for a passenger to walk down the aisle without stooping, and room for a "stewardess" or flight attendant (the first of whom were nurses hired by United in 1930) to serve meals and assist airsick passengers. The Tin Goose’s three engines made it possible to fly higher and faster (up to 130 miles per hour), and its sturdy appearance, combined with the Ford name, had a reassuring effect on the public’s impression of flying. However, it was another event in 1927 that brought unprecedented public attention to aviation and helped secure the industry’s future as a major mode of transportation.

Charles Lindbergh

At 7:52 a.m. on May 20, 1927, a young pilot named Charles Lindbergh set out on an historic flight across the Atlantic Ocean, from New York to Paris. It was the first transatlantic nonstop flight in an airplane, and its effect on both Lindbergh and aviation was enormous. Lindbergh became an instant American hero. Aviation became a more established industry, attracting millions of private investment dollars almost overnight, as well as the support of millions of Americans.

The pilot who sparked all of this attention had dropped out of engineering school at the University of Wisconsin to learn to fly. He became a barnstormer, doing aerial shows across the country, and eventually joined the Robertson Aircraft Corporation to fly mail between St. Louis and Chicago.

In planning his transatlantic voyage, Lindbergh daringly decided to fly by himself, without a navigator, so he could carry more fuel. His plane, *the Spirit of St. Louis*, was slightly less than 28 feet in length, with a wingspan of 46 feet. It carried 450 gallons of gasoline, which constituted half its takeoff weight. There was too little room in the cramped cockpit for navigating by the stars, so Lindbergh flew by dead reckoning. He divided maps from his local library into thirty-three 100-mile segments, noting the heading he would follow as he flew each segment. When he first caught sight of the coast of Ireland, he was almost exactly on the route he had plotted, and he landed several hours later, with 80 gallons of fuel to spare.

Lindbergh’s greatest enemy on his journey was fatigue. The trip took an exhausting 33 hours, 29 minutes and 30 seconds, but he managed to remain awake by sticking his head out of the window to inhale cold air, by holding his eyelids open, and by constantly reminding himself that if he fell asleep he would perish. In addition, he had a slight instability built into his airplane, which helped keep him focused and awake.

Lindbergh landed at Le Bourget Field, outside of Paris, at 10:24 p.m. Paris time on May 21. Word of his flight preceded him and a large crowd of Parisians rushed out to the airfield to see him and his little plane. There was no question about the magnitude of what he had accomplished. The age of aviation had arrived.

The Watres Act and the Spoils Conference

In 1930, Postmaster General Walter Brown pushed for legislation that would have another major impact on the development of commercial aviation. Known as the *Watres Act* (after one of its chief sponsors, Rep. Laurence H. Watres of Pennsylvania), it authorized the Post Office to enter into longer-term contracts for airmail, with rates based on space or volume rather than weight. In addition, the act authorized the Post Office to consolidate airmail routes where it was in the national interest to do so. Brown believed that the changes would promote larger, stronger airlines, as well as expanded coast-to-coast and nighttime service.

Immediately after Congress approved the act, Brown held a series of meetings in Washington to discuss the new contracts. The meetings were later dubbed the *Spoils Conference* because Brown gave them little publicity and directly invited only a handful of people from the larger airlines. He designated three transcontinental mail routes and made it clear that he wanted only one company operating each service, rather than a number of small airlines handing the mail off to one another. His actions brought political trouble that, two years later, resulted in major changes to the system.

Scandal and the Air Mail Act of 1934

Following the Democratic landslide in the election of 1932, some of the smaller airlines began complaining to news reporters and politicians that they had been unfairly denied airmail contracts by Brown. One reporter discovered that a major contract had been awarded to an airline whose bid was three times higher than a rival bid from a smaller airline. Congressional hearings followed, chaired by Sen. Hugo Black of Alabama, and by 1934 the scandal had reached such proportions as to prompt President Franklin Roosevelt to cancel all mail contracts and turn mail deliveries over to the Army.

The decision was a tragic mistake. The Army pilots were unfamiliar with the mail routes and the weather at the time they took over the deliveries, February 1934, was terrible. There were a number of accidents as the pilots flew practice runs and began carrying the mail, leading to newspaper headlines that forced President Roosevelt to retreat from his plan only a month after he had turned the mail over to the Army.

By means of the *Air Mail Act of 1934*, the government returned airmail services to the private sector, but it did so under a new set of rules that would have a significant impact on the industry. Bidding was structured to be more competitive and former contract holders were not allowed to bid at all, so many companies were reorganized. The result was a more even distribution of the government's mail business and lower mail rates that forced airlines and aircraft manufacturers to pay more attention to the development of the passenger side of the business.

In another major change, the federal government directed the dismantling of the vertical holding companies common up to that time in the industry, sending aircraft manufacturers and airline operators (most notably Boeing, Pratt & Whitney and United Air Lines) their separate ways. The entire industry was now reorganized and refocused.

Aircraft Innovations

For the airlines to attract passengers away from the railroads, they needed larger and faster airplanes. They also needed safer airplanes. Notorious accidents, such as the one in 1931 that killed Notre Dame Football Coach Knute Rockne and six others, kept people from flying.

Aircraft manufacturers responded to the challenge. There were so many improvements to aircraft in the 1930s that many believe it was the most innovative period in aviation history. Air-cooled engines replaced water-cooled engines, reducing weight and making larger, faster planes possible. Cockpit instruments also improved, with better altimeters, airspeed indicators, rate-of-climb indicators, compasses and the introduction of artificial horizon, which showed pilots the attitude of the aircraft relative to the ground – important for flying in reduced visibility.

Radio

Another development of enormous importance to aviation was radio. Aviation and radio developed almost in lock step. Guglielmo Marconi sent his first message across the Atlantic on the airwaves just two years before the Wright Brothers' first flight at Kitty Hawk, on the outer banks of North Carolina. By World War I, some pilots were taking radios up in the air so they could communicate with people on the ground. The airlines followed suit after the war, using radio to transmit weather information from the ground to their pilots so they could avoid storms. The first air traffic control tower was established in 1935 at what is now Liberty International Airport in Newark, N.J.

In the mid 1930s, technology changes enabled navigation via radio beacon signals, and in May 1941, the Civil Aeronautics Administration (CAA) approved an ultrahigh-frequency (UHF) radio range for scheduled airline navigation. This evolved into a very high frequency (VHF) omni-directional radio range (VOR) system that allowed pilots to navigate via their instrument panels.

The First Modern Airliners

Boeing built what generally is considered the first modern passenger airliner, the Boeing Model 247. It was unveiled in 1933 and United Air Lines promptly bought 60 of them. Based on a low-wing, twin-engine bomber with retractable landing gear built for the military, the Model 247 accommodated 10 passengers and cruised at 155 miles per hour. Its cabin was insulated to reduce engine noise levels inside the plane, and it featured such amenities as upholstered seats and a hot-water heater to make flying more comfortable for passengers. Eventually, Boeing also gave the 247 variable-pitch propellers, which reduced takeoff distances, increased the rate of climb and boosted cruising speeds.

Not to be outdone by United, TWA went searching for an alternative to the 247 and eventually found what it wanted from the Douglas Aircraft Company. Its DC-1 incorporated and improved on many of Boeing's innovations. The DC-1 had more powerful engines and accommodations for two more passengers than did the 247. More importantly, the airframe was designed so that the skin of the aircraft bore most of the stress on the plane during flight. There was no interior skeleton of metal spars, giving passengers more room than they had in the 247.

The DC-1 also was easier to fly. It was equipped with the first automatic pilot and the first efficient wing flaps, for added lift during takeoff and added drag during landing. However, for all its advancements, only one DC-1 was ever built. Douglas decided almost immediately to improve its design, adding 18 inches to its length so it could accommodate two more passengers. The new, longer version was called the DC-2 and was a big success, but the best was still to come.

The DC-3

Called *the plane that changed the world*, the DC-3 was the first aircraft to enable airlines to make money carrying passengers. As a result, it quickly became the dominant aircraft in the United States, following its debut in 1936 with American Airlines (which played a key role in its design).

The DC-3 had 50 percent greater passenger capacity than the DC-2 (21 seats versus 14), yet cost only 10 percent more to operate. It also was considered a safer plane, built of an aluminum alloy stronger than materials previously used in aircraft construction. It had more powerful engines (1,000 horsepower versus 710 horsepower for the DC-2), and it could travel coast to coast in only 16 hours – a fast trip at that time.

Another important improvement was the use of a hydraulic pump to raise and lower the landing gear. This freed pilots from having to crank the gear up and down during takeoffs and landings. For greater passenger comfort, the DC-3 had a noise-deadening plastic insulation and seats set in rubber to minimize vibrations. It was a fantastically popular airplane and it helped attract many new travelers to flying.

Pressurized Cabins

Although planes such as the Boeing 247 and the DC-3 represented significant advances in aircraft design, they had one major drawback. They could fly no higher than 10,000 feet, because people became dizzy and even fainted due to diminished levels of oxygen at higher altitudes.

The airlines wanted to fly higher, to get above the air turbulence and storms common at lower altitudes, as well as the mountainous terrain in some parts of the country. Motion sickness was a problem for many airline passengers and inhibited the industry’s growth.

The breakthrough came at Boeing with the B-307 Stratoliner, a derivation of the B-17 bomber introduced in 1940 and first flown by Transcontinental & Western Air (TWA). It was the first pressurized aircraft, meaning that air was pumped into the aircraft as it gained altitude to maintain an atmosphere inside the cabin similar to the atmosphere that occurs naturally at lower altitudes. With its regulated air compressor, the 33-seat Stratoliner could fly as high as 20,000 feet and reach speeds of 200 miles per hour.

The Air Transport Association (ATA)

The Air Transport Association was founded on Jan. 3, 1936. Representatives of 17 airlines met in Chicago to draw up a set of objectives for a new organization, whose purpose was "to do all things tending to promote the betterment of airline business, and in general, to do everything in its power to best serve the interest and welfare of the members of the association and the public at large." Today, the Air Transport Association of America, Inc. is the nation's oldest and largest airline trade association, fostering a business and regulatory environment that ensures safe and secure air transportation and enables U.S. airlines, passenger and cargo, to flourish, stimulating economic growth locally, nationally and internationally. Throughout its 70-year history, ATA and its member airlines have played a vital role in shaping the future of air transportation.

The Civil Aeronautics Act of 1938

Government decisions continued to prove as important to aviation’s future as technological breakthroughs, and one of the most important aviation bills ever enacted by Congress was the *Civil Aeronautics Act of 1938*. Until that time, numerous government agencies and departments had a hand in aviation policy. Airlines sometimes were pushed and pulled in several directions and there was no central agency working for the long-term development of the industry. All the airlines had been losing money because the postal reforms in 1934 significantly reduced the amount they were paid for carrying the mail.

The airlines wanted more rationalized government regulation, through an independent agency, and the *Civil Aeronautics Act* gave them what they needed. It created the Civil Aeronautics Authority (CAA) and gave the new agency power to regulate airline fares, airmail rates, interline agreements, mergers and routes. Its mission was to preserve order in the industry, holding rates to reasonable levels while, at the same time, nurturing the still financially shaky airline industry, thereby encouraging the development of commercial air transportation.

Congress created a separate agency – the Air Safety Board – to investigate accidents. In 1940, however, President Roosevelt convinced Congress to transfer the accident investigation function to the CAA and split the Authority into two agencies: the Civil Aeronautics Administration (CAA) and the Civil Aeronautics Board (CAB). The CAA was responsible for air traffic control (ATC), certification, safety enforcement and airway development. The CAB was responsible for safety rulemaking, accident investigation, and economic regulation of the airlines. These moves, coupled with the tremendous progress made on the technological front, put the industry on the road to success.

World War II

Aviation had an enormous impact on the course of World War II, and the war had just as significant an impact on aviation. There were fewer than 300 air transport aircraft in the United States when Adolf Hitler marched into Poland in 1939. By the end of the war, U.S. aircraft manufacturers were producing 50,000 planes a year.

Most of the planes, of course, were fighters and bombers, but the importance of air transports to the war effort quickly became apparent as well. Throughout the war, the airlines provided much needed airlift to keep troops and supplies moving – to the front and throughout the production chain back home. For the first time in their history, the airlines had far more business – for passengers as well as freight – than they could handle. Many of them also had opportunities to pioneer new routes, gaining an exposure that would give them a decidedly broader outlook at war's end.

While there were numerous advances in U.S. aircraft design during the war – enabling planes to go faster, higher and farther than ever before – mass production was the chief goal of the United States. The major innovations of the wartime period – radar and jet engines – began in Europe.

The Jet Engine

Isaac Newton was the first to theorize, in the 18th century, that a rearward-channeled explosion could propel a machine forward at a great rate of speed. However, no one found a practical application for the theory until Frank Whittle, a British pilot, designed the first jet engine in 1930. Even then, widespread skepticism about the commercial viability of a jet prevented Whittle's design from being tested for several years.

The Germans were the first to build and test a jet aircraft. Based on a design by Hans von Ohain, a student whose work was independent of Whittle's, it flew in 1939, although not as well as the Germans had hoped. It would take another five years for German scientists to perfect the design. Fortunately, by that time, it was too late to affect the outcome of the war.

Meanwhile, Whittle improved his jet engine during the war, and in 1942 he shipped an engine prototype to General Electric in the United States. America's first jet plane – the Bell P-59 – was built later that year.

Radar

Another important technological development with a much greater impact on the war's outcome (and later on commercial aviation) was radar. British scientists had been working on a device that could give them early warning of approaching enemy aircraft even before the war began, and by 1940 Britain had a line of radar stations along its east coast that could detect German aircraft the moment they took off from the Continent. British scientists also perfected the cathode ray oscilloscope, which produced map-type outlines of surrounding countryside and showed aircraft as pulsing lights. Americans, meanwhile, found a way to distinguish enemy aircraft from allied aircraft by installing what are now known as transponders, which signaled their identity to radar operators.

Dawn of the Jet Age

Aviation was poised to advance rapidly following the war, in large part because of the development of jets, but there still were significant problems to overcome. In 1952, a 36-seat British-made commercial jet, the Comet, flew from London to Johannesburg, South Africa, at speeds as high as 500 miles per hour. Two years later, the Comet's career ended abruptly following two back-to-back accidents in which the fuselage burst apart during flight – the result of metal fatigue.

The Cold War between the Soviet Union and the United States, following World War II, helped secure the funding needed to solve such problems and advance the jet's development. Most of the breakthroughs related to military aircraft and later were applied to the commercial sector. For example, Boeing employed a sweptback wing design for its B-47 and B-52 bombers to reduce drag and increase speed. Later, the design was incorporated into commercial jets, making them faster and therefore more attractive to passengers. The best example of military-civilian technology transfer was the jet tanker that Boeing designed for the Air Force to refuel bombers in flight. The tanker, the KC-135, was a huge success as a military plane, but even more successful when revamped and introduced, in 1958, as the first U.S. passenger jet, the Boeing 707. With a length of 125 feet and four engines with 17,000 pounds of thrust each, the 707 could carry up to 181 passengers and travel at speeds of 550 miles per hour. Its engines proved more reliable than piston-driven engines – producing less vibration, putting less stress on the plane's airframe and reducing maintenance expenses. They also burned kerosene, which cost half as much as the high-octane gasoline used in more traditional planes. With the 707, first ordered and operated by Pan American World Airways, all questions about the commercial feasibility of jets were answered. The Jet Age had arrived, and other airlines soon were lining up to buy the new aircraft.

The Federal Aviation Act of 1958

Following World War II, air travel soared, but with the industry's growth came new problems. In 1956 two airline aircraft collided over the Grand Canyon, killing 128 people. The skies were getting too crowded for existing systems of aircraft separation, and Congress responded by passing the *Federal Aviation Act of 1958*.

The legislation created a new safety regulatory agency, the Federal Aviation Agency, later called the Federal Aviation Administration (FAA) when Congress authorized the creation of the Department of Transportation (DOT) in 1966. The agency was charged with establishing and running a broad air traffic control system, to maintain safe separation of all commercial aircraft through all phases of flight. In addition, it assumed jurisdiction over all other aviation safety matters, such as the certification of aircraft designs, and airline training and maintenance programs. The Civil Aeronautics Board retained jurisdiction over economic matters, such as airline routes and rates.

Wide-Bodies and Supersonics

The year 1969 marked the debut of another revolutionary aircraft, the Boeing 747, which Pan Am again was the first to purchase and fly in commercial service. It was the first wide-body jet, with four engines, two aisles in its main deck cabin and a distinctive upper deck over the front section of the fuselage. With seating for as many as 450 passengers, it was twice as big as any other Boeing jet and 80 percent bigger than the largest jet up until that time, the DC-8.

Recognizing the economies of scale to be gained from larger jets, other aircraft manufacturers quickly followed suit. Douglas built its first wide-body, the DC-10, in 1970. Only a month later, Lockheed flew its first contender in the wide-body market, the L-1011. Both of these jets had three engines (one under each wing and one on the tail) and were smaller than the 747, seating about 250 passengers.

During the same period, efforts were underway in both the United States and Europe to build a supersonic commercial aircraft. The Soviet Union was the first to succeed, testing the Tupolev 144 in December 1968. A consortium of West European aircraft manufacturers first flew the Concorde two months later and eventually produced a number of those fast, but small, jets for commercial service. U.S. efforts, on the other hand, stalled in 1971 due to public concern about its expense and the sonic boom produced by such aircraft.

Chapter 2

Last Modified: 2/4/2009

Air Transport Association of America, Inc. ata@airlines.org

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 2

Economic Deregulation

Airline Deregulation

The Airline Deregulation Act

Today's airline industry has changed radically since 1978. Previously, the industry resembled a public utility, because a government agency, the Civil Aeronautics Board (CAB), determined the routes each airline flew and the fares that it could charge. Today, the market drives the industry, with customer demand and airline network competition determining prices and the level of service.

The turning point was the *Airline Deregulation Act*, approved by Congress on Oct. 24, 1978, and signed into law four days later by President Jimmy Carter. Pressure for airline deregulation had been building for many years, particularly among economists who pointed out that numerous studies showed that unregulated intrastate airfares were substantially lower than fares for interstate flights of comparable distances. However, it was a series of developments in the mid-1970s that intensified the pressure and brought the issue to a head.

Events Leading to Deregulation

One of those developments was the advent of wide-body aircraft, which significantly increased airline capacity on many routes, making it harder for airlines to recover the cost of extra seats in the market without adjusting pricing. Another was the Arab oil embargo in 1973, which led to skyrocketing fuel costs and inflation. These events placed a severe strain on the airlines as passenger demand fell while capacity and fuel prices rose. Also, the CAB had become increasingly unwieldy and many observed that consumers traveling in intrastate domestic markets, which were not regulated by the CAB, typically enjoyed lower fares.

In line with its mandate to ensure a reasonable rate of return for the carriers, the CAB responded by allowing carriers to increase fares and approved a series of agreements among the carriers to limit capacity on major routes. These actions occurred in the middle of a four-year moratorium on authorizing new routes.

None of these moves, which made flying more costly, was popular with the public; it cost more to fly. Furthermore, the CAB action did little to improve the carriers' financial picture. Despite fare increases and capacity constraints, earnings were poor throughout the mid-1970s.

In 1974, the Ford Administration began to press for governmental regulatory reforms, in response to growing public sentiment that existing regulations were overly burdensome to U.S. industry and contributed significantly to inflation. Shortly thereafter, Senator Edward Kennedy chaired hearings of the Senate Subcommittee on Administrative Practice and Procedure that concluded airline prices in particular would fall automatically if government constraints on competition were lifted.

The staff of the CAB reached the same conclusion in a report issued in 1975. The report said the industry was "naturally competitive, not monopolistic," and that the CAB itself could no longer justify entry controls or public utility-type pricing. On its own, the Board began to loosen its grip on the industry, acting at first under the leadership of John E. Robson, and later under Alfred E. Kahn, who became CAB chairman in 1977. Mr. Kahn, an economist, persuasively argued that the board should give the airlines greater pricing freedom and easier access to routes.

Air Cargo Deregulation

Congress took the first legislative steps toward airline economic deregulation in November 1977, when it gave cargo carriers freedom to operate on any domestic route and charge whatever the market would bear. Congress also declared that one year following enactment of the bill, the CAB could certify new domestic cargo carriers, as long as they were found "fit, willing, and able." No longer would there have to be the more demanding, and therefore restrictive, finding of public convenience and necessity.

Express Package Delivery

There was another important development following cargo deregulation – the rapid expansion of overnight delivery of documents and small packages.

Deregulation produced dramatic results for all aspects of the cargo business, but particularly for express package delivery. Overnight delivery of high-value and time-sensitive packages and documents began in the early 1970s. However, it was deregulation that really opened the door to success for such services. Deregulation gave express carriers the operating freedom that such high-quality services demand, resulting in outstanding growth over the next decade.

In 1994, Congress further encouraged the development of this part of the airline industry by preempting state efforts to regulate intrastate air/truck freight and air express package shipments.

Passenger Deregulation

The same principle of free-market competition was applied to the passenger side of the business in the *Airline Deregulation Act of 1978*. Congress mandated that domestic route and rate restrictions be phased out over four years. It provided for complete elimination of restrictions on routes and new services by Dec. 31, 1981, and the end of all rate regulation by Jan. 1, 1983. The CAB actually moved more quickly than that. It began granting new route authority so readily that within a year of the law's passage carriers were able to launch virtually any domestic service they wanted.

The CAB ceased to exist on Jan. 1, 1985, although several board functions shifted to other government agencies, primarily the Department of Transportation.

What Remains Regulated

International Aviation

Among the CAB functions transferred to the Department of Transportation (DOT) was the authority to select carriers to serve limited-entry international markets, to enforce fair competitive practices in international markets, and to review tariffs for foreign air transportation. Certain other international functions, including reviewing merger proposals, evaluating inter-carrier agreements and granting antitrust immunity remain with the DOT.

International aviation services are usually governed by bilateral air-transport service agreements that are negotiated between two countries. Bilateral civil aviation negotiations involving the United States are led by a team from the Department of State and the Department of Transportation. Traditionally, bilateral agreements specify how many airlines from each country may operate, what routes may be flown, which cities may be served, how many times per week an airline may operate, how prices may be determined, and whether or not an airline can pick up passengers and/or cargo in that country and transport it to a third country.

In the 1990s, the United States made a concerted effort to liberalize its international aviation policy and achieve an open aviation regime worldwide, recognizing the importance of aviation with respect to the globalization of the world economy. Since the first "Open Skies" agreement was signed in 1992 (with the Netherlands), this effort has been very successful, and as of January 2007, the United States had concluded 78 “Open Skies” agreements, which reduce government interference in airline business decisions and allow airlines to offer more affordable, convenient and plentiful service for consumers.

“Open Skies” agreements can be either bilateral or multilateral; such an agreement allows an airline designated by the United States and the foreign signatory unlimited access to points in each partner’s country and unlimited access to intermediate and beyond points. Airlines are free to make their own market decisions on routes, capacity and pricing. Moreover, “Open Skies” agreements have liberalized conditions for passenger, all-cargo and charter operations, as well as for cooperative marketing agreements.

