World

August 1983
Volume 13 Number 8

U.S. Department
of Transportation

**Federal Aviation
Administration**

Federal Aviation Administration
25
Twenty-fifth Anniversary
1958-1983
Promoting Safety in Aviation

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GRAND CANYON
National Park Service Photo by Richard Frear

World

FAA's Silver Anniversary: 25 Years of Aviation Progress

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"FAA's mission is to promote the safe and efficient use of the nation's airspace, facilities and the vehicles that travel the airways. To achieve this objective, we should control but not constrain aviation; we should regulate but not interfere with free enterprise of competitive purpose; and we should recognize that most air travelers do so by means of scheduled air carriers. We have a responsibility to consider their priority but not to the extent that it excludes the single individual from enjoying man's greatest achievement—solo flight. Above all, we must remember that the airspace belongs to the users and not the FAA."
—J. Lynn Helms

FAA WORLD is published monthly for the employees of the Department of Transportation/Federal Aviation Administration and is the official FAA employee publication. It is prepared by the Public & Employee Communications Division, Office of Public Affairs, FAA, 800 Independence Ave. SW, Washington, D.C. 20591. Articles and photos for FAA World should be submitted directly to regional FAA public affairs officers:

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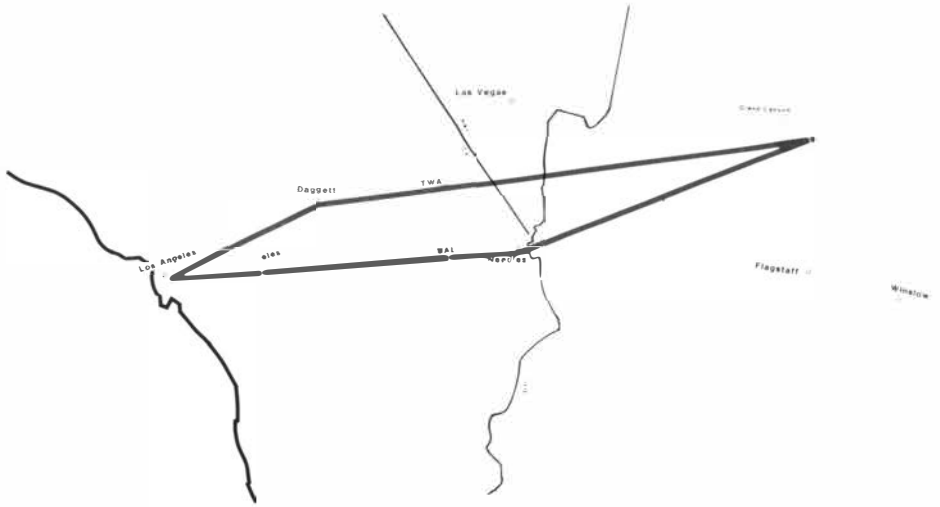
Thunder From the Canyon

The Birth of the FAA and a Modern Airways System

The CAA sign comes down from a temporary building on what is now Constitution Gardens that was to be the first home of the Federal Aviation Agency in 1959.

AOPA Pilot photo



The routes flown by the ill-fated airliners. The two should have crossed further south at different altitudes and within range of the VOR at Winslow, Ariz.

The midair collision over the Grand Canyon in 1956 was the trigger that launched the airways system into the modern technological era and led to the creation of the Federal Aviation Agency 25 years ago.

The trigger had been cocked since the end of World War II. In 1948, the Radio Technical Commission for Aviation (RTCA) recommended that the airways, which were 1930s vintage, should be modernized with post-war technology, such as VORs (very high frequency omnidirectional radio ranges), DMEs (distance measuring equipment), instrument landing systems and long- and short-range surveillance radars. And they advocated a civilian-military integrated system.

The ideas caught fire, and the Truman Administration adopted the plan in 1949. The Korean War dampened the fiscal enthusiasm for the program and by the end of 1952, all that was new on the airways were 350 VORs formed into 10-mile-wide Victor Airways, 100 instrument landing systems (ILSs), two dozen airport radars (ASRs) and two DMEs undergoing tests. There was only one surplus World War II long-range radar in the system; it was borrowed from the military and installed in Washington.

In 1953, President Eisenhower's Undersecretary of Commerce for Transportation, Robert Murray, issued a report for the interdepartmental Air Coordinating Committee (ACC) that said all was well in civil air policy: The government was doing an effective job in safety and that efforts to implement the civil-military common system of air navigation and air traffic control were going well.

Despite Civil Aeronautics Administrator Frederick B. Lee's desire to push on with the modernization program, Murray and Commerce Secretary Sinclair Weeks repeatedly cut CAA's share of the Commerce budget and its staffing. By 1955, CAA had the staffing level it had had in 1947, even though airline passenger traffic had doubled since 1949.

Also, by then, CAA had only 25 more VORs, 47 more ILSs, eight more ASRs and a total of 100 DMEs. The borrowed radar, which had a range of less than 60 miles, was supplemented by a discarded military 100-mile radar.

The civil-military joint-use concept wasn't moving forward too well, either. The CAA was committed to the DME, which had become a world standard, but the Navy had developed a single piece of equipment that combined the VOR and the DME to meet the needs of aircraft carrier pilots. Called the TACAN (Tactical Air Navigation), its superiority for military purposes had been sold to the Air Force as well.

The interdepartmental Air Navigation Development Board, set up to help further the joint-use concept, found itself stalemated on the subject.

A bigger problem was the need for long-range radars for the safe separation of a growing fleet of airliners. The Administration was well aware of this but was disturbed by the cost. It thought to solve the problem by dickering with the military for the shared use of its defense radars. Even with such an agreement, however, CAA would have to spend on remoting links to its facilities and to buying radars for areas not adequately covered by the military equipment.

FAA Administrators, 1958-1983

Federal Aviation Agency

Elwood R. Quesada
Nov. 1, 1958—Jan. 20, 1961
Najeeb E. Halaby
Mar. 3, 1961—July 1, 1965
William F. McKee
July 1, 1965—Mar. 31, 1967

Federal Aviation Administration, DOT

William F. McKee
Apr. 1, 1967—July 31, 1968
David D. Thomas (Acting)
Aug. 1, 1968—Mar. 23, 1969
John H. Shaffer
Mar. 24, 1969—Mar. 13, 1973
Alexander P. Butterfield
Mar. 14, 1973—Mar. 31, 1975
James E. Dow (Acting)
Apr. 1, 1975—Nov. 23, 1975
John L. McLucas
Nov. 24, 1975—Mar. 31, 1977
Langhorne M. Bond
May 4, 1977—Jan. 20, 1981
J. Lynn Helms
Apr. 22, 1981—

A Lockheed Super Constellation in Eastern Airlines colors at Washington National in 1962. Four years earlier, a TWA Super Connie midaired with the DC-7.

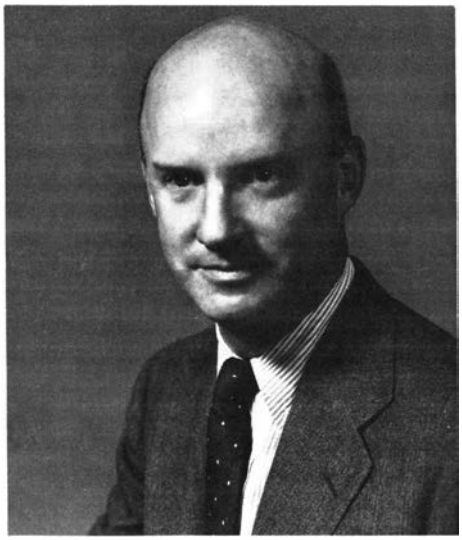
While this was going on, controllers were still operating in a manual fix-posting air traffic control system dating from the 1930s that relied entirely on voice communications.