In cases where the bilateral agreements are less liberal and restrictions exist, U.S. policy is to withhold liberal access to the U.S. market from those countries. In those agreements where limited or restricted opportunities are imposed on U.S. airlines by a bilateral partner’s country, DOT will determine which airline or airlines are awarded operating authority based on a legal proceeding. Interested U.S. airlines must compete for the limited authority by presenting a case demonstrating why they should be awarded the limited right.

“Open Skies” agreements have been very successful in increasing international trade and tourism, improving industry productivity and facilitating economic growth.

Antitrust Exemption

The CAB, because of its comprehensive regulatory jurisdiction over the airline industry, had the authority to approve agreements between airlines and to grant antitrust immunity to those transactions that it approved. With the sunset of the CAB, DOT received the authority to approve and immunize agreements affecting international air transportation; however, the authority over domestic transactions lapsed.

Essential Air Service

Another function assigned to DOT with the demise of the CAB was the responsibility for maintaining air service to small communities. With carriers free to fly wherever they want and set prices accordingly, Congress anticipated that some of the lightly traveled and unprofitable routes would lose commercial air service. To assure appropriate service, Congress established the Essential Air Service program, which provides subsidies to carriers willing to serve domestic locations that otherwise would be economically challenging to serve. DOT administers the program, determining subsidy levels and soliciting bids from carriers.

Safety

As Chapter 6 explains in greater detail, the government continues to regulate the airlines on all matters affecting safety. The government has performed this regulatory role since 1926, and continues to do so through the Federal Aviation Administration. The *Airline Deregulation Act* ended economic regulation of airline routes and rates, but not airline safety.

Effects of Deregulation

Hub and Spoke Networks

A major development that followed deregulation was the widespread development of hub-and-spoke networks, which existed on a more limited basis prior to 1978. Hubs are strategically located airports used as transfer points for passengers and cargo traveling from one community to another. Airlines schedule banks of flights into and out of their hubs several times a day. Each bank includes dozens of planes arriving within minutes of each other. Once on the ground, the arriving passengers and cargo from those flights are transferred conveniently to other planes that will take them to their final destinations. Although some airlines have de-peaked operations at certain hubs by spreading arrivals and departures more evenly throughout the day, connecting banks remains a key component of hub-and-spoke operations.

Airlines developed hub-and-spoke networks in order to efficiently serve far more markets with a given fleet size than they could if they only offered direct, point-to-point service. At a hub, local and connecting travelers benefit from high-frequency service throughout the day to many different domestic and international cities.

Carriers also found that hub-and-spoke systems allowed them to achieve higher load factors (percentage of seats filled) on flights to and from small cities, which in turn enabled them to offer lower fares to achieve route profitability. For example, a city of 100,000 residents is unlikely to generate enough passengers to any single destination to fill more than a handful of seats aboard a commercial jet; however, that city may very well generate passengers going to a number of different destinations. Operating a jet into a hub, where passengers can connect to dozens of different cities, therefore, makes economic sense for smaller markets.

Most of the major airlines maintain hub-and-spoke systems, with hubs in several locations across the United States. Geographic location, of course, is a prime consideration in deciding where to put a hub. Another is the size of the local market. Airlines prefer to locate their hub airports at cities where there already is significant “origin and destination” traffic (as opposed to connecting traffic) to help support their flights.

New Carriers

Deregulation did more than prompt a reshuffling of service by existing carriers. It opened the airline business to newcomers just as Congress intended. In 1978, there were 43 carriers certified for scheduled service with large aircraft. By contrast, in 2005, there were 139 certificated U.S. air carriers. The number has fluctuated over the years with changing market conditions. Since 1990, there has been a wave of new airlines operating different business models ranging from low-cost hub-and-spoke and point-to-point network operators to regional carriers operating smaller aircraft for their mainline network partners. At any given time, dozens of start-ups await approval of applications pending with DOT.

Increased Competition

The appearance of new airlines, combined with the rapid expansion into new markets by many of the established airlines, resulted in unprecedented competition in the industry. Today, the overwhelming majority of U.S. airline passengers have a choice of two or more carriers, compared with only two-thirds in 1978. The airlines compete intensely with one another in virtually all major markets. The advent of overlapping national aviation networks resulted in increasing competition in hundreds of small markets that would not normally support competitive service with a linear route system. Proportionately, the biggest increase in competition occurred in the small and medium-sized markets.

Discount Fares

Increased competition spawned discount fares, which travelers found to be the most important benefit of airline deregulation. Fares have declined more than 50 percent in real terms since deregulation in 1978. They have become so low, in fact, that interstate bus and rail service has been hard-pressed to compete with the airlines, which today provide the primary means of long-distance transportation between cities in the United States.

In 2000, in *Deregulation of Network Industries: What’s Next*, economists Steven Morrison and Clifford Winston noted that, “Accounting for fare and service quality changes, the annual benefits to travelers from airline deregulation currently exceed $20 billion.” While the real reductions in fares were “widely shared,” Morrison and Winston also note that travelers “gained substantially from the increase in flight frequency facilitated by the acceleration of hub-and-spoke operations.”

Growth in Air Travel

With greater competition on the vast majority of routes, extensive discounting and more available flights, air travel has grown rapidly since deregulation. In 1977, the last full year of government economic regulation of the airline industry, U.S. airlines carried 240 million passengers in scheduled service. In 2005 they carried 739 million. In a 2006 survey, the Travel Industry Association of America (TIA) found that 38 percent of Americans took a trip by air in 2005.

Frequent Flyer Loyalty Programs

Deregulation also sparked marketing innovations, the most noteworthy being frequent flyer loyalty programs, which reward customer loyalty with tickets, cabin upgrades, priority check-in, priority boarding, lounge access and other benefits. Most airlines have such a program and the essential elements are the same. Once customers enroll, they can earn points for the number of miles flown or the number of trips taken on the sponsoring carrier or its partners. These points are then redeemed for rewards that include tickets and upgrades.

A more recent development has been the growth of partnership marketing arrangements tied to frequent flyer loyalty programs. Because of their extensive membership rolls, frequent flyer programs are very attractive to non-airline companies who are willing to pay for the privilege of participating in them as marketing partners. In addition, the airline benefits as its loyalty program becomes more attractive through its relationship with partners: it is now possible to earn frequent flyer points by purchasing non-airline goods and services and redeem points for non-airline products. Typically, a partner company will pay the host airline one to two cents per mile earned when a frequent flyer member uses the partner’s goods or services, but such arrangements vary by airline and partner.

Frequent flyer programs are now integral to an airline’s product offering, complementing convenient schedules, price, safety and customer service. Alliances have increased the popularity of such loyalty programs by extending reciprocal benefits to customers of member airlines.

Global Distribution Systems (GDS)

Another important development following deregulation was the advent of computer reservation systems (CRS). These systems helped airlines and travel agents keep track of fare and service changes, and more efficiently process hundreds of millions of passengers worldwide.

Several major airlines developed their own systems and later sold partnerships in them to other airlines. The systems listed not only the schedules and fares of their airline owners, but also those of any other airline willing to pay a fee to have their flights listed. Travel agents also paid fees to access the systems.

In the 1990s, airlines began to divest from their computer reservation systems, allowing the systems to become independent businesses. The systems became known as global distribution systems (GDS) because of their increased functionality. For example, individual travelers access a GDS when booking a trip online. In addition, a GDS can be used to purchase hotel stays, rental cars and other travel services.

As airlines sold their stakes in GDS, the U.S. Department of Transportation reevaluated the set of rules that regulated the system. These rules had been designed to protect consumers by mandating, for example, that systems be objective and unbiased and that participation in each GDS be open to all carriers on a nondiscriminatory basis. DOT regulations also required that GDS information and booking functions provided for each airline be as reliable and current as they were for the owner airline. After the ownership link between airlines and GDS was severed, DOT determined that the GDS market should be liberalized to ensure that government regulation would not interfere with market forces and innovation in the GDS and airline distribution businesses, and to allow the various systems to better compete with one another. By mid-2004, all of the rules governing the systems had been terminated.

Code Sharing

Another innovation has been the development of code-sharing agreements. Code-sharing agreements allow two (or more) airlines to offer a broader array of services to their customers than they could individually. These marketing arrangements enable an airline to issue tickets on a flight operated by another airline as if it were its own, including the use of its own two-letter code for that flight. These arrangements allow airlines to market expanded networks for their passengers at minimal expense. Code-sharing agreements can be between a larger airline and a regional airline or between a U.S. airline and a foreign airline or any combination thereof. Indeed, the earliest code-sharing agreements involved national, regional and trunk carriers and their commuter feeders.

Code-sharing agreements often link each airline's marketing and frequent flyer programs and facilitate convenient connections between the code-sharing partner carriers. (Some own regional carriers outright, giving them greater control over these important services that feed traffic from smaller cities into the major hubs or key cities. In some cases, the regional airline will paint its planes in the livery of the larger partner.) Code sharing with foreign carriers allows U.S. airlines to expand their global network reach through the services operated by their partners.

Code sharing differs from interlining, a much older industry practice, developed when the government regulated where airlines could fly, in which a carrier simply hands off a passenger to another carrier to get that passenger to a destination the first carrier does not serve directly. In such situations, the passenger buys a single ticket, and the airline issuing the ticket makes the arrangements for the traveler on the second carrier. However, schedules are not necessarily coordinated, there are no frequent flyer links, and there is no sharing of codes in global distribution systems. The flights of each carrier appear independently in the GDS.

In addition to code sharing, several groups of airlines have formed global alliances, such as *oneworld*, *Star* and *SkyTeam*, that compete against each other for international passengers. Each alliance consists of several carriers, including some that may fly under the same flag, that not only share codes on one another's flights and link frequent flyer programs, but also offer consumers benefits such as common airport terminal and lounge facilities and coordinated flight schedules. In addition to expanded networks, participating airlines benefit from reduced costs through the sharing of staff, facilities, sales offices and ancillary services.

Chapter 1

Chapter 3

Last Modified: 2/4/2009

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 3

Industry and Corporate Structure

Types of Airline Certification

U.S. airlines are classified by the government based on the amount of their annual operating revenue. These classifications are major, national and regional. All airlines hold two certificates from the federal government: a fitness certificate and an operating certificate. The Department of Transportation (DOT) issues fitness certificates – called certificates of public convenience and necessity – under its statutory authority. A fitness certificate typically authorizes both passenger and cargo service and establishes that the carrier has the financing and the management in place to provide scheduled service. Some airlines, however, obtain only cargo-service authority.

Operating certificates, on the other hand, are issued by the Federal Aviation Administration (FAA) under Part 121 of the Federal Aviation Regulations (FARs), which spell out numerous requirements for operating aircraft with 10 or more seats. These requirements cover such things as the training of flight crews and aircraft maintenance programs. All major, national and regional airlines operate with a Part 121 certificate.

Majors

Major airlines generate annual operating revenue in excess of $1 billion. Once known as trunk carriers, they generally provide nationwide, and in many cases, worldwide service. Also included in this category are the largest feeder carriers who operate regional aircraft for their hub-spoke network partners. In 2005, sixteen U.S. passenger airlines were classified by DOT as major airlines.

Nationals

National airlines generate annual operating revenues between $100 million and $1 billion. Many of the airlines in this category serve particular regions of the country, although some provide long-haul and even international service. Among the nationals are some of the former local service lines that, prior to deregulation, were licensed by the Civil Aeronautics Board (CAB) to operate between major cities and the smaller surrounding communities. Also in this category are some of the former supplemental carriers, previously licensed by the CAB to operate unscheduled charter service, which supplemented the capacity of the trunk carriers.

Regionals

As their name implies, regional carriers are airlines whose service is often limited to a single region of the country, transporting travelers between the major cities of their region and smaller, surrounding communities. This has been one of the fastest growing and most profitable segments of the industry since deregulation.

Cargo Carriers

The categories of major, national and regional airlines include cargo carriers. Much of the cargo that moves by air is carried in the bellies of passenger jets. Other aircraft principally in use by all-cargo carriers, called freighters, carry only freight, mail and express packages. Freighters are, most often, passenger jets that have been stripped of their seats to maximize cargo-carrying capacity. In addition, their decks are reinforced to accommodate heavier loads, and they typically have other cargo-handling features, such as rollers built into the floors, extra-large doors, and, sometimes, hinged nose and tail sections.

DOT has a special fitness review procedure for all-cargo carriers, but most of the large ones hold a certificate of public convenience and necessity. Among the largest cargo carriers are companies that began in the small-package and overnight document-delivery business. These are the integrated carriers, so called because they offer door-to-door service, combining the services of the traditional airline and the freight forwarder.

How Major Airlines are Structured

Operations

Flight – flight attendants and pilots
Ramp – fuelers, baggage handlers, lavatory servicing, utility/cleaners and caterers
Customer Service – ticket counters/gate agents and special service personnel, including airport lounge representatives
Technical Operators – maintenance, engineering and quality control

Operations personnel are responsible for operating an airline's fleet of aircraft safely and efficiently. They schedule the aircraft and flight crews and develop and administer all policies and procedures necessary to maintain safety and to meet all FAA operating requirements. Operations is in charge of all flight-crew training – both initial and recurrent training for pilots and flight attendants – and it establishes the procedures crews are to follow before, during and after each flight to ensure safety. Dispatchers release flights for takeoff, following a review of all factors affecting a flight. These include weather, routes the flight may follow, fuel requirements, and both the amount and distribution of weight onboard the aircraft. Weight must be distributed evenly aboard an aircraft for it to fly safely.

By keeping planes in excellent condition, maintenance programs keep aircraft in safe, working order; ensure passenger comfort; preserve the airline's valuable physical assets (its aircraft); and ensure maximum utilization of those assets. An airplane costs its owner money every minute of every day, but generates revenue only when it is flying with freight and/or passengers aboard. It is vital to an airline's financial success that aircraft are properly maintained. In addition to large maintenance facilities, airlines typically have inspection and repair capabilities at hub or focus-city airports.

Sales and Marketing

This division encompasses such activities as pricing, scheduling, advertising, ticket and cargo sales, reservations and customer service, including food service. While all are important, pricing and scheduling, in particular, can make or break an airline, and both have become more complex and a source of competitive advantage since deregulation. As explained in Chapter 4, airline prices change frequently in response to supply and demand and to changes in the prices of competitors' fares. Schedules change less often than fares, but far more often than when the government regulated the industry. Airlines use sophisticated global distribution systems (GDS) and their own Web sites to market and distribute their schedules and fares directly to consumers and to intermediaries such as travel agents. Travel agents, who sell approximately 70 percent of all airline tickets, use GDS systems to research flight schedules and available fares, book reservations, and issue electronic or, decreasingly, paper tickets for travelers.

Reservations and Ticketing

Major changes in air transportation have simplified the process for airline passengers to make a reservation and to purchase a ticket. Electronic commerce is playing a rapidly growing part in today's airline industry. In addition to the paper tickets issued in the past, all of the major airlines now offer electronic ticketing for domestic and international air travel. Today's E-tickets allow an airline to document the sale and track the usage of transportation. Passengers worry less today about carrying flight coupons or losing their tickets. They have the ability to shop for the lowest priced transportation, make or change a reservation, select a seat assignment, request refunds, and perform other functions, not only through their travel agent but also from a personal computer or telephone. The number of air travelers shopping, making reservations and purchasing electronic tickets using the Internet is increasing daily.

Airlines continue to adapt new technologies to automate check-in procedures. Customers now have the ability to verify their itineraries, select seat assignments, obtain cabin class upgrades and print their own boarding passes, at their own discretion. Electronic self-service check-in kiosks are now prevalent at all major airports for use by passengers holding E-tickets. Internet check-in functionality is now available on many carriers' own Web sites.

Management and Administrative Staff

This area includes specialists in such fields as law, accounting, finance, corporate real estate, network planning, revenue management, governmental affairs, employee relations corporate communications and public relations. Their function is to plan, manage and support the firm's operations and employees, so that the airline runs efficiently and profitably. Staff personnel typically work out of corporate headquarters and fall into several broad corporate job categories: finance and property, purchases, information technology, personnel, medical, legal, communications, public relations and planning.

Finance and corporate real estate divisions handle company revenues, finances and assets. They oversee all company property and the purchase of food, fuel, aircraft parts and other supplies needed to run an airline. Information technology designs and maintains the company's internal computer systems used to store and analyze data needed for operations and planning. At an airline, this includes the important function of fleet planning, explained in greater detail in the Chapter 4.

Subcontractors

While major airlines typically do most of their own work, it is common for them to outsource certain tasks to other companies or individuals. These tasks could include flying operations and customer service, aircraft and engine maintenance, cabin cleaning, catering and reservations. Airlines might contract out for all of this work or a portion of it, keeping the jobs in house at their hubs and other key line stations. However, whether an airline does the work itself or relies on outside vendors, the carrier remains responsible for meeting all applicable federal safety standards.

Chapter 2

Chapter 4

Last Modified: 2/4/2009

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 4

Airline Economics

Chief Characteristics of the Airline Business

Service Industry

Because of all of the equipment and facilities involved in air transportation, it is easy to lose sight of the fact that this is, fundamentally, a service industry. Airlines perform a service for their customers – transporting them and their belongings (or their products, in the case of shippers) from one point to another at a published or negotiated rate. In that sense, the airline business is similar to other service businesses like banks, insurance companies or even barbershops. There is no physical product given in return for the money paid by the customer, nor inventory created and stored for sale at some later date.

Capital-Intensive

In contrast with many service businesses, airlines today need more than storefronts and telephones to get started. They need an enormous range of expensive equipment and facilities, from airplanes to flight simulators to maintenance hangars, aircraft tugs, airport counter space and gates. Consequently, the airline industry is a capital-intensive business, requiring large sums of money to operate effectively. Most equipment is financed through loans or the issuance of stock. Increasingly, airlines are also leasing equipment, including assets they owned previously but sold to someone else and leased back. Whatever arrangements an airline chooses to pursue, its capital needs require consistent profitability. Because airlines own large fleets of expensive aircraft that depreciate in value over time, they historically have generated a substantial positive cash flow (profits plus depreciation). Most airlines use their cash flow to repay debt, acquire new aircraft or upgrade facilities. When cash flow is significant, airlines may also issue dividends to shareholders.

Labor-Intensive

Airlines employ a virtual army of pilots, flight attendants, mechanics, baggage handlers, reservation and customer service representatives, cleaners, analysts, sales staff, accountants, lawyers, engineers, schedulers, auditors and others. New technologies have enabled airlines to automate many tasks and operate more efficiently but, because airlines are a service provider where customers require personal attention, human capital will retain a prominent role within any airline's operations. More than one-third of the revenue generated each day by the airlines goes to pay the wages, benefits and payroll taxes of its workforce, and labor costs per employee are above average compared to other service industries.

Airline employees have extensive contact with the customer, particularly in passenger transportation. Many airline employees belong to unions, making it one of the most unionized industries in the country. In 2004, according to the U.S. Bureau of Labor Statistics, about 50 percent of all workers in the air transportation industry were union members or were covered by union contracts, compared with 14 percent of workers throughout the economy.

Airline Profitability

Airlines, through the years, have earned a net profit margin consistently below the average for U.S. industry as a whole. Also, customer demand is highly seasonal. The summer months are extremely busy, as students are out of school and many individuals and families take vacations. Winter, on the other hand, tends to be slow, with the exception of the Thanksgiving and Winter holidays. Accordingly, passenger traffic and revenue rise and fall throughout the course of any given year. Airlines have responded in kind by adjusting their schedules periodically to realign their scheduled capacity to better fit this ebb and flow.

Airline Revenue - Where the Money Comes From

On average, 80 percent of a U.S. passenger airline's revenue comes from passengers purchasing tickets. Of the balance, the majority comes from cargo and other transport-related services. For the all-cargo sector, of course, freight, express and mail is the sole source of transport carriage revenue.

Approximately three-fourths of all U.S. airline passenger revenue is generated from domestic service while a fifth comes from international passengers. The majority of tickets are processed by travel agents, most of whom rely on global distribution systems to keep track of schedules and fares, to book reservations and to print tickets for customers.

Similarly, freight forwarders book the majority of air-cargo space. Like travel agents, freight forwarders are independent intermediaries that match shippers with cargo suppliers.

Airline Costs - Where the Money Goes

According to reports filed with the Department of Transportation in 2005, airline costs were as follows:

- Flying Operations – essentially any cost associated with the operation of aircraft, such as fuel and pilot salaries – 37 percent
- Maintenance – both parts and labor – 10 percent
- Aircraft and Traffic Service – basically the cost of handling passengers, cargo and aircraft on the ground and including such things as the salaries of baggage handlers, dispatchers and airline gate representatives – 14 percent
- Promotion/Sales – including advertising, reservations and travel agent commissions – 6 percent
- Passenger Service – in-flight service, including such things as food and flight attendant salaries – 6 percent
- Transport Related – outsourced regional capacity providers, in-flight sales – 17 percent
- Administrative – 6 percent Depreciation/Amortization – equipment and plants – 5 percent

Labor costs are common to nearly all of these categories. When looked at as a whole, labor accounts for a fourth of the airlines' operating expenses and three fourths of controllable costs. Fuel recently overtook labor as the airlines' largest cost (about 25 to 30 percent of total expenses), and transport-related costs are third (about 17 percent). Transport-related costs, in particular, have grown sharply in recent years, and many airlines have outsourced a substantial portion of their flying needs to smaller regional carriers to align supply and costs more closely with demand.

Break-Even Load Factors

Every airline – indeed every flight – has what is called a break-even load factor. That is the percentage of the seats the airline has in service that it must sell at a given yield, or price level, to cover its costs.

Since revenue and costs vary from one airline to another, so does the break-even load factor. Higher costs raise the break-even load factor, while higher fares have just the opposite effect. On average, the break-even load factor for the industry in recent years has surpassed 80 percent, thanks principally to higher fuel prices and lower fares.

Airlines typically operate very close to their break-even load factor. The sale of just one or two more seats on each flight can mean the difference between profit and loss.

Seat Configurations

Adding seats to an aircraft increases its ability to generate revenue at a low marginal cost. However, an aircraft's optimal seat configuration depends on the operator's marketing strategy. If an airline is targeting price-sensitive consumers, such as leisure travelers, an airline will seek to maximize the number of seats to keep prices as low as possible. On the other hand, a carrier that is targeting service-oriented business clientele may opt for a less dense seat configuration with either a larger premium cabin and/or an economy cabin with greater seat pitch. In reality, the key for most airlines is to strike the right balance as most serve a broad mix of both business and leisure customers.

Overbooking

In seeking to maximize revenue across their networks and serve as many passengers as possible, airlines sometimes overbook flights, meaning they book more passengers than they have seats on a given flight. This in part is done to account for passenger "no-shows."