This meant that the few available frequencies were always crowded and that no matter how carefully the en route controller computed an aircraft's position from the radioed-in altitude, speed and heading from checkpoints or position fixes, there was no way in which he could pinpoint the plane's actual location within five miles. To separate the planes, the controllers had to keep those at the same altitude at least 10 minutes or 30 to 100 miles apart.

It was an extravagant use of airspace. And the faster the planes flew, the fewer were the planes the system could accommodate and the more congested the airways became.

The inordinate delays, the pervasive congestion, the shrinking airspace and the growing threat of midair collisions were already of great concern to the press, the Congress and the aviation industry. There had been 65 midairs in the five years preceding 1955, but they had gone largely unnoticed because they involved only small planes and few deaths per collision.

That changed in January 1955 when a corporate DC-3 and a small TWA airliner—a Martin 202A—collided over Cincinnati, Ohio, with the loss of all 15 persons aboard.



Frederick B. Lee, CAA Administrator

Coming on the heels of mammoth delays and continuing terminal congestion, the collision not only raised the specter of a much greater loss of life with larger planes but made it clear to the White House that the Air Coordinating Committee report had been wide of the mark.

President Eisenhower appointed the Aviation Facilities Study Group, among whose members was Najeeb E. Halaby, to make a fresh appraisal of the situation. Its findings, released in January 1956, could not have been more alarming. It reported that the Federal airways were in a state of acute crisis; that the nation's airspace was dangerously overcrowded; that airports, navigation aids and the ATC system lagged dangerously behind aeronautical development; and that the risks of midair collisions had reached critical proportions. There also was a need for the development of a master plan to determine the kind of governmental organization that could take care of these problems.

The President then named Edward P. Curtis as Special Assistant to the President for Aviation Facilities Planning to work out a comprehensive plan based on the study group's report.

Things were looking up for CAA, and the system's luck seemed to be holding. Other than near misses,

This United Air Lines Douglas DC-7 was the same type of plane as the one that crashed into the Grand Canyon.

which sometimes ran as high as half a dozen per day, there were no collisions in the first five months of 1956, despite the intensifying problem.

On Saturday, June 30, the system's luck ran out with the midair collision of two large airliners and the loss of all aboard. As if to humiliate the CAA even further, the collision did not take place in bad weather or on a crowded airway but in good weather, in broad daylight and in an uncrowded sky.

The two four-engine, propeller-driven airliners left Los Angeles International Airport three minutes apart around 10 a.m. One was a Trans World Airlines Lockheed Super Constellation, carrying 64 passengers and a crew of six that took off to the northeast; the other was a United Air Lines Douglas DC-7, with 53 passengers and a crew of five, which headed east. Both were headed for the east coast, with the TWA flight going through Kansas City and the United flight through Chicago. The pilots were veteran fliers who had made this run frequently.

The Los Angeles Center assigned the TWA plane to an altitude of 19,000 feet and the United to 21,000. The planes were to fly through the Painted Desert, east and south of the Grand Canyon in Arizona, to pick up the VOR at Winslow before their paths diverged.

Before they left Los Angeles, both pilots had told the controllers that if they could fly VFR when they reached the California-Arizona border, they would make a side trip to show off the Grand Canyon to their passengers.

The TWA captain checked in near Daggett, Calif., and asked permission for an IFR clearance to climb to 21,000 feet to avoid a weather build-up. The request was denied because the United flight was in the vicinity at that altitude. Then the pilot asked for a clearance of 1,000 feet on top, which was approved. This meant he was VFR and on his own, and he climbed to 21,000 feet.

The United pilot called in over Needles, Calif. The weather didn't bother him because he was already above it. He was not told of the Constellation's new altitude, and there was nothing in the regulations that required it.

The defense radar at Winslow, which routinely tracked all aircraft passing through, reported at 11:30—the flights' estimated time of arrival—that neither plane had passed that way.

A minute later, communications personnel at United's headquarters in Los Angeles were horrified to receive a garbled message from the DC-7, of which they could make out only three words: "we are going . . ."