The practice is rooted in careful analysis of historic demand for a flight, economics and human behavior. Historically, some travelers, especially business travelers buying unrestricted, full-fare tickets, are no-shows and have not flown on the flights for which they have a reservation. Changes in their own schedules may have made it necessary for them to take a different flight, maybe with a different airline, or to cancel their travel plans altogether, often with little or no notice to the airline. At other times, they may simply be caught in traffic or perhaps in lengthy airport security lines. Some travelers, unfortunately, reserve seats on more than one flight.

Both airlines and customers benefit when airlines sell all the seats for which they have received reservations. An airline seat is a perishable product and if a customer fails to show up for a booked reservation, that seat cannot be returned for future use as in other industries. This undermines airline productivity, which otherwise contributes to lower airfares and expanded service. Consequently, some airlines overbook flights. Importantly for travelers, however, airlines do not do so haphazardly. Rather, they examine the history of particular flights to determining how many no-shows typically occur, and subsequently decide how many seats to authorize for sale. The goal is to align the overbooking with the eventual number of no-shows.

In most cases the practice works effectively. Occasionally, however, when more people show up for a flight than there are seats available, airlines offer incentives to passengers to relinquish their seats. Travel vouchers are the most common incentive, with volunteers getting re-booked on another flight.

Normally there are more than enough volunteers, but when there are not enough, airlines must bump passengers involuntarily. In the rare cases where this occurs, federal regulations require the airlines to compensate passengers for their trouble and help them make alternative travel arrangements. The amount of compensation is determined by government regulation.

Pricing

Since deregulation, airlines have had the same pricing freedom as companies in other industries. They set fares and freight rates in response to both customer demand and the prices offered by competitors. As a result, fares change much more rapidly, and passengers sitting in the same section on the same flight often pay different prices for their seats.

Although this may be difficult to understand for some travelers, it makes perfect sense, considering that a seat on a particular flight is of different value to different people. It is far more valuable, for instance, to a salesperson who suddenly has an opportunity to visit an important client than it is to someone contemplating a visit to a friend. The pleasure traveler likely will make the trip only if the fare is relatively low. The salesperson, on the other hand, likely will pay a higher premium in order to make the appointment.

For the airlines, the chief objective in setting fares is to maximize the revenue from each flight, by offering the right mix of full-fare tickets and various discounted tickets. Too little discounting in the face of weak demand will result in a flight departing with many empty seats, a lost revenue opportunity. On the other hand, too much discounting can sell out a flight far in advance and preclude the airline from booking last-minute passengers who might be willing to pay higher fares and therefore generate incremental revenue.

The process of finding the right mix of fares for each flight is called revenue management. It is a complex process, requiring sophisticated computer software that helps an airline estimate the demand for seats on a particular flight, so that it can price the seats accordingly. And it is an ongoing process, requiring continual adjustments as market conditions change.

Scheduling

Since deregulation, airlines have been free to enter and exit any domestic market at their own discretion and have adjusted their schedules often, in response to market opportunities and competitive pressures. Along with price, schedule is an important consideration for air travelers. For business travelers, who typically are time sensitive and value convenience, schedule is often more important than price. A carrier that has several flights a day between two cities has a competitive advantage over carriers that serve the market less frequently, or less directly.

Airlines establish their schedules in accordance with demand for their services and their marketing objectives. Scheduling, however, can be extraordinarily complex and must take into account aircraft and crew availability, maintenance needs and local airport operating restrictions.

Contrary to popular myth, airlines do not cancel flights because they have too few passengers for the flight. The nature of scheduled service is such that aircraft move throughout an airline's system during the course of each day. A flight cancellation at one airport, therefore, means the airline will be short an aircraft someplace else later in the day, and another flight will have to be canceled, rippling costs and foregone revenue across the network. If an airline must cancel a flight because of a mechanical problem, it may choose to cancel the flight with the fewest number of passengers and utilize that aircraft for a flight with more passengers. While it may appear to be a cancellation for economic reasons, it is not. The substitution was made in order to inconvenience the fewest number of passengers.

Fleet Planning

Selecting the right aircraft for the markets an airline wants to serve is vitally important to its financial success. As a result, the selection and purchase of new aircraft is usually directed by an airline's top officials, although it involves personnel from many other divisions such as maintenance and engineering, finance, marketing and flight operations.

There are numerous factors to consider when planning new aircraft purchases, beginning with the composition of an airline's existing fleet. Are any potential aircraft purchases related to replacement of existing aircraft or are they intended to drive service growth? What are the potential cost impacts on a carrier's fuel and maintenance programs, its crew resources and its training requirements? These are some of the issues that must be examined. In general, newer aircraft are more efficient and cost less to operate than older aircraft, as a result of new airframe and engine technologies. A Boeing 737-200, for example, is less fuel efficient than the 737-700 that Boeing designed to replace it. As planes get older, maintenance costs can also rise appreciably. However, such productivity gains must be weighed against the cost of acquiring a new aircraft. Can the airline afford to take on more debt? What does that do to profits? What is the company's credit rating, and what must it pay to borrow money? What are investors willing to pay for equity in the company if additional shares of stock are floated? A company's finances, like those of an individual considering the purchase of a house or new car, play a key role in the aircraft acquisition process.

Marketing strategies are important, too. An airline considering expansion into international markets, for example, typically cannot pursue that goal without long-range, wide-body aircraft. If it has principally been a domestic carrier, it may not have that type of aircraft in its fleet. What's more, changes in markets already served may require an airline to reconfigure its fleet. Having the right-sized aircraft for the market is vitally important. Too large an aircraft can mean that a large number of unsold seats will be moved back and forth within a market each day. Too small an aircraft can mean lost revenue opportunities. Since aircraft purchases take time (often two to four years if there is a production backlog), airlines also must do some economic forecasting before placing new aircraft orders. This is perhaps the most difficult part of the planning process, because no one knows for certain what economic conditions will be like many months, or even years, into the future. An economic downturn coinciding with the delivery of a large number of expensive new aircraft can lead to deep financial losses. Conversely, an unanticipated boom in the travel market can mean lost market share or operating-cost disadvantages for an airline that held back on aircraft purchases while competitors were moving ahead.

Sometimes airline planners may determine that their company needs an aircraft that is not yet in production or even in design. In such cases, they approach the aircraft manufacturers about developing a new model, if the manufacturers have not already anticipated their needs. Typically, new aircraft reflect the needs of several airlines because start-up costs for the production of a new aircraft are enormous and, consequently, manufacturers must sell substantial numbers of a new model just to break even. They usually will not proceed with a new aircraft unless they have a launch customer, meaning an airline willing to step forward with a large order for the plane, plus smaller purchase commitments from several other airlines.

There have been several important trends in aircraft acquisition since deregulation. One is the increased popularity of leasing versus ownership. Leasing reduces some of the risks involved in purchasing new technology. It also can be a less expensive way to acquire aircraft, since high-income leasing companies can take advantage of tax credits. In such cases, the tax savings to a lessor can be reflected in the lessor's price. Some carriers also use the leasing option to safeguard against hostile takeovers. Leasing leaves a carrier with fewer tangible assets that a corporate raider can sell to reduce debt incurred in the takeover.

A second trend in fleet planning, relates to the size of the aircraft ordered. The development of hub-and-spoke networks, as described in Chapter 2, resulted in airlines adding flights to small cities around their hubs. In addition, deregulation enabled airlines to respond more effectively to consumer demand. In larger markets, this often means more frequent service. These considerations increased the demand for small- and medium-sized aircraft to feed the hubs. Larger aircraft remain important for the more heavily traveled and capacity-constrained routes, but the ordering trend is toward smaller jet aircraft.

The third trend is toward increased fuel efficiency. As the price of fuel rose rapidly in the 1970s and early 1980s, the airlines gave top priority to increasing the fuel efficiency of their fleets. The most recent run-up in fuel prices in the 21st century has renewed focus on this issue by both airlines and airplane manufacturers, leading to numerous design innovations on the part of manufacturers. Today, airline fuel efficiency compares, on a per passenger basis, favorably with even the most efficient autos.

Similarly, the fourth trend has been in response to airline and public concerns about aircraft noise and engine emissions. Technological developments have produced quieter and cleaner-burning jets, and Congress produced timetables for the airlines to retire or update their older jets. A ban on the operation of Stage 1 jets, such as the Boeing 707 and DC-8, has been in effect since Jan. 1, 1985. In 1989, Congress dictated that all Stage 2 jets, such as 727s and DC-9s, were to be phased out by the year 2000, and many were replaced by Stage 3 jets, such as the Boeing 757 and the MD-80. Hush kits were also available for older engines, and some airlines chose to pursue this option rather than make the much greater financial commitment necessary to buy new airplanes. Others chose to re-engine, or replace their older, noisier engines with new ones that met Stage 3 standards. While more expensive than hush kits, new engines have operating-cost advantages that make them the preferred option for some carriers.

Chapter 3

Chapter 5

Last Modified: 2/4/2009

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 5

How Aircraft Fly

The Bernoulli Principle

Aircraft fly when the movement of air across their wings creates an upward force on the wings (and thus the rest of the plane) that exceeds the force of gravity pulling the plane toward the earth.

The physics behind this phenomenon was first described by Daniel Bernoulli, an 18th century Swiss mathematician and scientist who studied the movement of fluids. Bernoulli discovered that the pressure exerted by a moving fluid is inversely proportional to the speed of the fluid. In other words, fluid pressure decreases as fluid speed increases and vice versa.

The same principle applies to moving air. The faster that air moves through a space, the lower the air pressure; the slower it moves, the higher the pressure. Aircraft wings are designed to take advantage of that fact and create the lift force necessary to overcome the weight of the aircraft and get airplanes off of the ground. The undersides of wings are more or less flat while their tops are curved. In addition, wings are slanted slightly downward from front to back, so air moving around a wing has a longer way to travel over the top than it does underneath. The air flowing over the top moves faster than the air underneath, therefore, the air pressure above the wing is lower than it is under the wing, where slower moving air molecules bunch together. The pressure differential creates lift, so as the airplane accelerates and the wing moves faster through the air, the greater the lift, eventually overcoming the force of gravity upon the aircraft.

The Phases of Flight

Push-Back and Taxi-Out

This first phase of flight, after all doors have been secured, involves the movement of the aircraft away from the terminal Jetway and along taxiways to a runway. A motorized vehicle called a tug sometimes is used to push the aircraft back from its gate. At some airports, certain aircraft are permitted to power back. This means that following engine start at the gate, the thrust reversers are used to propel the aircraft away from the gate. The aircraft then moves under its own power along the taxiways. Since aircraft are designed primarily for flight, not ground use, they are taxied at very low speeds. Movement on active taxiways require clearance from FAA Air Traffic Control, which monitors all aircraft movements during taxi.

Takeoff and Climb

When ready for takeoff, and cleared by Air Traffic Control to proceed, the pilot or first officer of an aircraft releases the brakes and advances the throttle to increase engine power to accelerate down the runway. Once aligned on the runway, steering the aircraft is normally accomplished by using foot pedals or a tiller that manipulates the nose wheel until the speed is sufficient enough that wind rushing by the rudder on the aircraft tail makes nose-wheel steering unnecessary.

As the aircraft gains speed, air passes faster and faster over its wings and lift is created. Instruments onboard the aircraft display this airspeed, which measures not only the speed of the plane relative to the ground, but also factors in the speed of any wind that may be blowing toward the aircraft (aircraft normally take off headed into the wind). When the airspeed reaches a certain predetermined point known as rotation speed, the pilot manipulates panels on the tail of the aircraft to rotate the nose of the plane upward. This creates even stronger lift and the plane leaves the ground.

Rotation speed, abbreviated VR, is one of three important take off airspeed settings calculated before every flight. The others are V1 – the speed beyond which a safe stop on a runway is no longer possible, and V2 – the minimum speed needed to keep a plane flying. Some of the factors affecting VR and V2 are the weight of the aircraft, the air temperature and the altitude of the airport. Heavier aircraft require more lift, and thus more speed, to get off the ground. Aircraft also need to travel faster to fly on a hot day than on a cool day. Hot air is less dense than cool air and less density produces less lift for the same speed. Similarly, the higher the altitude, the less dense the air. For example, aircraft need more speed to leave the ground at Denver than New York, with all other factors (such as weight) being equal. Some of these factors also are important in calculating V1, although the key factor is the length of the runway being used.

Most large jets leave the ground at about 160 miles per hour and initially climb at an angle steeper than 15 degrees. The angle of a plane's wings relative to the air flowing around them is extremely important to maintaining lift. If the so-called angle of attack is too severe, the flow of air around the wings becomes disrupted and the plane loses lift or stalls.

To make an aircraft more aerodynamically efficient, the wheels on which an aircraft rolls (landing and take off gear) when it is on the ground are retracted into a cavity in the belly of the plane after it is airborne. There is less drag (wind resistance), and an aircraft can fly faster when its landing gear is retracted.

Cruise

Once a plane is in the air, it continues to climb until it reaches its designated cruising altitude, which is determined by the pilot and must be approved by Air Traffic Control. At this point, power is reduced from the setting that was needed to climb, and the aircraft maintains a consistent, level altitude. To fly level, the weight of the aircraft and the lifting force generated by the wings are exactly equal.

There is no standard altitude for cruising. Often, it is around 35,000 feet, but that can vary considerably depending on type of aircraft, length of flight, weather conditions, air turbulence and the location of other planes in the sky. Only RVSM-qualified airplanes may travel between 28,000 and 41,000 feet in domestic airspace. Cruising speeds are at a constant mach number, often about 82 percent of the speed of sound. This translates to a groundspeed of about 550 miles per hour, although that too can vary considerably with headwinds, tailwinds and other factors.

During flight, pilots normally follow designated airways, or highways in the sky, that are marked on flight maps and are defined by their relationship to radio-navigation beacons, whose signals are picked up by the aircraft. Some jets also have inertial navigation systems onboard to help pilots find their way. These computer-based systems calculate the plane's position from its point of departure by closely tracking its heading, speed and other factors after it leaves the gate. Some aircraft are capable of using signals from a constellation of satellites to pinpoint their location; this is known as the Global Positioning System (GPS). Airlines are increasingly using GPS equipment, which enables aircraft to operate safely off predetermined airways with the permission of Air Traffic Control. This capability makes operations more efficient and adds flexibility and capacity to the aviation system.

Pilots control and steer aircraft in flight by manipulating panels on the aircraft wings and tail. Those control surfaces are described in greater detail later in this chapter.

Descent and Landing

In this phase of a flight, the pilot gradually brings the aircraft back toward the ground by reducing engine power and speed, and thus lift. The so-called final approach begins several miles from the airport. By this point, Air Traffic Control has put the aircraft in a sequence to land, carefully separating it from all other aircraft headed for, or leaving, the same area. The landing gear is lowered, slowing the plane further. In addition, panels at the trailing edge of the aircraft's wings, known as flaps, are manipulated to increase drag and thus reduce speed and altitude. Other panels, known as elevators, and the rudder are used (as they are throughout the flight) to steer the plane and, if it is making an instrument approach, keep it on the localizer (heading) and glideslope (glidepath) – the continuous radio signals the flight crew will follow to the end of the runway.

Airline aircraft generally travel at about 120 miles per hour relative to the ground when they touch down. The flight crew then slows the aircraft quickly with several actions: pulling back on the throttles; raising yet another set of panels on the top of the wings, called spoilers, that disrupt airflow to reduce lift and create drag; reversing the thrust of the engines; and, of course, applying the brakes.

Taxi-In and Parking

The final phase of a flight is a reverse of the first phase. The aircraft is taxied slowly under its own power onto the taxiway and from there to a gate. Since most gates are equipped with moveable *Jetways*, or covered ramps, aircraft typically are parked under their own power.

Major Parts of an Aircraft

Fuselage

This is the main body of an aircraft, exclusive of its tail assembly, wings and engines. The term derives from a French word, fusele, meaning tapered, because the fuselage is the shape of a long cylinder with tapered ends. It is conventionally made of aluminum sections that are riveted together. Inside are three primary sections: the cockpit, the cabin (which often is subdivided into two or three sections with different seating arrangements and different classes of service) and the cargo hold. Some new aircraft will have fuselages made of non-metallic composite materials, which are lighter and more durable.

Cockpit

The cockpit is the most forward part of the fuselage and contains all the instruments needed to fly the plane. Sometimes referred to as the flight deck, the cockpit has seats for the pilot and copilot; a flight engineer on some planes; and seats for one or two observers that could be from the airline itself, or from the FAA. The cockpits have hardened doors, securing them from unauthorized persons during flight, takeoffs and landings.

Cabin

The cabin is the section of the fuselage behind (and below in the case of the double-deck Boeing 747 and Airbus A380) the cockpit, where an airline carries passengers, cargo, or both. A typical passenger cabin has galleys for food preparation; lavatories; one or more seating compartments, closets and overhead bins, for stowing baggage, coats and other items carried onto the plane by passengers; and several doors to the outside, most of which are used only for catering and emergency evacuations. The number of exits is determined by the number of seats. Small commercial jets typically carry 50 to 100 passengers; the larger ones can carry more than 400.

Cargo Hold

This is the area of the fuselage below the passenger deck where cargo and baggage are carried. It is basically the lower half of the fuselage cylinder. It is pressurized, along with the rest of the fuselage, and has heating systems for areas designated for the carriage of live animals. Aircraft also have ventilation systems that force air into these areas as well as automatic fire detection and suppression systems. Access to the cargo holds is provided by doors in the belly of the aircraft. There is no access from the cabin area.

Wings

The wings are the airfoil that generates the lift necessary to get and keep an aircraft off the ground. Like the fuselage to which they are attached, they are conventionally made of aluminum alloy panels riveted together, although newer aircraft employ non-metallic composite materials bonded together. The point of attachment is the aircraft's center of gravity or balance point. Most jet aircraft have swept wings, meaning the wings are angled back toward the rear of the plane. Swept wings produce less lift than perpendicular wings, but they are more efficient at high speeds because they create less drag. Wings are mostly hollow inside, with large compartments for fuel. On most of the aircraft in service today, the wings also support the engines, which are attached to pylons hung beneath the wings. Wings are designed and constructed with meticulous attention to shape, contour, length, width and depth, and they are fitted with many different kinds of control surfaces, described below.

Empennage

The empennage is the tail assembly of an aircraft, consisting of large fins that extend both vertically – the tail or vertical stabilizer – and horizontally – the horizontal stabilizer – from the rear of the fuselage. Their primary purpose is to help stabilize the aircraft, much like the keel of a boat or fletching of an arrow. In addition, they also have control surfaces built into them to help the pilots steer the aircraft.

Control Surfaces

The control surfaces attached to an aircraft's wings and tail alter the equilibrium of straight and level flight when moved up and down or left and right. They are manipulated from controls in the cockpit. In some planes, hydraulic lines connect the cockpit controls with these various exterior panels. In others, the connection is electronic, called fly-by-wire.

The rudder is a large panel attached to the trailing edge of a plane's vertical stabilizer in the rear of the plane. It is used to control yaw, which is the movement of the nose left or right, and is used mostly during takeoffs and landings to keep the nose of an aircraft on the centerline of the runway. It is manipulated via foot pedals in the cockpit. Jet aircraft also have automatic yaw dampers that function at all times to minimize side-to-side oscillations and ensure a comfortable ride.

The elevators are panels attached to the trailing edge of an aircraft's two horizontal stabilizers, also part of the tail assembly or empennage. The elevators control the pitch of an aircraft, which is the movement of the nose up or down. They are used during flight and are manipulated by pulling or pushing on the control wheel or side-stick controller in the cockpit.

The ailerons are panels built into the trailing edge of the wings. Like the elevators, they are used during flight to steer an aircraft and are manipulated by turning the control wheel or side-stick controller in the cockpit to the left or right. These steering motions deflect the ailerons up or down, which in turn affect the relative lift of the wings. An aileron deflected down increases the lift of the wing to which it is attached, while an aileron deflected up decreases the lift of its wing. Thus, if a pilot rotates the control yoke or stick, to the left, the left aileron deflects upward and the right aileron defects downward, causing the aircraft to roll, or bank, to the left. Spoilers are panels built into the top surfaces of the wings and are used principally during landings to spoil the lift of the wings and thus keep the aircraft firmly planted on the ground once it touches down. They also can be used during flight to expedite a descent or combined with aileron deflections to improve controllability.

The other major control surfaces are the flaps and slats, both designed primarily to increase the lift of the wings at the slow speeds used during takeoffs and landings. Flaps are mounted on the trailing edge of the wings, slats on the leading edge. When extended, they increase lift making the surface area of the wings larger and accentuating the curve of the wings. Flaps also are commonly deployed during final approach to increase lift, which provides control and stability at slower speeds. Flap and slat settings are controlled by the pilots, although automatic extension/retraction systems are sometimes provided to protect flight and structural integrity.

Landing Gear

The landing gear, the undercarriage assembly that supports an aircraft when it is on the ground, consists of wheels, tires, brakes, shocks, axles and other support structures. Virtually all jet aircraft have a nose wheel with two tires, plus two or more main gear assemblies with as many as 16 tires. The landing gear is usually raised and lowered hydraulically and fits completely within the lower fuselage when retracted. Aircraft tires are filled with nitrogen rather than air because nitrogen, aside from being inert, does not expand or contract as much as air during extreme temperature changes, thus reducing the chances of a tire blowout.

Engines

The exact number of engines on an airplane is determined by the power and performance requirements of the aircraft. Most jet airplanes have two or four engines, depending on aircraft size. Some have the engines attached to the rear of the fuselage. Many have them mounted on pylons, hanging below the wings. Some have a combination of both, with an engine under each wing and one on top of or within the fuselage at the rear of the plane.

The power produced by the engines is controlled by the pilots, either directly or indirectly, through computerized controls. All large aircraft are designed to fly safely on fewer than all engines. In other words, the remaining engine or engines have enough power to keep the aircraft airborne until it can safely land.

Jet Propulsion

As mentioned above, some form of propulsion is required to move an aircraft through the air and generate sufficient lift for it to fly. The earliest forms of propulsion were simple gasoline engines that turned propellers. All modern airliners are equipped with jet engines, which are more powerful and mechanically simpler and more reliable than piston engines. Jet engines first entered commercial service in the late 1950s and were in widespread use by the mid-1960s.

A jet engine takes in air at the front, and compresses it into continually smaller spaces by pulling it through a series of compressor blades. Then fuel is added to the hot, compressed air and the mixture is ignited in a combustion chamber. This produces a flow of extremely hot gases out the rear of the engine and creates a force known as thrust, which propels the engine (and thus the aircraft) forward. It is the same principle that propels a balloon forward when blown up with air and released. The air escaping from both a balloon and a jet engine creates a pressure differential between the front and back of the enclosed space that results in forward movement. Importantly, as the hot gases pass out the back of a jet engine, they turn a wheel known as a turbine. The turbine is connected by a center shaft to the compressor blades at the front of the engine and thus keeps the compressor spinning while the engine is on.

As with all combustion engines, power is increased by adding fuel to the combustion chamber. Today's most powerful jet engines can produce more than 90,000 pounds of thrust. Expressed another way, each of these giant engines can lift 90,000 pounds straight up off the ground. Since aircraft rely on their wings for vertical lift and engines only for horizontal movement, these large engines can lift enormous amounts of weight off the ground and power aircraft at great speeds.

Types of Jets

There are three basic types of jet engines. Turbojets are engines that use exhaust thrust alone to propel an aircraft forward, as just described.

Turbofans, or fanjets, are an improved version of the turbojet. With a larger fan at the front, the turbofan pulls in more air. It also diverts some of the incoming air around the combustion chamber and later mixes it with the hot exhaust gases escaping out the back. This lowers the temperature and speed of the exhaust, increasing thrust at lower speeds and making the engine quieter. Hi-bypass versions are an improved version of turbofan.

The third type is the turboprop, or propjet. It uses a jet engine to turn a propeller. Thrust is generated by both the propeller and the exhaust gases of the jet itself. Turboprops are used on small, short-range aircraft such as those often operated by regional and commuter airlines. They are efficient in these types of operations, but less so at the high speeds and high altitudes flown by large commercial jets.

Chapter 4

Chapter 6

Last Modified: 2/4/2009

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 6

Safety

The Record

The National Transportation Safety Board (NTSB) investigates U.S. transportation industry accidents. It also publishes transportation safety statistics. As part of its accident investigation function, NTSB gathers facts about the accident and seeks to determine the reasons for it. If appropriate, it can also make safety improvement recommendations to regulatory bodies, for example, the FAA.

NTSB statistics show that the U.S. airlines' safety record has improved steadily through the years, most notably the years since deregulation. From 2000-2005, U.S. airlines averaged .230 fatal accidents per billion aircraft miles flown. This compares with 1.984 fatal accidents per billion miles flown in 1978, the year that Congress enacted the legislation to deregulate rates and routes.

The airline safety record also compares very favorably with many other everyday activities. Since 1938, when the government began keeping records of aviation accidents, the very worst year for airline fatalities was 1974, with 460 deaths recorded. By contrast, more than 40,000 people die each year in highway accidents. Sadly, in a typical three-month period, more people die on the nation's highways than have died in all airline accidents since the advent of commercial aviation. According to the National Safety Council, which publishes an annual report on accidental deaths in the United States and measures passenger deaths per 100 million passenger miles, airlines are consistently the safest mode of intercity travel, followed by bus, rail and the automobile.

The Government's Safety Role

The federal government plays an important role in assuring the safety of air travel. It has done so since the enactment of the *Air Commerce Act of 1926*, and it continues to play a leading role in aviation safety today. Although the *Airline Deregulation Act of 1978* ended virtually all domestic economic regulation of the airlines, it did not end government regulation of safety. All safety requirements and programs in place at that time remain in force, and many new regulations have been added.

The Federal Aviation Administration (FAA)

The primary responsibility for airline safety regulation lies with the Federal Aviation Administration (FAA). Congress transferred the FAA agency to the Department of Transportation when it created the department in 1966. It is the successor to the Federal Aviation Agency, an independent agency created by the *Federal Aviation Act of 1958*.

The FAA is also responsible for developing, maintaining and operating the nation's Air Traffic Control (ATC) system, which is described in Chapter 9. Nearly three-fourths of the FAA's almost 50,000 employees are involved in some aspect of ATC. Their mission is to ensure the safe separation of aircraft during flight and to safely sequence aircraft for taxiing, takeoff and landing.

FAA's other major safety functions include reviewing the design, manufacture and maintenance of aircraft, setting minimum standards for crew training, establishing operational requirements for airlines and airports, and conducting safety-related research and development. In short, it sets the minimum safety standards for the airlines and acts as the public's watchdog for safety.

Aircraft Certification

Federal law requires that all civil aircraft operating in the United States be certified as airworthy by the FAA. There are well over 200,000 licensed civil aircraft in the United States, the vast majority of them privately owned general-aviation aircraft (small planes used primarily for pleasure flying, training, corporate travel and agricultural purposes such as crop-dusting).

The FAA certification process begins with the design of an aircraft. FAA aeronautical engineers participate in the design process and oversee the construction and flight testing of the prototype. If all tests are successfully completed, FAA issues a type certificate for the new aircraft, followed by a production certificate, once FAA is satisfied that the manufacturer has everything in place to properly duplicate the prototype.

The final step in aircraft certification is the issuance of an airworthiness certificate, which essentially is the FAA stamp of approval for each aircraft coming off the assembly line. It attests to the fact that the plane has been properly built, according to an approved design, and that it is safe for commercial service.

The FAA requires that all commercial transport aircraft be designed with built-in redundancies, so they can continue to fly even when a structural element fails. For example, there is more than one way to lower the landing gear, more than one way to communicate with the ground and more than one way to control the aircraft.

If design problems are discovered after a plane is in service and found to jeopardize safe operations, they are addressed through airworthiness directives, or ADs. Through these directives, the FAA informs all operators of the aircraft or engine type of the repairs or modifications needed to correct the problem. Usually ADs are written in consultation with the manufacturer but, unlike manufacturer-generated service bulletins, ADs carry the force of law. If a problem poses an immediate safety hazard, the FAA will direct the airlines to complete the work quickly, sometimes even before further flight. In most situations, however, there is no immediate safety hazard and the airlines are given a specified amount of time to complete the ADs.

Operating Certificates

Federal Aviation Regulations (FARs) require FAA certification of all airline companies, as well as the equipment they use. Every airline therefore is issued an operating certificate by the FAA. FARs spell out the operating requirements for engaging in large-plane service. The Department of Transportation mandates that financial, insurance and citizenship requirements be met before it issues the airline a second, separate certificate known as the certificate of public convenience and necessity.

Among other things, a commercial operator must have FAA-approved training and maintenance programs and comply with airworthiness certificates for each aircraft. The maintenance program must specify the intervals at which certain aircraft and engine parts will be inspected and, in some cases, replaced. In addition, the maintenance shops the airline intends to use (both its own shops and those of contractors) must be certified by FAA and open to inspection, on demand. Records of all maintenance work must be kept and also must be open to FAA inspection. Other requirements address such things as:

- the equipment a carrier must have aboard each aircraft
- flammability standards for cabin materials
- floor lighting for emergency evacuation
- onboard no smoking rules
- the number of flight attendants that must be aboard
- the content of preflight announcements
- rules for carry-on baggage

- the use of personal electronic devices
- security procedures
- aircraft de-icing procedures

Certification of Airline Personnel

As with aircraft and airlines, certain people who work on, fly or manage airplanes must be personally licensed by the FAA and have minimum levels of training and experience. These certification requirements apply to aircraft mechanics, pilots, flight engineers, aircraft dispatchers and the FAA's own air traffic controllers. The schools where these aviation professionals get their training, as well as the teachers in those schools, also require an FAA license.

Pilots in command of large aircraft must have a minimum of 1,500 hours of flight time. They must pass a written exam testing their knowledge of aircraft operations, meteorology, navigation, radio communication and other subjects important to operating aircraft in commercial service. They must demonstrate their flying skills to an FAA examiner (or FAA-designated examiner), performing various types of takeoffs and landings, in-flight maneuvers and emergency procedures, either in an airplane or a simulator. They also must pass a medical exam, both prior to employment and every year after being hired. Recurrent training also is required. The FAA Flight Standards Service establishes all training and operating requirements for the airlines.

Airport Certification

The FAA also regulates airports, although to a lesser extent than pilots, airlines and aircraft. It was empowered to do so by the Airport and Airway Development Act of 1970, which sought to promote the development of new aviation infrastructure. The act states that all airports with commercial service must be certified by the FAA and that certification will be granted only if the airport complies with certain safety criteria set by the FAA. Among those criteria are the number and type of fire-fighting vehicles at the airport, runway lighting and storage facilities for fuel.

The FAA also issues advisory circulars to airport operators on such topics as runway paving, environmental matters, drainage and apron design, and provides grants for airport projects that enhance safety and increase the capacity and efficiency of the airport.

Industry Programs

The National Transportation Safety Board (NTSB)

The NTSB, mentioned earlier, is responsible for investigating all U.S. transportation accidents, including all civil aviation accidents. Congress created the board under the same legislation that created the Department of Transportation in 1967. Prior to that time, the Civil Aeronautics Board handled accident investigations.

Initially, the five-member NTSB was an autonomous agency within the DOT, which was used for administrative support only. It became a completely independent federal agency, outside the DOT, through the 1974 Transportation Act. The president appoints the members of the board, with confirmation by the Senate. Terms of service are five years. The board chairman and vice chairman are appointed from among the members and serve terms of two years each.

NTSB investigations have two goals – to determine the cause of an accident and to serve as the basis for recommendations that enhance safety. The board does not have the authority to impose new aviation regulations. Only the FAA has that power. Many of the board's recommendations through the years, however, have been implemented as new regulations and are always carefully examined by the FAA, as well as the aviation sector.

When an airline accident occurs, the board dispatches a “go team” of experts in various phases of accident investigations. The teams typically consist of one member of the board and specialists in air traffic control, aircraft maintenance, aircraft operations and someone trained in witness interrogation. The team spends whatever time is necessary at the crash scene. Attention then shifts to the NTSB laboratory where, among other things, the aircraft's cockpit voice recorder and flight data recorder (called black boxes, though orange in color) are analyzed. The cockpit voice recorder continuously records the last 30 (or 120 for newer versions) minutes of cockpit conversation, both in the cockpit and between the cockpit and people in other aircraft, or on the ground. The flight data recorder maintains a continuous record of an aircraft's operating parameters, including altitude, speed and the position of key controls.

Typically, the NTSB holds a public hearing to collect additional information through witness testimony and various aviation experts. Hearings also permit the board to raise safety issues publicly. A final report, stating the probable cause of the accident, is presented to the full board at a public meeting, also called a Sunshine Hearing, in Washington, D.C. This normally occurs several months after the accident. However, safety recommendations stemming from the accident sometimes precede the final report. Completion of a major accident investigation can take years.

Aircraft Maintenance

The airlines long have practiced a sophisticated and comprehensive form of preventive medicine when it comes to maintenance. The nature of the airline industry leaves no choice but to ensure that essential equipment is in good working order before an aircraft goes into service.

Every airline has a maintenance program for each type of aircraft it operates. The programs are developed jointly with the manufacturers of the equipment and, as mentioned earlier, must be approved by the FAA. Each involves a series of increasingly complex inspection and maintenance steps pegged to an aircraft's flying time, calendar time, or number of landings and takeoffs. With each step, maintenance personnel probe the aircraft, taking apart more and more components for closer inspection. Among the many inspection and maintenance procedures, a typical program involves:

- a visual "walk around" inspection of an aircraft's exterior, several times each day, to look for leaks, worn tires, cracks, dents and other surface damage; important systems inside the airplane also are checked
- an inspection, every three to five days, of the aircraft's landing gear, control surfaces such as flaps and rudders, fluid levels, oxygen systems, lighting and auxiliary power systems
- an inspection, every six to nine months, of all of the above, plus internal control systems, hydraulic systems, and cockpit and cabin emergency equipment
- a check, every 12-17 months, during which aircraft are opened up extensively, so inspectors can use sophisticated devices to look for wear, corrosion and cracks invisible to the human eye
- a major check, every three and a half to five years, in which aircraft are essentially taken apart and put back together, with landing gear and many other components replaced

In between these scheduled maintenance checks, computers onboard the aircraft monitor the performance of aircraft systems and record such things as abnormal temperatures and fuel consumption. In the newest aircraft, this information is even transmitted to ground stations while the plane is in flight. Some of the major U.S. airlines have extensive maintenance facilities and do much of their own maintenance work. Others contract maintenance functions to expert maintenance, repair and overhaul organizations (MROs), also known as repair stations. These may be located in the United States or abroad, but in either case are FAA-approved under FAR Part 145. Regardless of who performs the work, or where that work is done, the airline itself retains ultimate responsibility for the quality of the work.

The airlines also have ultimate responsibility for all of the parts they buy. To ensure that parts meet original equipment manufacturer (OEM) specifications, airlines have adopted rigorous purchasing procedures and quality-control programs.

Aircraft manufacturers provide considerable product support to their airline customers. In effect, the manufacturers stand behind each of their aircraft for as long as they are in service. If a problem develops, it is immediately reported to the manufacturer, which in turn, alerts other owners of the aircraft model through service bulletins about the problem and the corrective course of action.

The FAA also receives the bulletins, and if the problem poses a serious safety hazard, it converts the bulletin into an AD – mandating inspections, modifications, repairs or other steps that are necessary to maintain safety. The FAA permits airlines to operate aircraft temporarily with certain items inoperative. The minimum equipment list (MEL) details which items may be inoperative during revenue flights. Airlines are given a specified period of time to repair or replace these items. They are not permitted to postpone repairs that relate to the safe operation of the aircraft. Items affecting safety or airworthiness must be repaired prior to further flight.

Training

Airline employees in general receive an extensive amount of training, but especially those who work aboard the aircraft and whose performance directly affects safety.

Pilots are among the most highly trained individuals in any field. Applicants for employment with a major airline must go through several steps just to get into a training program, then several more steps before they actually begin to fly.

Although airline hiring procedures may differ, those accepted for an interview are judged by many of the same criteria used to judge applicants for any job, including experience and professionalism. The second step is a screening process involving psychological and aptitude tests and a stringent medical examination. Step three usually is a test in a flight simulator that evaluates an applicant's flying skills. Between 10 and 15 percent of an airline's applicants typically make it through this process to gain acceptance to an airline's training program.

Programs vary, but as mentioned, all must meet certain standards established by the FAA, and all must be approved individually by the FAA. Proficiency is the common goal of today's training programs. In many areas, the FAA and the airlines no longer require a set number of hours of training at various tasks as they did in the past. Instead, they require whatever training is necessary for trainees to become proficient at the required tasks. The process recognizes the fact that applicants with different prior experiences enter training programs with different skills and abilities.

The airlines use various training methods, depending on subject matter. The methods include classroom instruction, training in simulators, hands-on equipment training, and the use of self-pacing, self-testing, computerized video presentations. In all cases, the training exercises conclude with exams, drills or flight checks to ensure understanding and competence.

Airline pilots and flight engineers also are required to complete certain recurrent training each year. Normally, recurrent training is done in an advanced simulator and takes two to four days, depending on the type of airplane the pilot operates. Pilots in command, or captains, must complete some elements of recurrent training every six months.

Collaborative Efforts

Government and industry officials commonly work together to address recognized safety problems, usually through committees or task forces comprising representatives of equipment manufacturers, airlines, pilots, mechanics, the FAA and NASA. The Commercial Aviation Safety Team (CAST) is an example of effective collaboration across the industry.

Recent initiatives that require broad industry collaboration include:

Aging Aircraft

Following a highly unusual fuselage structural failure, a major effort was undertaken to re-examine and revise maintenance and modification procedures for older aircraft. Now, as aircraft age, many components are automatically replaced at specified intervals, well ahead of the time they would be expected to fail.

Collision Avoidance

Years of joint research between government and industry resulted in the development and deployment of the Traffic Alert and Collision Avoidance System (TCAS), which warns pilots when aircraft are getting too close and tells them what they should do to maintain adequate separation. TCAS is now in all commercial jets with 10 or more seats.

Wind Shear

As with TCAS, government and industry jointly developed warning devices for aircraft that alert pilots to wind-shear conditions so they can take appropriate action to avoid these dangerous downdrafts of air.

De-icing

Following an accident attributed to ice on the wings of the aircraft (a condition that disrupts airflow over the wings and makes it difficult for aircraft to fly), government and industry officials developed and implemented new procedures for pilots to follow in icy conditions. After de-icing (a process in which a fluid that melts and repels ice is sprayed on an aircraft exterior), pilots have a specific amount of time to take off, depending on weather conditions, and the aircraft must be de-iced again if it exceeds the allotted time.

Flammability

In a series of steps, airlines and government officials have upgraded aircraft interiors with more fire-resistant materials for seats, cabin sidewalls, overhead bins and other cabin and cargo bay materials.

Human Factors

Recognizing that most accidents are caused by human error, industry and government alike have focused resources, in recent years, on studying human-factor issues. While ongoing, these efforts already have produced improvements in training and in the management of tasks in the cockpit.

Wildlife Impact Damage

It is estimated that wildlife damage, principally but not exclusively due to bird strikes, may cost the U.S. airline industry more than $300 million per year. Starting in the early 1990s, the U.S. Department of Agriculture (Animal and Plant Health Inspection Services) Wildlife Services Division and the FAA (Airports Division) wildlife biologists cooperated to maintain a Web-based National Wildlife Aircraft Strike Database. The two government agencies utilize the contract services of Embry-Riddle Aeronautical University to archive voluntary reports received on FAA Form 5200-7. Ideally, timely reporting by pilots, mechanics, ground-services personnel, station management personnel, safety investigators and airport wildlife biologists can be matched to a small sample of bird remains mailed to the Smithsonian Institution Feather Identification Laboratory in Washington, D.C. This can lead to valuable information that will help airports refine their Wildlife Management Plans required for certification by FAR Part 139. This can result in effective control measures that deal with attractants, habitat, migration patterns and detection and dispersal technologies.

Safety Management Systems (SMS)

The airline industry has adopted the concept of a “systems safety” approach to minimize incidents and accidents within the commercial aviation industry. SMS theory invokes a “continuous improvement process” in which hazards are identified, a risk assessment is accomplished, mitigation strategies are optimized and effectiveness of the mitigation is measured. SMS is an overarching philosophy under which all functions of airline management take an active role in contributing toward safety awareness, education, cost justification, resource allocation and conservation, product reliability and overall performance. SMS can be viewed as an umbrella under which other safety programs (Air Transportation Oversight System, Flight Operations Quality Assurance, Aviation Safety Action Programs, Internal Evaluation Programs, Voluntary Disclosure Programs, Continuing Airworthiness Systems, Maintenance Reliability Review Boards, Quality Assurance, etc.) can be integrated to provide a continuous picture of the safety “health” of an air carrier. In this manner, executive oversight can be focused on detecting problems and putting solutions in place before they become detrimental to the safe and efficient operation of the carrier.

Future Safety Efforts

While safety efforts have historically focused on understanding the causes of accidents and preventing their recurrence, future efforts will attempt to identify risks before they result in an accident. Recognizing risks to safety is difficult and requires a variety of detailed and potentially sensitive information to be integrated and analyzed. This approach enables the industry and regulators to concentrate safety resources on mitigating risks before they manifest as accidents.

Although the FAA is charged with the responsibility of setting and enforcing minimum safety standards, the ultimate and primary responsibility for safety rests with the airlines. The Federal Aviation Act that established the FAA's predecessor agency stated that every license holder assumes "private sector responsibilities for maintaining the highest degree of safety." Of course, it also makes good business sense for the airlines to do everything they can to ensure safety. To airlines, safety is the top priority, and every year they work jointly through the Air Transport Association on an agenda of safety-related programs.

Chapter 5

Chapter 7

Last Modified: 2/4/2009

Air Transport Association of America, Inc. ata@airlines.org

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 7

Security

The U.S. airline industry began security screening of passengers and their baggage in 1973, following a rash of aircraft hijackings. Passengers were required to be screened via metal detector prior to entering the concourse leading to their gate area, to prevent weapons from being carried aboard aircraft. Subsequently, airlines began to screen carry-on baggage by X-ray machine. This screening system has been in place for several decades and has been extremely successful in preventing hijackings.

During the 1980s, a new and much more serious threat emerged – the threat of sabotage and terrorist acts of aggression – particularly against U.S. flag carriers' flights originating from overseas locations. The Federal Aviation Administration (FAA) and the airlines, working closely together in 1985, took steps to significantly enhance and add new aviation security measures. In the 1990s, measures were once again enhanced to include the following steps for certain international flights:

- Guarding aircraft at all times while they are on the ground and parking them in secure areas overnight
- Searching aircraft cabins, cockpits and cargo holds prior to their first flight of the day
- Inspecting the property of all people who service aircraft, such as cleaning personnel, mechanics, caterers, and cargo and baggage handlers
- Accepting baggage only from ticketed passengers and only at ticket counters inside an airport
- Hand searching or X-raying all checked luggage
- Matching checked baggage against the names of people who have boarded a flight and pulling bags from the baggage compartment for further inspection if they do not match a passenger aboard the flight
- Questioning passengers before each flight to make sure they have not accepted gifts or packages from people they do not know

In 1993, terrorism struck the United States directly with the World Trade Center bombing, followed by the bombing of the federal building in Oklahoma City, Okla. Once again, security was increased at U.S. airports. As a result of the recommendations of the White House Commission on Aviation Safety and Security, published in February 1997, the FAA has purchased and deployed sophisticated explosive-detection screening equipment at certain U.S. airports for use by the airlines. U.S. airlines utilize a government-required and approved Computer-Assisted Passenger Pre-Screening System (CAPPS), which automatically determines – using government-mandated, objective criteria – which passengers require additional scrutiny. Enhancements to passenger-screening procedures and training have been implemented and mandatory background checks were required for airline-screening personnel. Various improvements in cargo-screening procedures were also implemented.

The aviation security landscape changed forever after September 11, 2001. Congress enacted the *Aviation and Transportation Security Act* (ATSA), which transferred the responsibility for screening passengers, baggage and cargo to the Transportation Security Administration (TSA), also created by the Act and subsequently placed in the Department of Homeland Security (DHS). In accordance with federal regulations, airlines immediately limited access to the security checkpoint to passengers with a valid boarding pass. Airlines also hired and trained additional screeners to conduct secondary screening of passengers at the gate.

Airlines went to work with aircraft manufacturers and the FAA to design and install hardened cockpit doors. These reinforced doors were installed on the entire U.S. fleet in advance of the April 2003 deadline.

As mandated by Congress, TSA was required to assess, hire and train federal screeners to screen passengers and checked baggage. TSA initially hired 45,000 full-time screeners to staff positions at over 420 commercial airports. The agency worked vigorously to purchase and deploy upgraded walk-through metal-detection devices, X-ray units and explosive trace detectors (ETD) for passenger-screening checkpoints.

In November 2002, TSA officially assumed responsibility for screening passengers and carry-on baggage. At the same time, the organization was faced with the challenging December 2002 deadline for conducting 100 percent checked-baggage screening. While many of the thousands of ETDs and explosive-detection systems (EDS) had been deployed, it was clear that more time was needed to meet the deadline. In order to provide a more reasonable implementation time, Congress extended the deadline by one year. In December 2003, TSA met the deadline for checked-baggage screening.

The airlines are required by the federal government to verify passengers against watch lists, issued by TSA. These watch lists include the names of individuals who are known or suspected terrorists. The selectee list includes the names of individuals that must be subjected to additional screening. The No-Fly List includes the names of individuals who are not allowed to fly. Simply because a passenger is subjected to additional screening does not necessarily mean that the individual is on the TSA watch list. The CAPPS designates passengers for additional screening.

The airline industry voluntarily participated in the TSA-sponsored Aviation Security Advisory Committee (ASAC) and provided 43 recommendations to enhance cargo security. Many of these recommendations were incorporated into the TSA Air Cargo Security Final Rule, issued in May 2006 and accompanied by proposed security programs that go far beyond the industry-identified security measures. Some measures pose significant operational challenges for the carriers.