The search for the planes began in the Grand Canyon area because of the pilots' earlier comments. Just before dark, two brothers who ran a small recreational airline in the area reported sighting the remains of the Super Constellation on a butte near the eastern end of the canyon. Except for its stabilizers, 500 feet away, the plane had been reduced to rubble. The next morning, the wreckage of the DC-7 was found on another butte about a mile away. It took 10 days and 76 hazardous helicopter trips to remove the 128 dead from the canyon.

There was no doubt that the planes had collided: The blue and white and red and white pieces of metal scattered about on both buttes attested to that. The Civil Aeronautics Board, whose responsibility it was to work out the probable cause, concluded

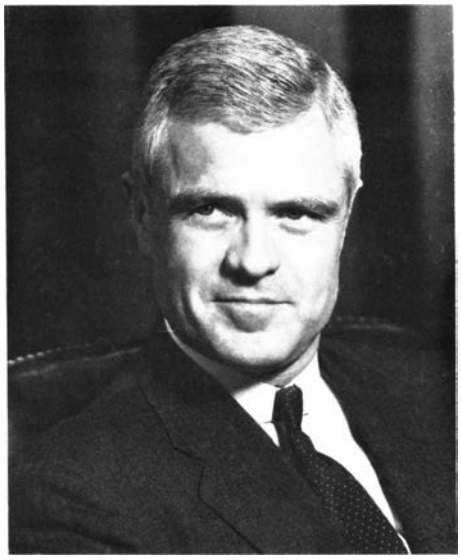
Sen. Mike Monroney was a prime mover of the Federal Aviation Act. The Aeronautical Center is now named after him.

that "the pilots did not see each other in time to avoid the collision." In addition to the pilots' "preoccupation with matters unrelated to cockpit duties," CAB also pointed its finger at the "insufficiency of the route traffic advisory information due to the inadequacy of facilities and lack of personnel in air traffic control."

Here were two pilots, in effect, playing blind man's bluff with each other. In flying off the airway on a VFR basis, the pilots were doing what they were entitled to do under the existing Civil Aviation Regulations (CARs). On the other side, the controllers were so busy taking care of planes on the airways flying under instrument flight rules, they had no time and, indeed, no responsibility to take care of VFR planes, particularly those off the airways.

The horror and revulsion over the crash reverberated like thunder from one end of the country to the other, literally for months on end. For the first time, Congress and the public learned just how primitive the existing ATC system really was and how short it was of modern equipment, personnel and funds.

Less than a week after the last body had been recovered, then CAA Administrator Charles A. Lowen, Jr., and Murray's successor as undersecretary, Louis S. Rothchild, appeared before the Senate Appropriations Committee and were successful in getting enough money to boost the number of VORs in the



James T. Pyle, CAA Administrator

system to well over 900 and to purchase 82 advanced long-range surveillance radars.

The new equipment would make it possible to replace the inadequate and indirect 10-mile-wide transcontinental airway, which snaked around the available VORs, with an IFR control area with a floor above which no VFR flights would be permitted.

Even the long drawn out VOR-DME/TACAN controversy was affected. A compromise came in mid-August under the name VORTAC, which retained the VOR for civil directional use but replaced the DME with the TACAN distance-measuring component. Now, the civil-military common system would be ready when the first jet airliners flew, which was not far off. Boeing already had more than $500 million in advance orders for the B-707, and the Douglas DC-8 was not far behind.

Lowen saw the value of using computers to speed the preparation of flight progress strips in the en route centers. A leased IBM 650 digital computer was installed in the Indianapolis Center in October 1956.

James T. Pyle, Lowen's deputy when he died in September, was confirmed as CAA Administrator in February 1957. The previous fall, Pyle had the satisfaction of flying a prototype B-707 and of letting a $9 million contract to Raytheon for 23 en route radars with a potent 200-mile reach.