Through the multiple layers of security and random cargo inspections, the rule will serve to further enhance cargo security. But TSA needs to work with carriers to ensure that the cargo-security measures deliver the highest possible level of security without adversely impacting carrier operations.

What we have, and what is conveniently overlooked by many, is an effective cargo-security system that has been and continues to be enhanced.

TSA has implemented a risk-based process to evaluate and prioritize threats. This practice helps to preserve limited resources, by allocating funds in accordance with sound risk-management principles. The aviation security system has been substantially improved over the years to maximize efficiency while maintaining the highest possible levels of passenger, cargo and employee security. The system will continue to evolve as new and promising technology is identified.

Chapter 6

Chapter 8

Last Modified: 2/4/2009

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 8

Chapter 8: Airports

The United States possesses the largest, most extensive aviation system in the world with more than 19,800 airports, ranging from large commercial transportation centers enplaning more than 30 million passengers annually to small grass or cobblestone strips serving only a few aircraft each year. Of these, 3,431 are designated as part of the national airport system and are therefore eligible for federal assistance. The federal interest in capital investment for airports is guided by several objectives, most notably ensuring safety and security, preserving and enhancing the system's capacity, helping small commercial and general aviation airports, funding noise mitigation and protecting the environment.

NATIONAL SYSTEM AIRPORTS - 3,431 total airports (including 67 proposed new airports) categorized as follows:

Commercial Service Airports (517 airports) – publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service:

- 382 primary airports designated as large, medium, small or non-hub (more than 10,000 passenger boardings each year)
- 135 nonprimary airports (between 2,500 and 9,999 passenger boardings each year)

Reliever airports (274 airports) – those designated by the FAA to relieve congestion at Commercial Service Airports and to provide improved general aviation access.

General Aviation Airports (2,573 airports) – the remaining airports including privately owned, public use airports that enplane more than 2,500 or more passengers annually and receive scheduled airline service.

Ownership

Although almost all commercial airports in the United States are publicly owned, the private sector plays a significant role in their operations and financing. Employees of private companies – airlines, concessionaires and contractors – account for 90 percent of all employees at the nation's airports. The largest source of capital for airport development is tax-exempt bonds, secured by future airport revenue and subject to the scrutiny of credit-rating agencies. In other countries, most airports are owned and operated by national governments.

Privatization

The possible sale or lease of commercial airports in the United States to private companies has generated considerable attention in recent years. Several factors, such as providing additional private capital for development, have motivated greater interest in airport privatization. Concerns over the possible abuse of the monopoly power of an airport, along with long-established legal and regulatory protections for existing airport investments and their revenue streams, however, have held back wholesale airport privatization in the United States.

Even if a sale or lease transfer could overcome legal obstacles, the ability of a private airport to operate profitably is uncertain. A privately owned airport would not be eligible for tax-exempt debt financing, federal airport grants or passenger facility charges (PFCs). Since these sources constitute the majority of capital funding at most airports, financing costs would rise significantly.

As part of the *Federal Aviation Reauthorization Act of 1996*, Congress established an airport-privatization pilot program that exempted up to five airports from legal requirements that limit their sale or lease to private entities. A single commercial service passenger airport (Stewart/Newburgh, New York) has joined the program. While the facility was originally operated by a private management company under a 99-year lease, they subsequently assigned their interest to the Port Authority of New York & New Jersey, with the Port Authority assuming control in November 2007. As a result, Stewart is removed from the Privatization Pilot Program.

The City of Chicago has entered into discussions with the FAA, the airlines and potential buyers about the sale of Chicago Midway Airport. The FAA preliminarily approved the city's application for participation in the pilot privatization program in October 2006. The city is currently in negotiations with the airlines, and must complete those negotiations before moving forward.

National governments of many foreign countries have historically owned and operated airports; over the past decade and a half many countries have begun to privatize all or parts of their nation's aviation system. The United Kingdom, which sold its major commercial airports in 1987, is one of the few countries where airports have generated profits for their shareholders.

Organizational Structure & Governance

Airports in the U.S. that receive scheduled commercial service typically are owned by cities or counties and operated by governmental units. Types of airport ownership/management structures include:

- Department of City/County Government – the head of the airport department reports to the mayor or city/county manager; another variation is where the airport is governed by an appointed commission that is subordinate to the city council or board
- Component of State Government – the airport is controlled by the state rather than the local government with the Department of Transportation or a subagency owning and operating the airport
- Airport Authority/Commission – these are autonomous bodies with an appointed board that makes final decisions on policy and expenditures
- Port Authority – airport management reports to the head of the Port Authority who also oversees the marine facilities and other related transportation departments
- Bifurcated Arrangement – the city or an individual corporation operates the airport terminal while the state manages the airfield

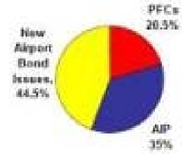
Because airports resemble small cities, they are organized like a small city, with departments that include purchasing, engineering, finance, legal, operations, personnel, administration, security and public relations. They also have fire and police departments and must handle such typical municipal duties as trash and snow removal.

Financing

Commercial service airports, contrary to popular misconception, are not funded by government general fund tax dollars – federal, state or local. Rather, those airports are funded either directly or indirectly out of aviation revenue generated by airlines, their passengers or airport vendors in the form of direct payments or through earmarked taxes collected from aviation system users. Over 80 percent of commercial service airport revenues are generated via the aeronautical activities on the airports; the balance coming from concessions revenues, interest, etc.

Airport Investment
($ billions)

	Airport Revenue Bonds (New Issues)	AIP	PFCs	Total New Investment	Airport Revenue Bond Refinancing
2001	6.32	3.11	1.59	11.02	2.10
2002	3.11	3.40	1.86	8.37	3.40
2003	4.47	3.27	2.01	9.75	2.80
2004	2.84	3.37	2.23	8.44	1.70
Total	**16.74**	**13.15**	**7.69**	**37.58**	**10.00**

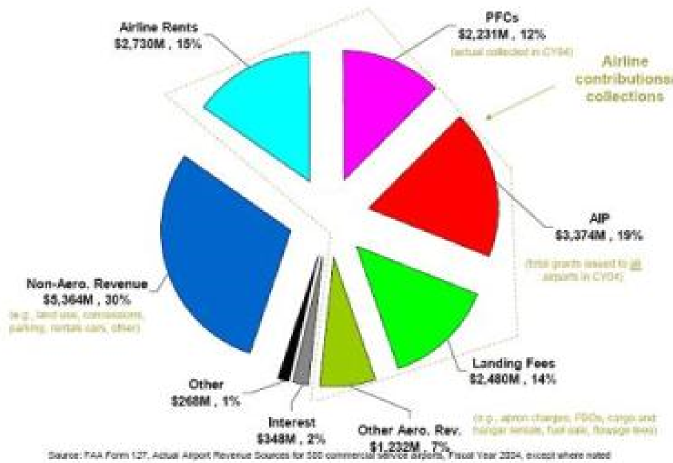


Cumulative percentage of airport capital investment sources (new funds) since 2001

Source: ACI-NA

Airports rely on a variety of public and private funding sources to finance their capital development, including airport bonds, federal and state grants, PFCs, and airport-generated income.

AIRPORT REVENUE SOURCES (Capital + O&M)
Over 65% of Airport Revenue from Commercial Users



Source: FAA Form 127, Actual Airport Revenue Sources for 500 commercial service airports, Fiscal Year 2004, except where noted

Airport Improvement Program (AIP)

Airport grant programs are funded from taxes and fees specifically collected for that purpose. As of January 2007, these included a 7.5 percent domestic ticket tax and a $3.40 per-person per-flight-segment fee for all domestic flights, except to certain rural airports. A $15.10 international arrival tax and a $15.10 international departure tax (both adjusted for the annual rate of inflation, beginning Jan. 1, 1999), a 6.25 percent tax on domestic air freight, a 4.3 cents-per-gallon domestic air fuel tax, and taxes on the fuel used in small planes and for noncommercial purposes also fund the grant programs. These revenues are credited to the Airport and Airway Trust Fund (AATF), created by Congress in 1970 to fund improvements to airports and the nation's air traffic control system. The FAA dispenses grants to airports out of the fund for projects under the Airport Improvement Program (AIP), which had total outlays of $3.6 billion in FY2006.

Passenger Facility Charge (PFC)

Since 1992, airports gained the right to charge airline passengers a $3.00 fee, known as a passenger facility charge, which the airlines collect as an add-on to the airfare. Effective April 2001, Congress authorized an increase in the maximum PFC rate that airports can charge passengers – $4.50 per segment, with a cap of $18.00 for a round trip. These taxes must be pledged to specific capital improvements that will: (1) preserve or enhance safety, capacity or security of the national air transportation system; (2) reduce noise; or (3) enhance competition between or among air carriers. Every PFC is tied to specific capital improvement projects that have been approved by the FAA, and the fee expires when all of the money needed for the approved projects has been raised (unless new projects have been approved under a separate application).

More than 360 airports have received federal government approval to levy this tax. Currently, more than $2.7 billion in PFCs are collected each year, and the FAA has already authorized the collection of more than $61 billion. However, even though one of the main objectives of the PFC program is to increase airport safety and capacity, only 18 percent of collected funds have been used for airfield safety and capacity improvements. In fact, more PFC funds are now being spent on interest for capital projects (32 percent) than are being spent on airfield safety and capacity. Passenger facility charges, when used wisely, have been a useful tool in meeting aviation infrastructure needs.

Revenue Bonds

More than 95 percent of all airport debt issued since 1982 has been in the form of general airport revenue bonds (GARBs), which are secured by an airport's future revenue. For the period 2001-2005, airports issued $30.1 billion in new debt and refinanced an additional $19.6 billion, all via general airport revenue bonds.

Capital improvements such as the construction of a new terminal or parking garage are sometimes funded privately (for example, by an airline if the new facility is for its exclusive use), but more often through the sale of revenue bonds by the airport operator. Revenue bonds are repaid, with interest, from the future revenue the new facility generates. For example, revenue bonds sold for a new terminal would be repaid with the rent the airport collects from the airlines and other tenants using the terminal.

Usually, the airport owns all of the facilities built on its property, regardless of how their construction was financed. Facilities built for exclusive use of a tenant, however, are sometimes leased to that tenant for a long period of time.

Years ago, general obligation bonds, which are backed by the taxing power of a governmental unit, were far more common because of their stronger credit standing and, therefore, lower financing costs. The decline in general obligation bonds reflects the improved acceptance of GARBs by investors. Today, smaller commercial service and general aviation airports are the most common issuers of general obligation bonds for airport development.

Airport Costs

With the exception of some small and nonhub airports that receive subsidies from their municipality, U.S. airports are self-sustaining. The revenue, collected from businesses, passengers and shippers using the airport, covers most of the operating expenses associated with operating the airport.

Typically, companies doing business at an airport (airlines, car rental companies, restaurants, stores, etc.) pay rents for the space they occupy. Many businesses also pay a gross-receipts fee based on the total value of their business at the airport. Airlines do not pay gross-receipts fees, but pay flight fees based on the weight of each aircraft that lands and/or departs. In some instances, they also pay aircraft parking and fueling fees, or make direct payments on long-term airport debt.

Rate-Making Concepts

There are two common methods for computing air-carrier fees: residual and compensatory. In a residual agreement, the signatory airlines accept the financial risk and guarantee the airport sufficient revenues to meet its operating costs and debt-service costs. Under the residual method, after an airport deducts all non-airline revenue from its total annual expenses, the airlines are responsible for the remaining (residual) amount, and rates are set accordingly.

Compensatory agreements are generally found at mature airports that have realized successful revenue generation. The airport undertakes the risk of meeting costs but also receives all the upside advantage. Under the compensatory method, an airport is divided into various cost centers (e.g., airfield, terminals, parking areas), and airlines pay a share of those costs based on the amount of space they occupy, planes they land/depart and other measures of airport use.

While the fees airlines pay to airports represent a small portion of overall airline operating costs (approximately 5 percent), they have been one of the industry's fastest-rising costs. Between 1992 and 1999, airport costs exclusive of PFCs rose 35 percent. Including PFCs, they rose 70 percent. In contrast, the producer price index over that same period of time increased less than 8 percent and airline prices rose less than 4 percent.

Revenue Diversion

Of increasing concern to airlines (and many airport operators) has been local political interest in diverting money away from airports for other nonaviation purposes. This activity, known as revenue diversion, is prohibited by federal law, but is allowed, in a few instances, under special arrangements that were "grandfathered" in the federal statutes addressing this issue.

Regulation of Airports

As mentioned in Chapter 6, airports that receive scheduled air service by carriers must be certified by the FAA as operating within strict federal safety guidelines for design and operation. This certificate is known as a Part 139 certificate after the section of the federal air regulations (FARs) dealing with airport safety. Part 139 certificates are the equivalent of the Part 121 certificates for airline operations. Airports also may have to comply with state and local regulations, although these usually deal with environmental or administrative matters rather than strictly with safety.

Airport Capacity

Airports have two components – landside and airside. Landside includes an airport's roads, parking lots, passenger drop-off and pick-up points, check-in areas, baggage-claim areas, and concession areas. Airside includes aircraft gates, aprons, taxiways and runways.

Landside capacity is the number of passengers per year that the airport's roads, parking lots and terminals can handle. Airside capacity, on the other hand, is the number of aircraft operations that the airport's runways, taxiways and gates can accommodate safely. Landside is geared toward the movement of ground traffic (people and packages) into and out of the airport, and airside to the movement of air traffic into and out of the airport.

The FAA calculates an airport's airside capacity using an engineering formula that takes into account the various ways an airport's runways are used, or not used, in different wind and weather conditions. Known as an Engineered Performance Standard (EPS), it is expressed in aircraft operations per hour.

Decisions that the FAA air traffic control division makes about the flight paths carriers will follow in and out of an airport also affect airside capacity. Airport capacity, or lack of it, is one of the most significant issues facing civil aviation. A great deal of attention has been focused in recent years on getting more capacity out of airports that already exist. This can be done by adding, extending or altering runways, taxiways and landing aids or, perhaps, by changing departure and approach patterns.

These and other capacity enhancements, however, often face stiff opposition from residents of surrounding communities, who often want to see airport operations scaled back because of environmental concerns. Building entirely new airports in less densely populated areas, on the other hand, is a more expensive option to expanding existing facilities, and often less convenient for most travelers.

Chapter 7

Chapter 9

Last Modified: 2/4/2009

Air Transport Association of America, Inc. ata@airlines.org

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 9

Air Traffic Control

ATC Facilities

The air traffic control (ATC) system is managed and operated by the Federal Aviation Administration (FAA), an agency of the U.S. Department of Transportation. The government developed the ATC system primarily to maintain safe separation of aircraft arriving in, departing from and flying over the United States. Secondarily, it is an air navigation provider's job to keep air traffic moving as efficiently as possible throughout the system. In short, ATC is aviation's traffic cop, working to ensure that aircraft fly safely through the airspace and that traffic moves in an orderly fashion with minimal delay.

The U.S. ATC system is the safest and oldest ATC system in the world. Today our system is prone to capacity and delay problems affecting both passengers and shipments. We continue to rely on technologies and procedures developed decades ago that consume tremendous amounts of capital resources. The architecture of the ATC system is what requires the most urgent modernization.

Smart Skies, a national campaign led by the airlines of the Air Transport Association, advocates modernization of the U.S. air traffic control system and how it is funded. Visit www.smartskies.org for more information.

There are several types of ATC facilities. These include the ATC towers (ATCTs) familiar to most travelers, terminal radar approach control facilities (TRACONs), air route traffic control centers (ARTCCs) and flight service stations (FSS).

Air traffic tower personnel control airborne aircraft and ground movements of aircraft and vehicles transiting to and from runways, taxiways, ramps, and during takeoffs and landings. The FAA bases its decision to build and operate a tower on the number of aircraft operations at a given airport. More than 450 U.S. airports currently have such towers.

TRACONs generally control aircraft in a 30-50 mile radius from the airport and from the surface up to 11,000 feet. FAA facilities consist of 517 ATCTs, including 168 combined ATCT/TRACONs, 21 air route traffic control centers (ARTCCs) and the Air Traffic Control System Command Center in Herndon, Va. TRACONs are less than the number of towers because some TRACONs handle more than one airport. For example, a single TRACON handles multiple airports and all of the traffic approaching and departing from the entire New York-metro area. FAA is in the process of consolidating TRACONs to improve efficiency.

The 21 ARTCCs issue clearances/instructions for airborne aircraft, and provide services to aircraft at many small airports without ATC towers. Their job is to keep track of aircraft while they are en route or during the high-altitude cruise phase of their flights. They are located in Albuquerque, Anchorage, Atlanta, Boston, Chicago, Cleveland, Denver, Fort Worth, Houston, Indianapolis, Jacksonville, Kansas City, Los Angeles, Memphis, Miami, Minneapolis, New York, Oakland, Salt Lake City, Seattle and Washington, D.C.

Flight service stations are primarily information centers for general aviation pilots flying in and out of small cities and rural areas. Flight service stations provide flight information such as pilot weather briefings, flight planning and aeronautical information, and also assist in emergency situations by initiating and coordinating searches for missing or overdue general aviation aircraft.

Air Traffic Control System Command Center

Another key facility, overseeing the National Airspace System (NAS), is the FAA Air Traffic Control System Command Center (ATCSCC), located in Herndon, Va. One of the command center's priorities is to anticipate situations that will create bottlenecks or other constraints in the system, and then respond with a management plan for air traffic transiting constrained airspace. For example, if bad weather develops or a runway is closed for repairs, ATCSCC will manage the number of flight operations into and out of the affected area or airport.

Surveillance Systems

ATC primarily uses radar to keep track of aircraft flying over the United States with centers utilizing radar systems with ranges of up to 200 miles. Consolidating the numerous radar systems require costly automation to consolidate and effectively display the data. In the future, satellites are expected to supplant ground-based radar as the primary means of tracking airplanes.

Communications

Flight crews and air traffic controllers communicate by radio using VHF frequencies between 118 and 136 megahertz. Pilots tune to the frequency of the controller tracking their flight and switch frequencies as they move through the system and are handed off from one controller to the next.

A Typical Flight

From the standpoint of ATC, all airline flights begin with the flight plan, which spells out the route the flight crew plans to follow, alternative airports the crew would use in the event of an aircraft emergency or a problem at the intended destination, as well as the amount of fuel onboard the aircraft. The aircraft dispatcher submits the flight plan to ATC prior to the departure of the flight. Many airlines that fly the same routes every day keep flight plans stored in the FAA host computer and merely activate them through their dispatch systems prior to flight. In any event, a flight plan provides crucial information to ATC about what a particular crew intends to do.

Once the pilots have completed their preflight planning, aircraft inspections, and have settled into the cockpit, they make their first call to ATC. Typically this call is made to clearance delivery, which reads back to the crew the filed ATC flight plan and instructions the crew can expect from takeoff to landing. Ideally, but not always, this information matches the route filed in the flight plan. ATC sometimes has system constraints or traffic-management initiatives in place that the flight crew may not be aware of, at which point ATC would give pilots new instructions before or during a flight.

When the flight crew is ready to depart, it contacts ground control for permission to leave the gate. Once an aircraft leaves the gate area and begins to taxi, it comes under the jurisdiction of FAA ground control.

The tower controller assumes full control of the aircraft as soon as it reaches the end of the runway it will use for takeoff. When the runway is clear, the tower grants permission for takeoff. It also instructs the crew on the heading, or direction, it should follow immediately after takeoff.

When safely airborne, tower control hands off the aircraft to departure control, which oversees the flight as it climbs away from the airport and enters the en route airspace. Given the speed and climb capabilities of modern jets, this may only take a few minutes. Departure control then turns over the flight to an en route center.

All of these and subsequent handoffs are accomplished by radio. The controller handing off the flight instructs the crew to contact the next level of ATC surveillance, and gives the crew the necessary radio frequency. Once contacted, a receiving controller acknowledges radar contact with the flight crew and issues instructions for heading and altitude.

Depending on where the plane is going, it may be handed off many times during the course of its flight, from one en route controller to another. En route controllers are assigned to specific sectors or areas in which they work to maintain safe separation of aircraft.

Aircraft separation standards vary according to circumstances. When aircraft are cruising at high speeds in en route airspace, the standard is five miles of horizontal radar separation or 1,000 feet of vertical separation. When aircraft are moving at much slower speeds as they depart or approach the airport terminal area, the standard is three miles of horizontal radar separation.

As an aircraft approaches its destination airport and begins its descent, the flight crew is instructed to contact approach control. An approach controller will issue instructions to the crew to blend the aircraft into the flow of other aircraft arriving at the airport. As soon as the crew is on its final, straight-in approach, the approach controller hands the aircraft off to the airport tower, which grants final clearance to land and monitors the aircraft until it completes its landing and exits the runway. A ground controller then directs the aircraft to its gate.

Flight Rules

While all commercial airlines are controlled every step of the way, the same level of positive control does not always extend to general aviation aircraft. These aircraft can, and often do, fly at 18,000 feet (FL180) and below, without the benefit of ATC instruction. Since aircraft climb and descend at an angle, the airspace controlled by ATC in the airport terminal area resembles the conical shape of a giant, upside-down wedding cake over the airport proper.

Instrument flight rules (IFR) govern how aircraft must fly in bad weather and low visibility. To fly commercial aircraft or to fly IFR, the flight crew or pilot must be instrument-rated, meaning they are proficient at navigating and flying using cockpit instruments only, without the benefit of good visibility out of the cockpit windows. Commercial airline flights always file IFR flight plans, regardless of weather, since flight operations are mostly conducted at FL180 and above.

General aviation pilots must file an IFR flight plan whenever a flight cannot be operated under visual flight rules (VFR). General aviation aircraft may fly under VFR when weather and visibility are good. They do not have to file a flight plan nor communicate with ATC, unless they choose to operate into or out of an airport with a control tower. Under VFR, pilots are responsible for maintaining adequate separation from other aircraft, which is why these rules sometimes are called the *see and be seen* rules.

Airport and Airway Trust Fund

In 1970, Congress created the Airport and Airway Trust Fund (AATF) to pay for improvements to airports and the ATC system, such as new runways and taxiways, control towers, landing aids and radar systems. In the years since, Congress also has authorized the use of trust fund money for FAA operating costs, such as the salaries of controllers.

The money in the fund comes from taxes and fees paid primarily by airlines, air travelers and shippers. Congress has raised the taxes several times. General aviation contributes increasingly to congestion but accounts for a minimal and disproportionate share of trust fund revenues.

Delays, Modernization and Corporatization

Because ATC is involved in the movement of all commercial aircraft, the capabilities and efficiencies of ATC have a direct bearing on airline schedule performance and customer experience. An equipment glitch or personnel shortage at an ATC facility, for example, usually means that the flights it handles will be delayed. Bad weather, of course, is the primary cause of most back-ups, but deficiencies in the National Airspace System itself also play a major role in airline delays.

The FAA projects that U.S. airlines will carry more than one billion passengers by 2015, with enplanements rising an average of 3.1 percent per year. In order to prepare for this growth, the aviation community will need to invest in the Next Generation Air Transportation System (NextGen), the successor to today's antiquated ATC system. In 2005, every minute of aircraft delay cost the industry more than $62, for an annual system total of nearly $6 billion.

When air travel and air cargo service soared following deregulation, the FAA began a massive modernization effort intended to bring the ATC system up to where it needed to be to handle air traffic efficiently. However, the effort quickly bogged down and remains troubled, with little to show in terms of reducing airline delays.

The concept of a federal corporation to run ATC, more along the lines of a modern business, was advanced by the airlines in the mid-1980s. However, the idea met considerable opposition at that time, and again in 1994, when the Clinton administration advanced its own version of the concept. There has been no recent attempt to corporatize.

Chapter 8

Chapter 10

Last Modified: 2/4/2009

AIR TRANSPORT ASSOCIATION

Airline Handbook Chapter 10

Energy and Environmental Matters

From Fossil to Fuel

Petroleum, or crude oil, is a hydrocarbon (a chemical compound containing hydrogen and carbon) that can be distilled into gasoline, kerosene, oils and waxes. Hydrocarbons are formed from large deposits of decomposed plant and animal matter. The best environments for the production of petroleum are restricted basins of water, such as oceans or lake bottoms, where there is little or no water circulation. Petroleum, which is squeezed out of decomposing micro-organisms as sediment, becomes increasingly compacted over time. This process takes billions of years and occurs in large quantities in certain regions of the world.

Once extracted from the ground, oil is transported to refineries in the United States via pipeline, oceangoing tanker or barge. The United States buys oil from a globally diverse group of suppliers, including private domestic producers from Alaska to Louisiana, as well as a mix of private and state-owned suppliers in nations such as Kuwait, Mexico, Russia, Canada and Venezuela. With increasing demand throughout the economy and limited access to domestic supplies, U.S. consumers must rely on foreign suppliers to make up the difference.

After it is refined, jet fuel travels by pipeline to storage sites, airports or fuel terminals where it is distributed by truck, barge or pipeline. Once it reaches the airport, fuel is distributed in a variety of ways. Some airports have internal hydrant systems that carry fuel from a storage site at or near the airport, then under ground to the terminal gates, where hoses span the final distance to the wing of the airplane. At airports without such systems, refueling trucks are used to move fuel from the storage site to the aircraft.

Accommodating Demand

Producers sell oil through a variety of arrangements, including private bilateral contracts and market contracts that are priced through a commodity exchange. Air carriers buy fuel from multiple suppliers and at differing rates. Not every supplier operates at every airport that a carrier may serve, so multiple arrangements are necessary. Since airline schedules make fuel demand generally predictable, carriers can purchase fuel months or years in advance in order to receive a discounted rate from the supplier.

Locking in the prevailing price for future deliveries of a commodity like jet fuel is called a hedge. Hedging allows airlines to limit the uncertainty over future costs by mitigating volatility and improving financial planning. However, hedging requires a relatively healthy financial condition, a willing counter-party and often a sizable upfront transaction cost. Hedging also can be financially risky, because an airline could find itself locked into paying more for fuel if the market price drops below what it has agreed to pay in the hedge contract.

The Cost of Doing Business

Fuel and labor are the two largest operating expenses for all U.S. airlines, with fuel constituting 20 percent to 30 percent of the industry's operating costs. Several factors contribute to the price of jet fuel, which historically has tracked closely with movements in the price of crude oil. Those factors include: interrupted refinery operations; environmental regulations; surges in regional demand; seasonal swings in demand; supply disruptions caused by natural disasters, military conflict or geopolitical events; and market speculation.

The difference between crude oil and jet fuel prices, commonly known as the "crack spread," historically averaged about $5 per barrel. In the weeks following hurricanes Katrina and Rita in 2005, however, the crack spread widened dramatically when major oil supply disruptions prompted refiners to focus their operations on producing gasoline. As a result, airline demand for fuel far exceeded the available supply, causing the spot price of jet fuel to surge to more than double the spot price of oil. At its peak, the crack spread added the equivalent of $60 per barrel to the final cost of jet fuel, which reached $131.47 in the Gulf Coast on Oct. 5, 2005.

Just as motorists pay different prices for gasoline in different parts of the country, airlines pay different prices regionally for jet fuel. West Coast prices traditionally run higher, because of limited refining capacity as well as inferior storage, logistics and distribution capabilities. In addition to the mountainous terrain, which limits trucking capability, the West Coast lacks the more robust pipeline network of the East, although the latter is becoming increasingly strained by today's demand and competing product needs (i.e., gasoline vs. diesel vs. jet). Much of the product on the West Coast is imported, often from countries with even higher prices.

Airlines constantly strive to improve jet fuel efficiency, because unlike other modes of transport, airlines have no alternative source of energy. Airlines conserve fuel in many different ways, including reducing and more accurately measuring onboard weight; cruising longer at higher altitudes; employing greater use of flight-management systems; and conducting more in-depth analyses of weather conditions. In addition, airlines modernize their fleets with more fuel-efficient airplanes; invest in winglets to reduce aircraft drag and thereby reduce fuel consumption; redesign hubs and schedules to alleviate congestion; and pool resources to purchase fuel in bulk through alliances with other carriers.

Airlines also are monitoring the potential to utilize synthetic jet fuel currently employed in some parts of the world. While there are many questions that need to be addressed about the widespread use of synthetic fuels to propel commercial aircraft in the United States, ATA is encouraged by efforts by the Department of Defense, NASA, the Federal Aviation Administration, airframe and engine manufacturers, and academic institutions to bring coal-to-liquids (CTL) technology to the marketplace. Any incremental fuel supply, especially if both environmentally friendly and economically viable, is worth pursuing.

Did You Know?

- Determining how much fuel is needed for a particular flight involves a variety of factors such as aircraft type, passenger load, cargo, weather conditions and route length. Every aircraft is required to carry, at minimum, enough fuel to reach its destination, or reach a pre-determined alternate airport and still be able to fly for an additional 45 minutes.
- There are limits both for how much an aircraft can weigh to take off and land. Fuel burn is most efficient at higher altitudes; every aircraft type burns fuel at a different rate. Occasionally, an aircraft will carry more fuel than is needed for a particular flight either because fuel is more expensive at an intermediate stop, or because "ballast" is required to provide correct weight and balance.
- Winglets, those vertical fins at the ends of the wings, make airplane wings more aerodynamic, cut fuel consumption between 3 and 5 percent, saving more than 100,000 gallons of fuel per aircraft per year while reducing noise and emissions.
- Jet fuel is linked to the commodities markets principally through home heating oil, a refined product similar in consistency. Because home heating oil is traded on public exchanges, it is often used as a reference to price jet fuel – when the price of heating oil rises, so does the price of jet fuel. The inverse is also true, in that jet fuel prices often move heating oil prices.
- Jet A and Jet A-1 are kerosene grades of fuel for aircraft powered by turbine engines. Jet A is the most commonly used fuel for commercial airplanes and has a maximum freezing point of

-40°F; Jet A-1 has a maximum freezing point of -53°F to meet the low-temperature requirements of long, high-altitude flights. Jet A and Jet A-1 have a high flash point (100° F), making them relatively stable fuel types.

- About 50 percent of our petroleum imports are from countries in the Western Hemisphere, with 19 percent from the Persian Gulf, 18 percent from Africa and 13 percent from other regions.
- The United States consumes more than 20 million barrels (840 million gallons) of petroleum products each day, almost half in the form of gasoline used in more than 200 million motor vehicles with combined travel of more than seven billion miles per day.
- Approximately 145 refineries in the United States produce 1.55 million barrels of jet fuel per day.

Supply tightness has become a growing commercial challenge and frustration at many airports. By securing off-site storage, tankering fuel or supplementing pipeline-transported supplies with shipments by land or sea, however, airlines have managed to keep passengers and shippers from experiencing palpable disruption.

Fuel Prices

Fuel prices are influenced by a myriad of global and local factors, but are closely linked to the price of crude oil, which is being driven principally by a robust global economy, increasing supply tightness, geopolitical insecurity, and unique production and demand factors.

The technical specifications for jet fuel make it more complex to refine. U.S. buyers have also been somewhat disadvantaged in recent years when compared to their foreign counterparts, due to a relatively weak dollar. Beyond the price of crude oil, the price of jet fuel has risen sharply with overburdened refineries, competition with other products in multi-product pipelines and refinery outages.

Existence of the futures market and other derivative instruments allows any participant to “lock in” the prevailing price for future deliveries, such as home heating-oil prices for the winter season. Such a strategy, called a “hedge,” involves a series of transactions, offsetting profits or losses on a futures transaction against losses or profits on the physical purchase or sale of oil. By limiting the uncertainty over future costs, the hedge allows companies to mitigate volatility and thereby improve financial planning. A hedge instrument may or may not accompany the actual (physical) delivery. In most cases it does not. An airline could hedge volume at a fixed price, but most frequently hedges occur in paper markets or on an exchange, typically settled on a monthly or quarterly basis between the airline and an oil company or bank.

The primary means by which airlines purchase jet fuel is through “term contracts” based upon a projected volume for a given period. For example, ABC Airlines might agree with supplier X to supply its requirements in Chicago for a one-year term from Feb. 1, 2006, through Jan. 31, 2007, estimated at five million gallons per year on a Platts Gulf Coast index (based on the week prior to delivery) plus or minus a fixed differential (usually stated in cents per gallon). After term contracts and hedging, spot-market purchases constitute a minute portion of the industry’s jet fuel consumption. These purchases tend to be limited to larger, more sophisticated airlines that have become integrated into the supply chain for reasons of price or supply surety. And even those airlines only tap the spot market for well under 10 percent of annual purchases.

At the federal level, airlines pay 4.4 cents for every gallon consumed on a domestic flight. Of that amount, 4.3 cents goes to the Airport and Airway Trust Fund while 0.1 cents supports the Leaking Underground Storage Tank Fund. In addition, in most states airlines pay a flat rate per gallon or an ad valorem sales tax on the purchase of fuel. In California, for example, airlines pay a fuel tax in excess of 8.0 percent of the price of jet fuel. So if the price of jet fuel purchased in California were to double, the airlines’ fuel-tax burden would double as well, generating substantial revenue for the state's treasury.

Fuel Efficiency

Beyond the numerous, diverse, successful measures that U.S. airlines have taken and continue to explore to conserve fuel, the single biggest advance in fuel conservation, and emissions reduction, will come from reform of the U.S. air traffic control (ATC) system, which continues to rely on 1950s technology and procedures. Efficiency gains could reduce unnecessary fuel consumption by as much as 400,000 barrels a day by 2030, according to Securing America's Future Energy (SAFE), a nonpartisan organization working to reduce America's dependence on oil.

Airlines have developed many different operational and planning techniques aimed at conserving fuel and optimizing fuel purchases. On the operational front, airlines are:

- employing single-engine taxi procedures during normal operations and selective engine shutdown during ground delays
- reducing and measuring more accurately onboard weight while redistributing belly cargo
- tankering extra fuel on certain flights to avoid refueling at more expensive locations
- cruising longer at higher altitudes and employing shorter, steeper approaches

In terms of planning for fuel usage, airlines are:

- optimizing flight planning for minimum fuel-burn routes and altitudes
- working with FAA to change en route fuel reserve requirements to reflect state-of-the-art navigation, communication, surveillance and wind forecast systems
- employing self-imposed ground delays to reduce airborne holding
- modernizing their fleets with more fuel-efficient airplanes
- investing in winglets to reduce aircraft drag and thereby increase fuel conservation
- redesigning hubs and schedules to alleviate congestion
- advocating expanded and improved airfield capacity
- using airport power rather than onboard auxiliary power units (APUs) when at the gates
- changing paint schemes to minimize heat absorption (which requires additional cooling)
- altering the location in which fuel is purchased (i.e., to avoid higher-priced West Coast)
- pooling resources to purchase fuel in bulk through alliances with other carriers \

ATA provides assistance to member airlines via the FAA Command Center in Herndon, Virginia, working collaboratively with member airlines and FAA to optimize routes and provide subject matter expertise. Specifically, they:

- work with FAA to decrease reroute mileage
- increase ATC/airline coordination during severe weather
- analyze the jet stream and make recommendations for routing transcontinental flights
- inform FAA of single flight route issues and reduce mileage for flights unable to accept airborne reroutes
- provide advance notice to airlines of future reroutes or "playbook" routes to prevent over-fueling
- alert FAA to opportunities for avoiding fuel waste during departure delays and airborne holding

Environment

Soaring fuel prices have intensified the airline industry's efforts to increase fuel efficiency – the most effective means of reducing emissions. By employing more fuel-efficient operational procedures, reducing aircraft weight, cutting marginal routes and matching capacity more closely with demand, U.S. airlines continue to carry more passengers and cargo while using substantially fewer gallons of fuel. These voluntary measures have resulted in significant reductions of greenhouse gases and more localized ozone-forming pollutants. As the industry continues to replace older aircraft with quieter and cleaner jets, per-operation noise and air quality impacts will diminish accordingly.

ATA members also continue to support noise abatement measures consistent with the safe and efficient operation of aircraft. Improvements in navigation technology facilitate compliance with noise reduction measures and help diminish noise impacts on communities. Area Navigation (RNAV) and Required Navigation Performance (RNP) procedures and improvements in positional accuracy from Automatic Dependent Surveillance – Broadcast (ADS-B) permit aircraft to operate more closely at optimal altitudes and follow more precise flight tracks, thereby enabling even better noise management. However, some noise abatement procedures require longer flight paths, which increase the amount of fuel-related emissions, and such conflicting goals must be considered in each situation. Many new operational procedures, such as the Continuous Descent Approach (CDA), also offer the potential for significant reductions in both noise and emissions.

While future advances in air traffic management promise to further reduce noise and emissions, it is important to remember that the converse is also true. In the absence of critical investment in our air traffic control (ATC) system, worsening congestion threatens to overtake hard-earned gains in fuel efficiency and environmental compatibility. Rapidly advancing ATC reform is critically important to mitigating aviation environmental impacts.

Through collaboration with industry, agency and intergovernmental partners, ATA is engaged in many approaches to address environmental issues. ATA experts play key roles in the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP). CAEP is responsible for environmental measures affecting international aviation, including noise and emissions standards for aircraft engines and potential measures to address greenhouse gas emissions. In addition, ATA serves on the Advisory Board for the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER), a research center sponsored by the Federal Aviation Administration (FAA), NASA and Transport Canada. Moreover, ATA represents its members on the Joint Planning and Development Office (JPDO) Environmental Integrated Product Team (IPT), which works to ensure that environmental concerns will not constrain the planned expansion and modernization of the U.S. ATC system. At the same time, in coordination with industry and government partners, ATA is exploring the potential to use more environmentally friendly alternative fuels.

ATA and its members are working hard to identify measures that will lessen the environmental impacts of aviation and better manage environmental constraints on aviation growth.

Chapter 9

Last Modified: 2/4/2009

Print

accident As defined by the National Transportation Safety Board (NTSB), an occurrence incidental to flight in which, as a result of the operation of an aircraft, any person (occupant or non-occupant) receives fatal or serious injury or any aircraft receives substantial damage.

active aircraft All legally registered civil aircraft that flew one or more hours.

aerial application flying The operation of aircraft for the purposes of dispensing any substances required for agriculture, health, forestry, seeding, firefighting or insect control purposes.

aerial observation flying Any use of an aircraft for aerial mapping and photography, surveying, patrolling, fish spotting, search and rescue, hunting, sightseeing, or highway traffic advisory not included under Federal Aviation Regulations (FAR) Part 135.

aerodrome A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

aileron A control surface located on the trailing edge of each wing tip. Deflection of these surfaces controls the roll or bank angle of the aircraft.

air cargo Freight, mail and express traffic transported by air, including: (1) Freight and Express - commodities of all kinds, including small-package counter services, express services and priority reserved freight; and (2) Mail - all classes of mail transported for the U.S. Postal Service (USPS).

air carrier An entity that undertakes directly, by lease or other arrangement, to engage in air transportation. More specifically, large certificated air carriers, small certificated air carriers, commuter air carriers, on-demand air taxis, supplemental air carriers and air-travel clubs.

air navigation service provider (ANSP) Used generically to refer to the organization, personnel and facilities that provide separation assurance, traffic management, infrastructure management, aviation information, navigation, landing, airspace management or aviation assistance services for airspace users. Examples include NAV CANADA and NATS UK. Can be government-owned or a private entity.

air route traffic control center (ARTCC) An air traffic control facility, usually called an en route "center." Centers handle "en route" traffic, generally flying on instrument flight plans, as they move across the United States. There are 20 centers in the continental United States.

air taxi An aircraft operator who conducts services for hire in an aircraft with 60 or fewer passenger seats and a payload capacity of 18,000 pounds or less. An air taxi company provides "seats on demand." For example, instead of chartering an aircraft, a customer purchases a seat on a private jet.

air traffic control (ATC) A service provided under appropriate authority to promote the safe, orderly and expeditious flow of air traffic.

air traffic management (ATM) The dynamic, integrated management of air traffic and airspace - safely, economically and efficiently - through the provision of facilities and seamless services in collaboration with all parties.

Air Traffic Organization (ATO) A performance-based division of FAA, created to operate the nation's air traffic control system.

aircraft Any machine capable of atmospheric flight. May be heavier or lighter than air.

airfoil Any surface such as an airplane wing, aileron or rudder designed to obtain a useful reaction from the air moving past it.

airline A business that provides scheduled or chartered air transport of passengers and/or cargo.

airport An area of land or water that is used or intended to be used for the landing and takeoff of aircraft, and includes its associated buildings and facilities, if any.

Airport and Airway Trust Fund (AATF, Trust Fund) Created by the Airport and Airway Revenue Act of 1970, the AATF provides funding for improvements to the nation's airports and air traffic control system. Money in the fund comes solely from users of the system, principally from collections related to passenger tickets, passenger flight segments, international arrivals/departures, cargo waybills, aviation fuels and frequent flyer mileage awards from non-airline sources like credit cards.

Airport Improvement Program (AIP) Established under the *Airport and Airway Improvement Act of 1982*, this program provides grants to public agencies - and, in some cases, to private owners and entities - for the planning and development of public-use airports that are included in the National Plan of Integrates Airport Systems. Eligible projects include those improvements related to enhancing airport safety, capacity, security and environmental concerns.

airworthiness A term used to describe both the legal and mechanical status of an aircraft with regard to its readiness for flight.

alternative fuels The Energy Policy Act of 1992 defines alternative fuels as methanol, denatured ethanol and other alcohol; mixtures containing 85 percent or more (but not less than 70 percent as determined by the Secretary of Energy by rule to provide for requirements relating to cold start, safety or vehicle functions) by volume of methanol, denatured ethanol and other alcohols with gasoline or other fuels. Includes compressed natural gas, liquid petroleum gas, hydrogen, coal-derived liquid fuels, fuels other than alcohols derived from biological materials, electricity or any other fuel the Secretary of Energy determines by rule is substantially not petroleum and would yield substantial energy security and environmental benefits.

altimeter An instrument that displays the altitude above mean sea level (MSL) of an aircraft.

appropriations Created by an act of Congress, appropriations enable the Federal Government to fund its activities. Appropriations allow FAA to incur obligations and make payments out of the Treasury for specified purposes.

area navigation (RNAV) RNAV is a system that allows navigation on any desired flight path, rather than one defined by ground-based fixed airways. An RNAV system can determine position by referencing the position of ground- or space-based navigation aids, such as the Global Positioning System (GPS), using onboard flight management computers.

artificial horizon An instrument that enables a pilot to determine the attitude of the aircraft in relation to the horizon, i.e. whether the aircraft is nose-up, nose-down or banking left or right.

Automated Flight Service Station (AFSS) FAA's competitive outsourcing of the operation of it Automated Flight Service Stations to Lockheed Martin. A-76 refers to the Office of Management and Budget (OMB) circular that establishes federal policy about the Federal Government's performance of commercial activities and under which the outsourcing occurred. OMB Circular A-76, among other things, limits the circumstances in which the Federal Government should perform commercial activities (e.g., national defense, no viable commercial source available, etc.).

automated flight service stations (AFSSs) A network of 58 facilities across the U.S. operated by the U.S. Department of Transportation, Federal Aviation Administration (FAA). These stations are part of the FAA air traffic system and are staffed by uniquely trained air traffic control specialists. The primary role of an AFSS is to provide weather briefings and flight planning services to pilots, and is responsible for collecting, processing, and delivering aeronautical and meteorological information to promote safe and expeditious flight.. These facilities are used primarily by the general aviation community; however, military and commercial pilots are also frequent customers.

Automatic Dependent Surveillance-Broadcast (ADS-B) An aircraft-based surveillance service capable of replacing today's ground-based radar system. With ADS-B, the airplane's GPS determines the aircraft's location. ADS-B then broadcasts that position, via a radio transmission, approximately once-per-second to controllers on the ground and other aircraft. ADS-B would give controllers and other traffic a more precise location for each aircraft.

available seat mile (ASM) One seat transported one mile; the most common measure of airline seating capacity or supply. For example, an aircraft with 100 passenger seats, flown a distance of 100 miles, produces 10,000 ASMs. Sometimes measured in available seat kilometers (ASKs).

available ton mile (ATM) One ton of capacity (passenger and/or cargo) transported one mile. Sometimes measured in available ton kilometers (ATKs).

average haul The average distance one ton is carried. It is computed by dividing ton-miles or ton-kilometers by tons of freight originated.

bank angle see: roll

Bermuda I Agreement The agreement that governed scheduled air transport services between the U.S. and the U.K. until it was replaced in 1977, was signed on Feb. 11, 1946, and came to be known as the "Bermuda Agreement." Term is now commonly used for any agreements that contain capacity and pricing provisions patterned on the first U.S.-U.K. agreement. Such agreements include: (1) Capacity Principles: Requirements that an airline's capacity must meet in providing services over agreed routes. (2) Designation: Each party is entitled to designate "an airline or airlines" for operation of services over the agreed routes, subject to appropriate laws and regulations; (3) Pricing Article: This sets forth requirements for establishing prices to be charged by designated airlines for services over the agreed routes. The article specifies what consultative procedures are to be followed if a Party is dissatisfied with a price proposed by an airline, and ultimately allows that Party to exercise unilateral control if agreement is not reached.