The Grand Canyon crash was still fresh in the public's mind, and with Congress clearly aware, as Pyle put it, that "we had a fantastic amount of catching up to do," the CAA had no trouble at all in getting the money it needed to modernize the airways. The $5 million that the Secretary of Commerce had thought ample for the purpose before the crash more than tripled the year after the crash and rose to 25 times that figure the year after that.

But the lack of up-to-date facilities and equipment had not been CAA's only problem. Established as a stripped down operating agency, it lacked the authority to make decisions in the discharge of its mission. Its regulations, for example, were written for it by the Civil Aeronautics Board. In disputes over the airspace with the military, it had to refer the matter to interdepartmental bodies like the Air Coordinating Committee and the Air Navigation Development Board.

Special Assistant Curtis discovered, as the study group had suggested, that there was more to his task than just the facilities. In his May 1957 report to the President, he pointed to a major crisis in the making because of the growing congestion of the airways and the inability of the

The Airways Modernization Board, set up as an interim measure following the Grand Canyon crash, created the National Aviation Facilities Experimental Center (NAFEC) in Atlantic City on the site of a former naval air station.

existing dispersed airspace management system to deal effectively with the common needs of civil and military aviation.

Curtis proposed the creation of a new, independent Federal Aviation Agency to replace the CAA. Until that new agency could be established, he recommended the creation of an interim Airways Modernization Board to coordinate civil-military avionics activity and manage research and development.

Eisenhower approved the Curtis plan and appointed Elwood R. Quesada, a retired Air Force general, as his Special Assistant for Aviation and chairman of the interim board.

Three more midair crashes shook the country. The first had occurred that February at Van Nuys, Calif., as Pyle was being confirmed. The second was at Las Vegas, Nev., in April 1958 and the third at Brunswick, Md., on May 20, 1958. A total of 61 persons lost their lives.

The day after the Brunswick collision, Sen. A. S. (Mike) Monroney of Oklahoma, with 33 co-sponsors, introduced S. 3880, a bill to create an independent Federal Aviation Agency "to provide for the safe and efficient use of the airspace by both civil and military operations and to provide for the regulation and promotion of civil aviation in such manner as to best foster its development and safety." The day after that, the companion bill, H.R. 12616, was introduced in the House. The legislation passed both houses without difficulty, and President Eisenhower signed the Federal Aviation Act into law on August 23.

The act authorized FAA to take over the organization and functions of CAA, the personnel and responsibilities of the Airways Modernization Board and the function exercised by the CAB to draft and enforce safety regulations along with the personnel that went with the function. The Air Coordinating Committee was abolished and its powers transferred to the FAA Administrator.

In the same act, the CAB, a spinoff like CAA from the Civil Aeronautics Authority of 1938, was freed of its administrative ties to the Department of Commerce and left with its functions of economic regulation of the air carriers and the investigation of accidents. While FAA was given the right to participate in accident investigations, the determination of probable cause was left to CAB.

But it was in its enumeration of the powers of the Administrator that the genius of the act shone forth. These included:

- the regulation of air commerce in such a manner as to best promote its development and safety and the requirements of national defense;
- the promotion, encouragement and development of civil aeronautics;
- the control of the use of the country's navigable airspace and the regulation of both civil and military operations within that airspace in the interests of the safety and efficiency of both;
- the conduct of research and development as regards needed airway facilities and their installation and operation; and
- the development and operation of a common system of air navigation and air traffic control for both civil and military aviation.

In an almost unheard of delegation of power, the act provided that no one in the Executive Branch could overrule the Administrator in matters of safety.

On Nov. 1, 1958, General Quesada became the first Administrator of the FAA. On Dec. 31, 1958, FAA came into being, and James Pyle, the CAA Administrator becam FAA's Deputy Administrator.