Bermuda II Agreement Following British denunciation of the Bermuda I Agreement in 1976, a replacement was negotiated and approved on July 23, 1977, to govern air services between the U.S. and the U.K. Referred to as "Bermuda II," this bilateral agreement was subsequently amended in April 1978, December 1980 and November 1982. The revised and amended agreement covers scheduled and charter air transportation. Its principles differ from Bermuda I in three primary respects: First, while the authority for multiple designation still is included, this right is limited for specific passenger and combination routes over the North Atlantic. Secondly, capacity principles are similar to Bermuda I, except for additional consultative procedures to deal with excess passenger or combination capacity on North Atlantic routes. (The Annex on Capacity was rewritten in 1986.) Thirdly, all U.S.-U.K. North Atlantic cargo operations - scheduled and charter - are covered by an Annex which phased out governmental regulation in 1983 (i.e., full deregulation of cargo).

bonding authority An ability to issue bonds to raise funds.

break-even load factor (BELF) The load factor at which a flight, or collection of flights, earns revenue equating to its expenses; i.e., at which operating or pretax profit equals zero. see:load factor

broad-area precision navigation Performance-based area navigation that provides the ability to operate on flight paths that are independent of the location of ground-based navigation aids. The navigation is capable of determining a three-dimensional position with precision sufficient to support the operation.

budget authority Authority provided by Congress to enter into obligations resulting in immediate or future outlays of federal funds. Budget authority may be one year or multi-year. Budget authority for FAA programs consists of appropriations and contract authority.

business aviation (BA) Non-airline civil aircraft operations, including fractional and corporate flying, but not including personal aviation.

capacity The maximum number of aircraft, cargo, or passengers which can be accommodated or contained.

capacity management The long-term and short-term management and assignment of NAS airspace and routes to meet expected demand. This includes assigning related NAS assets, as well as coordinating longer term staffing plans for airspace assignments. It includes the allocation of airspace to airspace classifications based on demand, as well as the allocation of airspace and routes to ANSP personnel to manage workload.

cargo Anything other than passengers, carried for hire, including both mail and freight.

cargo waybill A document that lists the goods and shipping instructions for a cargo shipment. The waybill is frequently attached to the side of a package or envelope and sometimes indicates the customer’s cost to ship the item. There is a 6.25 percent tax on cargo waybills, which is deposited into the Airport and Airway Trust Fund. Cargo airlines contribute to the AATF in this way.

cash balance The available cash or liquid Treasury notes remaining in the Trust Fund; a measure of all revenues received (taxes, interest and adjustments) minus all cash outlays. The cash balance of the Trust Fund consists of both “committed” and “uncommitted” funds.

certificated air carrier An air carrier holding a Certificate of Public Convenience and Necessity issued by the U.S. Department of Transportation (DOT) to conduct scheduled services interstate and, when authorized, to overseas locations. These carriers may also conduct nonscheduled or charter operations.

certificated airports Airports that service air-carrier operations with aircraft seating more than 30 passengers.

charter When an aircraft, typically the entire aircraft, is hired for a nonscheduled trip.

charter rules The United States has negotiated several types of charter arrangements with other countries. In several cases the U.S. government has signed bilateral agreements covering only charter air services, or it has approved provisions for charters in the form of letter exchanges or memoranda of understanding. More frequently, the United States negotiates a charter annex to the standard bilateral agreement. There are two basic types of charter annexes: (1) Country-of-Origin, in which charter air services may be performed by either Party’s airlines according to the charterworthiness rules which are effective in the country-of-origin of the traffic; (2) Double Country-of-Origin ("Belgian Rules"), which dictates that charter air services may be performed by either Party’s airlines, from either territory, according to the rules of charterworthiness of either country.

Chicago Agreement These types of agreements are patterned on the standard form bilateral international Air Transport Agreement drafted at the Conference convened in Chicago in 1944 to establish a multilateral arrangement for international civil aviation. The bilateral form was drafted as a suggested interim measure, pending conclusion of a multilateral exchange of traffic rights, which never materialized. A “Chicago” agreement provides a general operating framework, but unlike other types of air transport agreements, does not include pricing or capacity arrangements.

Chicago Convention (December 7, 1944) Consists of general principles, standards and recommended practices for international civil aviation. An outgrowth of the Chicago Conference of 1944, the Convention also established the International Civil Aviation Organization (ICAO), with headquarters in Montreal. ICAO consists of an Assembly, Council and various other specialized bodies. The organization’s aims and objectives are to develop the principles and techniques of international air navigation, and to foster the planning and development of international air transport. The United States ratified the Chicago Convention on August 9, 1946 (see: http://www.icao.int/icaonet/dcs/7300.html).

civil aviation All non-military flights.

cockpit voice recorder A device that records the sounds audible in the cockpit, as well as all radio transmissions made and received by the aircraft, and all intercom and public address announcements made in the aircraft. It generally is either a continuous loop recorder that retains the sounds of the last 30 minutes or a digital system that records the last two hours.

codesharing A marketing practice in which two or more airlines agree to share, for marketing purposes, the same two-letter code used to identify carriers in the computer reservation systems used by travel agents.

combi A type of aircraft whose main deck is divided into two sections, one of which is fitted with seats and one which is used for cargo.

commercial aviation A sector of the U.S. economy comprising scheduled and nonscheduled passenger and cargo airlines, aviation manufacturers, airport and aircraft service providers (including government services) and air cargo service providers.

commercial service airport As defined by Federal law, an airport receiving scheduled passenger service and having 2,500 or more enplaned passengers per year.

committed balance The budget authority issued by Congress, against the Trust Fund, not yet liquidated through outlays. This committed money consists of both “obligated” and “unobligated” amounts.

commuter air carrier An air carrier operator operating under 14 CFR 135 that carries passengers on at least five round trips per week on at least one route between two or more points, according to its published flight schedules that specify the times, day of the week and places between which these flights are performed. The aircraft that a commuter operates has 60 or fewer passenger seats and a payload capability of 18,000 pounds or less.

complexity An ATC description of how non-homogeneous the traffic demand is. Factors that cause complexity to be higher are large numbers of vertically transitioning aircraft, large numbers of crossing paths, large variation in speeds, etc.

compressor A fan-like disk, or several disks, at the front end of a jet engine that draws air into the engine and compresses the air. The compressed air is then passed into a combustion chamber where it is mixed with fuel and burned, producing thrust, which propels the aircraft.

computer reservation system (CRS) A system for electronically collecting and displaying information about commercial flights and passenger reservations on them.

conflict Any situation involving an aircraft and a hazard (including another aircraft) in which the applicable separation minima may be compromised.

connecting flight A flight on which a passenger changes aircraft and/or airlines at an intermediate stop to reach her or his final destination, wherein the previous flight segment had a different flight number.

constant dollar Dollar value adjusted for changes in the average price level by dividing a current dollar amount by a price index.

consumer price index (CPI) A Department of Labor measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services. The CPI serves as an economic indicator, a deflator of other economic series and a means of adjusting dollar values.

continuous descent approach (CDA) The stair-stepped approaches to airports in use today begin many miles from the airport and require substantial time flying at low altitudes. Planes decend in steps and require additional thrust each time they level off. With CDA, an aircraft is positioned at its most efficient cruise altitude until it is relatively close to its destination airport. At that point, the aircraft reduces engine thrust to idle and begins a gentle descent to the runway. Benefits include significant reduction in noise, fuel burn and emissions, and shorter flights.

contract authority Allows FAA to enter into contracts before appropriations. For FAA, this most frequently applies to AIP (Airport Improvement Program) funds.

control tower The control tower is located at the airport and generally handles airplanes at and in close proximity of the airport.

controlled time of arrival (CTA) The assignment and acceptance of an entry/use time for a specific NAS resource. Examples include point-in-space metering, time to be at a runway, or taxi waypoints.

cooperative surveillance The aircraft relays its three-dimensional position. Non-cooperative surveillance would be the determination of an aircraft's three-dimensional position without the aircraft participating.

corporate aviation Refers to flying an airplane that is owned and operated by a corporation. It operates according to FAR Part 91.

cost per available seat mile (CASM) see: unit cost

cost per available ton mile (CATM) see: unit cost

coterminalization The right to serve two or more specified points in the territory of a party to an air transport services agreement on the same flight, provided these points are contained in the same route. If two or more separate routes are granted, the right to coterminalize points on separate routes must be specifically established.

crack spread The difference between crude oil and refined petroleum product prices, when expressed in similar units, is known as the crack spread. For example, if crude oil costs $60 per barrel and jet fuel costs $75 per barrel, the jet fuel crack spread is $15 per barrel.

crude oil A mixture of hydrocarbons that exists in the liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface-separating facilities. The U.S. benchmark for crude oil prices is West Texas Intermediate (WTI), measured in Cushing, Oklahoma.

cruise The phase of flight that begins when the crew establishes the aircraft at a defined speed and predetermined constant initial altitude and proceeds in the direction of a destination. It ends with the beginning of descent for the purpose of an approach or by the crew initiating an en route climb phase.

current dollar Dollar value of a good or service in terms of prices current at the time the good or service is sold.

deregulation The term commonly used to refer to the Airline Deregulation Act of 1978, which ended federal regulation of passenger airline routes and rates. Cargo airline routes and rates were deregulated in 1977.

directional infrared countermeasures (DIRCM) A system produced by Northrop Grumman to protect aircraft from MANPADS missiles.

dispatcher An airline employee who is responsible for authorizing the departure of an aircraft. The dispatcher must ensure, among other things, that the aircraft crew has all of the proper information necessary for their flight.

earnings see: net income

economic impact With regard to a specific industry or sector, the sum of first-level (i.e., sales, revenue, output) and induced (purchases required to produce the sales or output and household spending by the industry’s employees) impacts. In the case of commercial aviation, primary impacts on the U.S. economy are related to: airlines and supporting services; aircraft, engines and parts manufacturing; and air visitor travel and other trip-related expenditures.

elevator A control surface, usually on the trailing edge of the horizontal stabilizer, which is used to control the pitch attitude of an aircraft. Movement of the elevator will force the nose of an aircraft up or down.

empennage A collective term that refers to all of the various tail surfaces of an aircraft, i.e., the vertical and horizontal stabilizers.

employees Private air transportation workers as classified in sub-sector 481 by the U.S. Bureau of Labor Statistics (BLS); includes U.S.-based employees of non-U.S. carriers.

en route A term that refers to the middle portion of a flight (neither arrival nor departure) when the aircraft is communicating with center controllers.

en route center Sometimes refered to as a "center," or an Air Route Traffic Control Center, it houses the air traffic controllers and equipment needed to identify and direct aircraft during the en route - as opposed to the approach and departure - portion of their flights.

engine The source of propulsion and electrical power for the aircraft.

enplanement see: revenue passenger enplanement entered into force (EIF) Signifies the date when an international agreement or amendment entered into force definitively, following completion of all necessary ratification procedures of each country and confirmation by the governments in an exchange of diplomatic notes.

environmental damage With respect to an aircraft or its parts, refers to physical deterioration of an item's strength or resistance to failure as a result of chemical interaction with its climate or environment.

essential air service (EAS) Government-subsidized airline service to rural areas of the United States, which began after the Airline Deregulation Act of 1978.

excise tax A tax levied on a good, service or activity.

expect departure clearance time (EDCT) The time issued to a flight to indicate when it can expect to receive departure clearance.

facilities and equipment (F&E) FAA capital account program that funds technological improvements to the nation’s air traffic control (ATC) system. The account funds planned facility improvements, equipment procurement and the necessary technical support for systems installation. Funded entirely by the AATF.

fatal injury Any injury that results in death within 30 days of an accident.

fatality For purposes of statistical reporting on transportation safety, a fatality is considered a death due to injuries in a transportation crash, accident or incident that occurs within 30 days of that occurrence.

Federal Aviation Regulations (FAR) Airworthiness directives authored by the Federal Aviation Administration. see: Part 121, Part 135, Part 91

Federal Energy Regulatory Commission (FERC) The federal agency with jurisdiction over, among other things, interstate natural gas pricing, oil pipeline rates and gas pipeline certification.

fiscal year (FY) The 12-month period for which the federal government sets its budget and measures operational performance, beginning October 1 and ending September 30 of the subsequent year. The fiscal year is designated by the calendar year in which it ends (i.e., FY2005 begins October 1, 2004, and ends September 30, 2005).

flaps Control surfaces installed on the trailing edge of a wing and used to increase the amount of lift generated by the wing at slower speeds. Flaps also create drag, which has the effect of slowing an aircraft during its landing approach.

flight The entire passage consisting of one or more flight legs, from leaving the airport of origin to arrival at the airport of final destination and operated under one flight number.

flight data recorder (FDR) Records pertinent technical information about a flight. An FDR will record information about the performance of various aircraft systems, as well as the aircraft’s speed, altitude, heading and other flight parameters. Like a cockpit voice recorder (CVR), a flight data recorder is designed to withstand the forces of a crash so that its information can be used to reconstruct the circumstances leading up to the accident (the more recent and sophisticated FDR is known as a digital flight data recorder, or DFDR).

flight deck Also called the cockpit, it is the section of an aircraft where pilots sit and control the aircraft.

Flight Management System (FMS) A computerized avionics component found on most commercial and business aircraft to assist pilots in navigation, flight planning, and aircraft control functions. It is composed of four major components: FMC (Flight Management Computer), AFS (Auto Flight System), Navigation System including IRS (Inertial Reference System) and GPS, and EFIS (Electronic Flight Instrument System).

flight plan A planning document that covers the expected operational details of a flight such as destination, route, fuel on board, etc. It is filed with the appropriate FAA air traffic control facility. There are both VFR and IFR flight plans. VFR plans are not mandatory.

flight segment Consists of a flight with a single takeoff and a single landing. A nonstop flight from New York to Chicago is one segment. A flight from New York to Los Angeles with a stop-over in Chicago is two segments.

flight service station (FSS) An air traffic facility that provides information typically to general aviation or business aviation pilots, including: en route communications, broadcast aviation weather and NAS information, and the receipt and processing of IFR flight plans. The FSS system was outsourced in 2005 to Lockheed Martin in a program called “AFSS A-76.”

flight time Typically refers to block time, i.e. chocks-away to chocks-under, which includes taxi time plus airborne time, i.e. wheels-off to wheels-on. NOTE: FAA Regulations (FAR 1.1) define flight time as block time whereas European regulations (J.A.R. 1.1) define flight time as airborne time. When the term "flight time" is used, or values of flight time are quoted, the definition which applies shall be stated.

fossil fuels Any naturally occurring organic fuel formed in the Earth’s crust, such as petroleum, coal and natural gas.

freight All air cargo excluding mail.

freight ton mile (FTM) A ton of freight flown one mile. It is the standard measure of air freight activity; sometimes expressed as a freight ton kilometer (FTK).

frequent-flyer programs Airline marketing programs designed to win customer loyalty by awarding “points” for miles flown. Points can be redeemed for free flights or upgrades in cabin service or, in some instances, non-airline services or items.

full-time equivalent (FTE) The number of full-time employees that could have been employed if the reported number of hours worked by part-time employees had been worked by full-time employees. For the purposes of ATA reports, all part-time employees are treated as 0.5 FTEs.

fuselage The main body of an aircraft, cylindrical in shape. It contains the cockpit, main cabin and cargo compartments.

general aviation A term used to describe all non-military and non-airline flying, encompassing everything from recreational aircraft to experimental aircraft to privately owned and operated business jets. General aviation flies according to FAA’s part 91 or 135 rules.

geographic regions For reporting related to the conduct of scheduled service, DOT established in 14 CFR 241 four separate air carrier entities: (1) Domestic: All operations within and between the 50 states of the United States, the District of Columbia, the Commonwealth of Puerto Rico and the U.S. Virgin Islands, and Canadian transborder operations; (2) Atlantic: All operations via the Atlantic Ocean (excluding Bermuda);

(3) Latin: All operations within, to or from Latin American areas, including the non-U.S. Caribbean (including Bermuda and the Guianas), Mexico and South/Central America; (4) Pacific: All operations via the Pacific Ocean, including the North/Central Pacific, South Pacific (including Australia) and the Trust Territories. [Note: International denotes all operations not considered Domestic. System denotes the summation of Domestic and International operations.]

glideslope The ideal descent path to a runway. It can be electronically defined by radio signals transmitted from the ground. An aircraft carrying a special radio receiver can detect this electronic glidepath and follow it down to the runway.

global distribution system (GDS) see: computer reservation system

global positioning system (GPS) A worldwide radio-navigation system formed from a matrix of satellites and their ground stations. GPS is funded by and controlled by the U. S. Department of Defense (DOD). While there are many thousands of civil users of GPS world-wide, the system was designed for and is operated by the U. S. military. GPS provides specially coded satellite signals that can be processed in a GPS receiver, enabling the receiver to compute position, velocity and time.

gross domestic product (GDP) The market value of goods and services produced by labor and property in the United States, valued at market prices. As long as the labor and property are located in the United States, the suppliers (workers and owners) may be either U.S. residents or residents of foreign countries. GDP replaced gross national product (GNP) as the primary measure of U.S. production in 1991.

gross output A measure of total economic activity consisting of sales, receipts and other operating income, plus commodity taxes and changes in inventories.

ground control “Ground” is an air traffic control function that handles aircraft once they have landed, or before they are cleared to takeoff (typically from the gate to the runway).

ground delay program (GDP) A delay program, implemented at the FAA Command Center, based on established airport acceptance rates. Designed to control air traffic volume to airports where the projected traffic demand is expected to exceed the airport’s acceptance rate for a lengthy period of time. Flights that are destined to the affected airport are issued Expected Departure Clearance Times (EDCT) at their point of departure; flights that have been issued EDCTs are not permitted to depart until their Expected Departure Clearance Time.

ground servicing Activity that begins when the aircraft is stopped and available to be safely approached by ground personnel for the purpose of securing the aircraft and performing the duties applicable to the arrival of the aircraft, aircraft maintenance, etc. It ends with completion of the duties applicable to the departure of the aircraft or when the aircraft is no longer safe to approach for the purpose of ground servicing, e.g., prior to crew initiating the "taxi-out" phase.

hazardous material (HAZMAT) Any toxic substance or explosive, corrosive, combustible, poisonous or radioactive material that poses a risk to the public’s health, safety or property, particularly when transported in commerce.

Hijacking Convention (The Hague, December 16, 1970) Formally called the Convention for the Suppression of Unlawful Seizure of Aircraft. The Hijacking Convention supplements provisions on unlawful seizure of aircraft found in the Tokyo Convention. The Hijacking Convention obligates a state, when an alleged offender is present in its territory and the state does not proceed with extradition, to establish its jurisdiction over the offense. The Hijacking Convention includes additional provisions on prosecution and extradition of offenders. The Hijacking Convention was ratified by the United States on September 14, 1971.

horizontal stabilizer The small wings at the rear of an aircraft's fuselage that balance the lift forces generated by the main wings farther forward on the fuselage. The stabilizer also usually contains the elevator.

hub-and-spoke system A system for utilizing aircraft that enables a carrier to increase service options at all airports encompassed by its system. It entails the use of a strategically located airport (the hub) as a passenger exchange point for flights to and from outlying towns and cities (the spokes).

human factors The discipline concerned with the understanding of interactions among humans and other elements of a system. It is application of theory, principles, data and other scientific methods to system design to optimize human well-being and overall system performance.

hypersonic flight Flight conducted at speeds greater than Mach 5 or five times the speed of sound.

incursion Any occurrence at an airport involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in loss of separation with an aircraft taking off, intending to takeoff, landing or intending to land.

infrastructure The basic facilities, services and installations needed to operate.

inspection An examination, against a specific standard, of an airframe, aircraft engine, propeller, appliance or component part (new or used) by means of visual or test procedures to establish conformity with acceptable data.

instrument flight rules (IFR) Rules governing flight relying on the aircraft's instruments and navigation aids. IFR permit aircraft to fly in certain limited visibility and cloud conditions. Virtually any commercial operation - including airlines and business jets - utilizes the IFR system.

instrument landing system (ILS) Provides radio-based horizontal and vertical guidance to an aircraft approaching a runway. It is used to guide landing aircraft during conditions of low visibility.

intent Information on planned future aircraft behavior, which can be obtained from the aircraft systems (avionics). It is associated with the commanded trajectory and takes into account aircraft performance, weather, terrain and ATM service constraints. The aircraft intent data correspond either to aircraft trajectory data that directly relate to the future aircraft trajectory as programmed inside the avionics or the aircraft control parameters as managed by the automatic flight control system. These aircraft control parameters could either be entered by the flight operator or automatically derived by the flight management system.

International Air Services Transit Agreement (December 7, 1944) A multilateral agreement among States, opened for signature concurrently with the Chicago Convention. Under its terms, each contracting State grants to the others "... the following freedoms of the air in respect of scheduled international air services: (1) The privilege to fly across its territory without landing; (2) The privilege to land for non-traffic purposes." The United States accepted the Transit Agreement on February 8, 1945. see: www.icao.int/icao/en/leb/transit.pdf

jet fuel The term includes kerosene-type jet fuel and naphtha-type jet fuel. Kerosene-type jet fuel is used primarily for commercial turbojet and turboprop aircraft engines. Naphtha-type jet fuel has been largely phased out but was used primarily for military turbojet and turboprop aircraft engines.

Jetway A registered trademark for a certain kind of aircraft loading bridge that allows passengers direct, protected access to an aircraft from the terminal.

job impact The total U.S. employment associated with both commercial aviation and supporting economic activity that results from any purchases made by its firms and employees.

knot An abbreviation for one nautical mile per hour. Since a nautical mile is 15 percent longer than a statute mile, a speed expressed in knots is 15 percent higher than it would be if expressed in miles per hour.

landing The phase of flight that begins when the aircraft is in the landing configuration and the crew is dedicated to touch down on a specific runway. It ends when the speed permits the aircraft to be maneuvered by means of taxiing off the runway for the purpose of arriving at a parking area. It may also end by the crew initiating a "go-around" phase.

large certificated air carrier An air carrier holding a certificate issued under section 41102 of Title 49 of the U.S. code that: (1) operates aircraft designed to have a maximum passenger capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds.

lift The force generated by the movement of air across the wings of an aircraft. When enough lift is generated to overcome the weight of an aircraft, the aircraft rises.

load factor or loads (LF) The percentage of available seats that are filled with paying passengers, or of freight capacity that is utilized. Average load factor is computed as the ratio of RPMs to ASMs or, in the case of cargo services, RTMs to ATMs.

Local Area Augmentation System (LAAS) An accuracy-improving augmentation to the standard GPS signal that serves the immediate airport area (approximately a 20-30 mile radius). It broadcasts its correction message, via a very high frequency (VHF) radio data link from a ground-based transmitter.

long range navigation (LORAN) A ground-based terrestrial navigation system using low-frequency radio transmitters that uses the time interval between radio signals received from two or more stations to determine the position of a ship or aircraft.

mail ton mile (MTM) A ton of mail moved one mile. It is the standard measure of air mail activity; sometimes expressed as a mail ton kilometer (MTK).

maintenance Those actions required for restoring or maintaining an item in serviceable condition, including servicing, repair, modification, overhaul, inspection and determination of condition.

major carrier An airline with annual operating revenues of more than $1 billion, as defined by the Department of Transportation.

Man-Portable Air Defense System (MANPADS) Surface-to-air, heat-seeking missiles.

metric ton A unit of weight equal to 1,000 kilograms, or 2,240.6 pounds.

metroplex A group of two or more adjacent aerodromes whose arrival and departure operations are highly interdependent.

microjet see: very light jet

minimum equipment list (MEL) A FAA-mandated list of aircraft equipment that must be functioning before an aircraft may legally take off with passengers. Repairs to some items not essential to an aircraft's airworthiness may be deferred for limited periods of time approved by the FAA.

Multilateral Agreement on the Liberalization of Air Transportation (MALIAT) (Negotiated October 31 to November 2, 2000 in Kona, Hawaii; signed May 1, 2001, in Washington, D.C.; entered into force December 21, 2001) An agreement to promote open skies between signatory countries. The agreement allows for full schedule freedom, open traffic rights including seventh freedom cargo rights, no capacity controls, greater investment (while protecting against "flag of convenience" airlines), multiple airline designation, third-country code-sharing, and a minimal tariff filing regime. Signatories are: Brunei, Chile, Cook Islands, New Zealand, Samoa, Singapore, Tonga and the United States of America. In addition, Peru was a signatory to MALIAT but withdrew on January 15, 2005. The Protocol to MALIAT provides for parties to exchange seventh freedom passenger and sabotage rights. Signatories to the Protocol are: Brunei, Chile, Cook Islands, New Zealand and Singapore.

national airspace system (NAS) The common network of U.S. airspace, air navigation facilities, equipment and services, airports or landing areas.

national carrier An airline with annual operating revenues of between $100 million and $1 billion, as defined by the Department of Transportation.

NAV CANADA A private, non-share capital corporation that owns and operates Canada's civil air navigation service.

navigational aid (NAVAID) Any visual or electronic device, airborne or on the surface, that provides point-to-point guidance information or position data to aircraft in flight.

near midair collision An incident in which the possibility of a collision occurred as a result of aircraft flying with less than 500 feet of separation, or a report received from a pilot or flight crew member stating that a collision hazard existed between two or more aircraft.

net income What remains after subtracting all the costs (namely, business, depreciation, interest and taxes) from a company's revenues. An important measure of how profitable a company (or industry) is over a period of time. Sometimes called the bottom line, net profit or earnings, it is also used to calculate earnings per share.

net profit see: net income

net profit margin Net profit (or loss) as a percent of operating revenues.

Next Generation Air Transportation System (NGATS or NextGen) A vision for the future of the U.S. aviation system that aims to remove many constraints in the current system, support a wider range of operations and increase system capacity by three times that of current levels. Plans include a shift from service providers to "users," and from ground-based to satellite-based technology, among other advances.

nonscheduled service Revenue flights not operated as scheduled service, such as charter flights and all non-revenue flights incident to such flight.

nonstop clause An agreement's provision which permits the designated airlines to omit points on any of the specified routes on any or all flights. Unless otherwise indicated in this document's route descriptions, a nonstop provision is included in a bilateral agreement.

nonstop flight A flight with no intermediate stops.

obligations Spending commitments made against budget authority, reflecting the actual amounts of orders placed, contracts awarded, services received and similar transactions requiring payments. Obligations made in a fiscal year will not necessarily reflect cash outlays made in that year. For facilities and equipment, obligations are liquidated over several years.

on-flight trip length The distance traveled by a passenger on a single flight number (i.e., coupon). Average is computed as the ratio of RPMs flown to passengers enplaned and commonly referred to as length of haul.

open skies agreement To open markets further and increase carrier flexibility, U.S. government policy, beginning with the 1992 agreement between the United States and the Netherlands, has been to negotiate open skies agreements that introduce a number of more liberal concepts to the bilateral regime. The most significant provisions of open skies agreements include: unlimited designations, unrestricted capacity and frequencies, totally open route descriptions (3rd, 4th, 5th, 6th freedoms), unrestricted operational flexibility, fair and equal opportunity to compete, double disapproval pricing, open cooperative marketing arrangements (code sharing, blocked space, leasing) and liberal charter arrangements ("Belgian rules").

operating expenses Expenses incurred in the performance of air transportation, based on overall operating revenues and expenses. Does not include non-operating income and expenses, nonrecurring items, or income taxes.

operating income Operating revenues minus operating expenses.

operating profit see: operating income

operating profit margin Operating profit (or loss) as a percent of operating revenues.

operating revenues Revenues from the performance of air transportation and related incidental services, including (1) transportation revenues from the carriage of all classes of traffic in scheduled and nonscheduled services, and (2) non-transportation revenues consisting of federal subsidies (where applicable) and services related to air transportation.

Part 121 (FAR 121) A section of the FAA Federal Air Regulations that prescribes safety rules governing the operation of air carriers and commercial operators of large aircraft.

Part 135 (FAR 135) A section of the FAA Federal Air Regulations that prescribes safety rules governing the operation of commuter air carriers (scheduled) and on-demand “for-hire” air taxi and charter providers.

Part 91 (FAR 91) A section of the FAA Federal Air Regulations that refers principally to general aviation. Part 91 operations are generally non-commercial. Corporate aviation operations, for instance, usually fall under Part 91.

passenger The total number of revenue passengers boarding aircraft in scheduled service.

passenger facility charge (PFC) A tax authorized by Congress, approved by FAA, assessed by airports and collected by airlines (on behalf of airports) as an add-on to the passenger airfare. PFCs are used by airports to fund FAA-approved projects that enhance safety, security or capacity; reduce noise; or increase air carrier competition. The PFC program authorizes the collection of fees up to $4.50 for every enplaned passenger at commercial airports controlled by public agencies.

passenger revenue per available seat mile (PRASM) see: unit revenue

performance-based navigation Performance-based navigation specifies RNAV system performance requirements for aircraft operating along an ATS route, on an instrument approach procedure, or in airspace. Performance requirements are defined in terms of accuracy, integrity, continuity, availability and functionality needed for the proposed operation in the context of a particular airspace concept. Performance requirements are identified in navigation specifications that also identify the navigation sensors and equipment that may be used to meet the performance requirement.

performance-based operations Use of performance capability definition versus an “equipment” basis to define the regulatory/procedural requirements to perform a given operation in a given airspace.

personal aviation The activity of pilots who fly for recreation, and generally do not use the IFR air traffic control system.

personal earnings Total direct wages, salaries and employer-based benefits associated with both commercial aviation and supporting economic activity that results from any purchases made by its firms and employees.

petroleum A generic term applied to oil and oil products in all forms, such as crude oil, lease condensate, unfinished oils, petroleum products, natural gas plant liquids, and non-hydrocarbon compounds blended into finished petroleum products.

pitch A description of the movement of the nose of an aircraft up or down, in relation to its previous altitude.

Post 1977 Agreement Beginning in 1978, the U.S. negotiated a series of agreements that departed from previous Bermuda-style agreements. These new agreements are characterized by increased operational flexibility for airlines and less governmental regulation of services. Like the Bermuda-type agreements, a Post 1977 agreement includes multiple designations, but it explicitly provides that each Party may designate as many airlines as it wishes. A standard Post 1977 agreement includes: Capacity Principles - In general, Post 1977 capacity principles say that each Party’s airlines shall have a fair and equal opportunity to operate the specified air services. Neither Party may unilaterally limit the service - volume of traffic, frequency, or aircraft type - of an airline of the other Party except for technical reasons. Pricing Articles - Two general types of pricing articles have been included in Post 1977 agreements. Under each, intervention by the Parties is limited to: (1) Prevention of predatory or discriminatory prices or practices; (2) Protection of consumers from prices that are unduly high or restrictive due to abuse of monopoly power; and (3) Protection of airlines from prices that are artificially low because of direct or indirect governmental subsidy or support.

Precision Runway Monitor (PRM) A system that allows simultaneous, independent IFR approaches. During inclement weather, airports with parallel runways spaced less than 4,300 feet apart experience decreased capacity because they cannot conduct independent simultaneous operations due to existing equipment limitations.

pressurized aircraft An aircraft that has a cabin that is kept at a designated atmospheric pressure that is lower than the altitude it is flying so passengers and crew can breathe normally.

privatization A process of transferring property from public ownership to private ownership and/or transferring the management of a service or activity from the government to the private sector.

propfan One of several terms used to describe new generations of jet engines which typically turn very large, multi-bladed propeller-like fans to produce the thrust needed for flight.

provisional application Governments have agreed that the terms of an agreement or amendment shall be applied, pending definitive entry into force.

pylon The part of an aircraft’s structure that connects an engine to either a wing or the fuselage.

radar Term coined from the phrase "Radio Detecting and Ranging." It is based on the principle that ultra-high frequency radio waves travel at a precise speed and are reflected from objects they strike. It is used to determine an object’s direction and distance.

ramp The aircraft parking area at an airport, usually adjacent to a terminal.

regional airline Airlines providing short- and medium-haul scheduled airline service typically connecting smaller communities with larger cities and hub airports and operating turboprops of 9-78 seats and jets of 30-108 seats. Arrangements with mainline partners commonly take the form of contract flying or pro-rate flying.

repair To make an item serviceable by replacing or processing failed or damaged parts.

required navigation performance (RNP) An operating standard that must be met for an aircraft to operate in certain areas of the NAS. RNP requires an aircraft to stay within a specific envelope of airspace and continuously monitor its performance.

required surveillance performance (RSP) A concept that defines the surveillance requirements according to the airspace involved. The surveillance system must provide the updated aircraft position in order to ensure a safe separation.

research, engineering and development (R/E/D, RE&D) This capital account funds research intended to assure the safety, capacity and cost effectiveness of the air traffic control system, to meet growing demands and user requirements. The program has helped develop standards, regulations and guidance materials that support the FAA regulatory mission. Funded entirely by the AATF.

return on investment (ROI) Net profit plus interest expense (on long-term debt) divided by long-term debt plus stockholders' equity (net worth).

revenue Remuneration received by carriers for transportation activities.

revenue aircraft departure (RAD) Identifies the number of revenue departures on the identified aircraft flown by the operator within the reporting period. A revenue departure is a movement of an aircraft for the purpose of intended revenue generating flight, i.e., the number of revenue flights "scheduled" by an operator. Note: Revenue departures are used only for Schedule/Dispatch Reliability calculations. Schedule reliability is expressed as a percentage of scheduled revenue flights that are not delayed or interrupted.

revenue aircraft hour (RAH) One aircraft operated in revenue service for one hour; the most common measure of aircraft utilization. Also referred to as a block hour, which includes all time spent taxiing as well as airborne hours, or time in flight.

revenue aircraft mile (RAM) One aircraft in revenue service flown one mile; sometimes expressed as a revenue aircraft kilometer (RAK).

revenue management The process an airline uses to optimize revenue across its system of flights. In this process airlines seek to determine the optimal mix of prices (yield management) and seats (inventory management). The goal is to maximize revenue per flight, or per network of flights, rather than per person.

revenue passenger enplanement One fare-paying passenger - originating or connecting - boarding an aircraft with a unique flight coupon.

revenue passenger mile (RPM) One fare-paying passenger transported one mile; the most common measure of demand for air travel. Sometimes measured in revenue passenger kilometers (RPKs).

revenue per available seat mile (RASM) see: unit revenue

revenue ton mile (RTM) One ton of revenue traffic (passenger and/or cargo) transported one mile. Sometimes measured in revenue ton kilometers (RTKs).

RNAV see area navigation and area navigation oeprations

roll A basic aircraft maneuver, used to rotate or turn the aircraft to one side along its longitudinal axis, created by an up or down motion of the wings.

rudder A control surface, usually installed on the trailing edge of the vertical stabilizer, which controls the yaw motion of the aircraft - that is, the motion of the nose of the aircraft left and right.

Sabotage Convention and Montreal Protocol (Montreal, September 23, 1971) Formally called the Convention for the Suppression of Unlawful Acts against the Safety of Civil Aviation. The Sabotage Convention goes beyond the Hijacking Convention by containing separate definitions of what constitutes an offense onboard aircraft, and specifying when that aircraft is "in service." The Sabotage Convention places additional international legal obligations on states to act against a wider range of offenses involving aircraft. The United States ratified the Sabotage Convention on Nov. 1, 1972. On Feb. 24, 1988, an ICAO conference opened for signature a Protocol to amend the Montreal Convention of 1971. The Protocol provides for suppression of unlawful acts of violence at airports serving international civil aviation. A signatory to the Protocol, which finds an alleged perpetrator on its territory, must either take that person into custody for the purpose of prosecution, or proceed with extradition. The United States ratified the Airport Terrorism Protocol on Nov. 18, 1994.

scheduled service Transport service based on published flight schedules, including extra sections.

seat pitch The distance between seats in an aircraft's passenger cabin as measured from any point on a given seat to the corresponding point on the seat in front of or behind it.

separation minima The minimum displacements between an aircraft and a hazard, including another aircraft, that maintain the risk of collision at an acceptable level of safety.

serious injury An injury that requires hospitalization for more than 48 hours, commencing within seven days from the date when the injury was received; results in a bone fracture (except simple fractures of fingers, toes, or nose); involves lacerations that cause severe hemorrhages, nerve, muscle, or tendon damage; involves injury to any internal organ; or involves second- or third-degree burns or any burns affecting more than five percent of the body surface.

simulator A ground-based device used to train pilots that simulates flight scenarios, including emergency situations.

Simultaneous Offset Instrument Approach (SOIA) A technique by which two planes can land on runways located closer than the current FAA specification (4300 feet) for simultaneous landings.

situational awareness Refers to a service provider's or operator's ability to identify, process and comprehend important information about what is happening with regard to the operation. Airborne traffic situational awareness is an aspect of overall situational awareness for the flight crew of an aircraft operating in proximity to other aircraft.

slats Special surfaces attached to or actually part of the leading edge of the wing. During takeoff and landing, they are extended to produce extra lift.

small certificated air carrier An air carrier holding a certificate issued under section 41102 of Title 49 of the U.S. Code that provides scheduled passenger air service with small aircraft (maximum passenger capacity of 60 seats or fewer or a payload capacity of 18,000 pounds or fewer).

special use airspace (SUA) A part of airspace that is reserved for flight operations that are not in a "normal" category. The aircraft participating in the SUA activities are separated from other controlled traffic by the boundaries of the SUA airspace. In some cases, non-participating aircraft may enter SUA, but have limitations imposed on their operations. Generally, SUA is used for military activity, but civilians use such airspace to test new aircraft. The space program is also a large user of SUA.

specification A statement contained in an ATA publication that describes the functional or physical characteristics of a process, service or item that is the subject of the publication. Often referred to as a "spec."

speed brakes Also known as air brakes, they are surfaces that are normally flush with the wing or fuselage in which they are mounted, but which can be extended into the airflow to create more drag and slow the aircraft.

spoilers Special panels built into the upper surface of the wing that, when raised, "spoil" the flow of air across the wing and thereby reduce the amount of lift generated. They are useful for expediting a descent and for slowing the aircraft when it lands.

Stage 2 Aircraft Term used to describe jets which meet Stage 2 Federal Aviation Regulation (FAR) Part 36 noise parameters on takeoff and landing.

Stage 3 Aircraft Term used to describe aircraft that meet the Stage 3 noise requirements as specified in FAR Part 36. The Stage 3 requirements specify noise levels that must be certified for the aircraft type at each of three measuring points (flyover, lateral and approach), with the levels varying based on the number of engines and weight of the aircraft. Under U.S. law, but for a few, limited exceptions, all commercial jet aircraft weighing more than 75,000 pounds and operating in the U.S. were required to meet the Stage 3 requirements as of December 31, 1999.

Stage 4 Aircraft In July 2005, the FAA issued a final rule to adopt the ICAO "Chapter 4" standard as the new U.S. "Stage 4" standard. Under Stage 4, new type design aircraft certified on or after January 1, 2006 have to be 10 decibels quieter (as measured at the specified flyover, lateral, and approach points) than the previous Stage 3 noise standard required. As it applies to new type designs only, this certification standard does not apply to pre-existing aircraft or to the continued production of types previously certified.

stage length The distance traveled by an aircraft from takeoff to landing. Average stage length is computed as the ratio of aircraft miles (or kilometers) to aircraft departures.

stall Results when the wing's airflow is disrupted, and the wing no longer produces lift, with sudden drop and possible loss of control.

supersonic flight Flight at speeds greater than the speed of sound, which varies according to altitude but which exceeds 700 miles per hour at sea level.

supplemental air carrier An air carrier authorized to perform passenger and cargo charter services.

Terminal Radar Approach Control Facility (TRACON) The facility that controls airplanes, typically when they are within 30 miles of the airport, or transiting airspace near the airport. As of August 1, 2006, there were 168 TRACONs in the United States.

thrust The force produced by a jet engine or propeller. As defined by Newtonian physics, it is the forward reaction to the rearward movement of a jet exhaust.

Tokyo Convention (September 14, 1963) Formally called the Convention on Offenses and Certain Other Acts Committed on Board Aircraft. This Convention is concerned with insuring that when an offense has been committed onboard an aircraft, at least one state - that in which the aircraft is registered - will take jurisdiction over the suspected offender. The Convention also contains provisions relating to powers of the aircraft commander, duties of states, and extradition in the event of an offense. The United States deposited its instrument of ratification for the Tokyo Convention on September 5, 1969.

Traffic Alert and Collision Avoidance System (TCAS) An airborne collision-avoidance system, with a display in the cockpit that alerts pilots to other aircraft traffic in the area.

traffic flow management (TFM) The regulation of air traffic in order to avoid exceeding airport or air traffic control capacity in handling traffic, and to ensure that available capacity is used efficiently.

trajectory-based operations The use of four-dimensional trajectories as the basis for planning and executing all flight operations supported by the air navigation service provider.

transponder An electronic device that "responds" to interrogation by ground-based radar with a special four-digit code that air traffic control specifically assigns to the aircraft on which it is located. Certain transponders have the ability to transmit automatically the altitude of the aircraft in addition to the special code.

turbofan A type of jet engine in which a certain portion of the engine’s airflow bypasses the combustion chamber.

turbojet The original designation for a “pure” jet engine whose power is solely the result of its jet exhaust.

turboprop A type of engine that uses a jet engine to turn a propeller. Turboprops are often used on regional and business aircraft because of their relative efficiency at speeds slower than, and altitudes lower than, those of a typical jet.

U.S. flag carrier One of a class of air carriers holding a Certificate of Public Convenience and Necessity issued by the U.S. Department of Transportation (DOT) and approved by the president, authorizing scheduled operations over specified routes between the United States (and/or its territories) and one or more foreign countries.

UK-NATS An entity providing air traffic control services to aircraft flying in United Kingdom (U.K.) airspace. A public/private partnership between a consortium of seven U.K. airlines (42 percent), NATS staff (five percent), U.K. airport operator BAA plc (four percent) and the U.K. government (49 percent) and a golden share.

uncommitted balance Surplus revenues in the Airport and Airway Trust Fund against which no commitments, in the form of budget authority, have been made. This measure provides the most widely accepted estimate of the money available in the Trust Fund for new appropriations for aviation purposes.

unit cost The average amount of operating expenses incurred per unit of output, typically measured in cents per available seat mile or available ton mile. Commonly referred to as CASM or CATM.

unit revenue The average amount of revenue received by the airline per unit of capacity available for sale. Most often used to measure the effectiveness with which revenue management activity balances price and volume to generate passenger revenue per ASM, known as PRASM or RASM.

Unmanned Aircraft System (UAS) An aircraft with no pilot onboard or at the controls. Instead, the aircraft is controlled from outside of the aircraft (e.g., from the ground, another aircraft or space), by an onboard flight control program, or by a combination of offboard and onboard controls. A UAS includes the aircraft and its flight control system and operator.

unobligated balance The portion of Federal budget authority not designated as payment for specific products or services. In one-year accounts, the unobligated balance expires at the end of the fiscal year it was made available. In multi-year accounts, it remains available for obligation for the specified number of years.

user fee A fee charged to users of goods or services.

vertical stabilizer The large "tail" surface normally found on top of the rear of the fuselage. The rudder is usually installed at the trailing edge of the vertical stabilizer.

very light jet (VLJ) Typically an aircraft weighing less than 6,000 pounds (though NASA uses 10,000 pounds) equipped with turbojet engines and capable of operating at high altitudes.

Violent Acts at Airports Protocol (Montreal 1988) Formally called the Protocol for the Suppression of Unlawful Acts of Violence at Airports Serving International Civil Aviation. On February 24, 1988, an ICAO conference opened for signature a Protocol to amend the Montreal Convention of 1971. The Protocol provides for suppression of unlawful acts of violence at airports serving international civil aviation. A signatory to the Protocol who finds an alleged perpetrator on its territory must either take that person into custody for the purpose of prosecution, or proceed with extradition. The United States ratified the Airport Terrorism protocol on November 18, 1994.

virtual tower The ability to operate the surface and aerodrome without direct visual observation.

visual flight rules (VFR) Rules governing flight during periods of generally good visibility and limited cloud cover (i.e., a pilot’s ability to fly and navigate by looking out the windows of the airplane), predominantly employed by piston-powered general aviation. Aircraft flying under the VFR system are not required to be in contact with air traffic controllers and are responsible for their own separation from other aircraft. The visual flight rules (VFR) system is utilized almost exclusively by recreational pilots or low-flying piston-engine airplanes.

Warsaw Convention (October 12, 1929) The first international convention pertaining to liability in international air transportation, the Convention prescribes rules for air carrier liability in case of death or injury to passengers, destruction, loss or damage to baggage, and losses resulting from delay of passengers, baggage and cargo. Liability limits set by the Convention were raised in 1955 by the Hague Protocol to the

Warsaw Convention. Some Parties to the Warsaw Convention have not ratified the Hague Protocol, which amended the Convention. The U.S. ratified the Warsaw Convention on July 31, 1934. The U.S. continued to adhere to the Warsaw Convention only after all airlines serving the U.S. agreed to sign an amendment that raised the liability limit to $75,000 and prohibited the use of certain Warsaw defenses. This Agreement took effect on May 16, 1966. On Sept. 25, 1975, a number of nations, including the U.S., signed four Protocols which amended the Warsaw Convention, and the Hague and Guatemala Protocols. The four Protocols amended the increased liability limit found in the Guatemala Protocol, altered the monetary measurement from gold to Special Drawing Rights, and eliminated outdated documentary requirements with respect to the transport of cargo. The Guatemala Protocol and the first three Montreal Protocols have not come into force because the terms of entry into force have not been met. The U.S. Government ratified Montreal Protocol IV, and it entered into force for the U.S. on March 4, 1999.

wide area augmentation system (WAAS) A navigation system developed by the Federal Aviation Administration, which is accurate down to three meters (approximately 95 percent of the time). Accuracy is achieved through corrections to the surveyed location of 25 wide area reference stations on the ground and the Global Positioning System (GPS) signal. WAAS was commissioned in July 2003, and is currently used solely by general aviation.

wide-body aircraft Generally considered to be any airliner with more than one aisle in the passenger cabin. Examples of wide-body aircraft include the Airbus A300, A310, A330, A340, A350 and A380; the Boeing B-747, B-767, B-777, B-787, DC-10 and MD-11. Technically, any aircraft with a fuselage diameter in excess of 200 inches may be considered a widebody.

wind shear Weather phenomenon entailing a strong downdraft of air that can result in the loss of lift for an aircraft passing through it.

yaw A description of the movement of the nose of an aircraft from side to side or left and right. Yaw motion is controlled by the vertical stabilizer and the rudder..

yield The average amount of revenue received per revenue passenger mile (RPM) or revenue ton mile (RTM), net of taxes.