The FAA was in place only 66 days after the U.S. jet age was launched with the flight of a Pan Am 707 to Paris. ■

—By Samuel Milner

The Sensing Element for Aviation

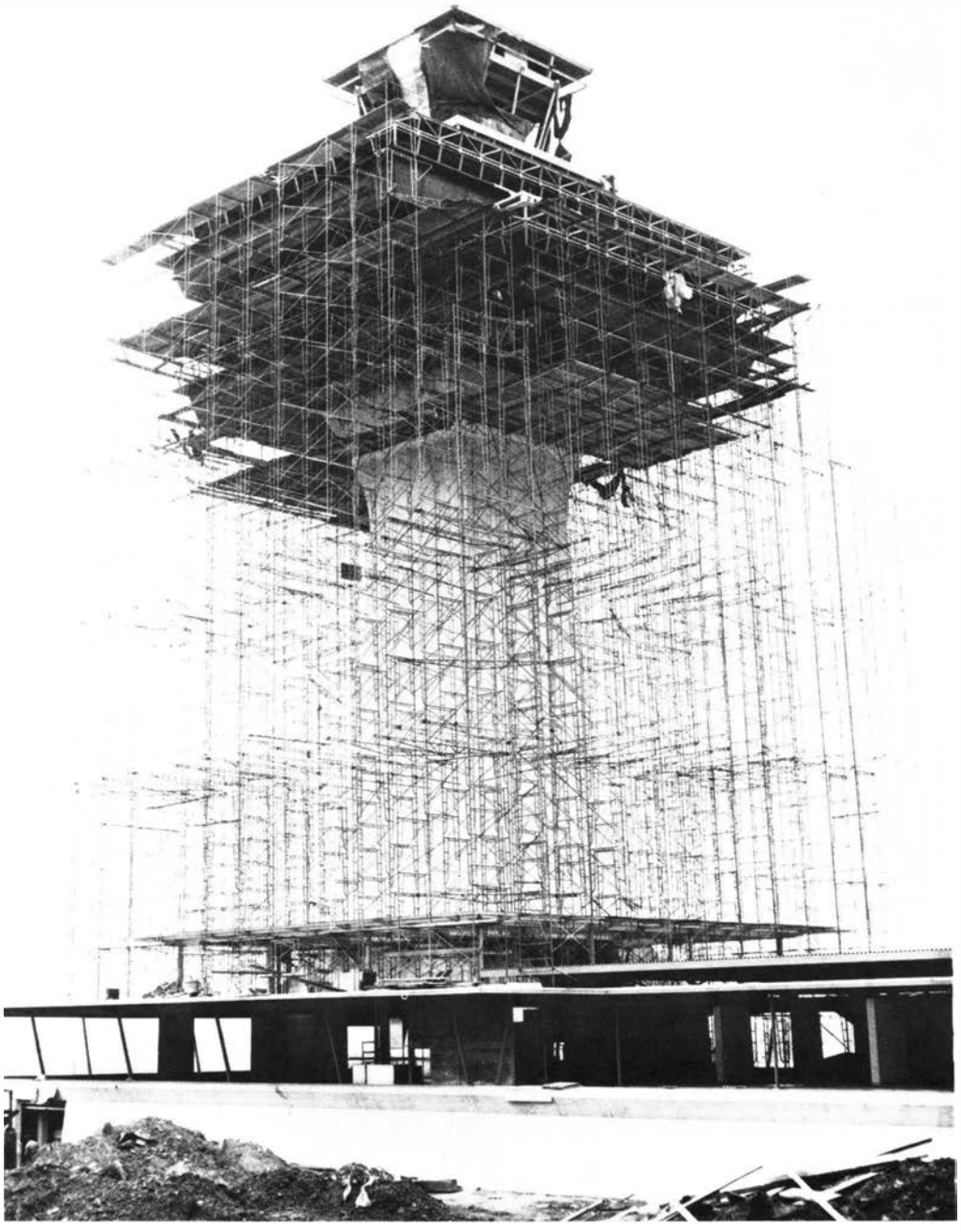
How the Administrators Managed Their Mission

Gazing at the earth from his unique vantage point in outer space, Apollo astronaut Russell Schweikert referred to his mission as the "sensing element for man." Afforded the detachment that comes with seeing the earth as a whole, Schweikert understood what it means to see the "big picture" unobscured by the various interests which compete for our attention in our daily pursuits.

This has been a problem for the men who have been charged with the responsibility for safeguarding and promoting the well being of civil aviation—the FAA Administrators.

For each of these eight men, carrying out the charter has required a delicate balancing act with the technological, economic and bureaucratic realities. He has had to know when to act and when to wait. And he has had to know how to sort out these considerations in order not to lose the big picture in aviation. He has been the sensing element for civil aviation.

For the last 25 years, FAA has been served by a group of leaders who were eminently qualified for the job, although with different styles of leadership and a changing agenda for civil aviation. Ultimately, each man added to the stature of the Office of Administrator and left his mark upon the agency.



An intricate gridwork of scaffolding enveloped the Dulles Tower as it was being built in 1962. The airport was begun in the waning days of the CAA.

William F. McKee (left) with James E. Dow, later to be acting administrator.

David D. Thomas, McKee's deputy, later became acting administrator.

FAA's first Administrator, **Elwood "Pete" Quesada** could not have been better cast for the part by Hollywood. One of the youngest three-star generals in Air Force history, a skilled pilot and charismatic, Quesada understood that his mission was to take charge of the new agency and make it clear that FAA did indeed intend to be responsible for aviation safety during the jet age.

Elwood R. Quesada (left) being sworn in as the first Administrator of FAA, as President Dwight Eisenhower observes.

Fresh from his one-year stint as head of the Airways Modernization Board (AMB), Quesada folded AMB into FAA, hoping to lose no momentum in the development of the air traffic control technology mandated by commercial jet air travel. It was Quesada who initiated a dramatic increase in the size of FAA's engineering staff and relocated the agency's research and development center from Indianapolis, Ind., to Atlantic City, N.J.

FAA's agenda during 1958–1960 ranged over a diverse number of issues. Staff meetings deliberated over issues such as overcrowded radio frequencies, aircraft engine noise abatement, aviation medicine, the progress of the building of Dulles Airport and the integration of military and civilian radar equipment. On the last point, Quesada's Project Friendship resulted in the placement of civilian controllers at 38 air defense long-range radar sites by the summer of 1960. This represented a giant step toward the sought-after common system of air traffic control advocated during the 1950s.

What really put the FAA on the map—and generated the greatest controversy during Quesada's tenure—was the Administrator's safety rulemaking and enforcement program. As Quesada recalled in 1961, "When I took office, years of timid and indecisive regulation by the government had bred a dangerous spirit of complacency throughout the field of aviation."

Najeeb E. Halaby

Quesada's response was the so-called "4-F" program, which stood for firm application of rules, fairness toward aviation users in consideration of public safety requirements, fast action in enforcement proceedings and factual investigation. According to historian Stuart Rochester, under "4-F," the agency "processed more than 400 safety rules, initiated some 7,000 enforcement actions and tripled

the number of violation reports filed by the CAA in its most active two-year period."

One new rule required airlines to equip their carriers with flight data recorders, which would facilitate investigations into the probable cause and responsibility for accidents. Two controversial rules required airline pilots to take an annual electrocardiogram and imposed a mandatory retirement on the pilot's 60th birthday.

On Oct. 4, 1960, following the crash of an Eastern Air Lines Lockheed Electra in Boston Harbor—the fifth Electra crash in two years—Quesada traveled to the crash site. There, with the aid of an ornithologist, he attributed the cause of the accident to the ingestion of birds into the aircraft engine. Quesada, who had resisted pressure from the Senate and the Civil Aeronautics Board to ground the Electra and had argued that the plane could fly safely at reduced speeds until the structural defects that had caused the earlier accidents could be corrected, was subjected to "the severest of ridicule" for his "starling explanation" and for, in effect, jumping the gun on the CAB's accident investigation. However, his explanation ultimately held up.

By 1960, people were taking note of the FAA; however, the safety record of 1959-1960 illustrated dramatically that the fledgling agency's work had only just begun.

John H. Shaffer (second from left) testifies before a Congressional committee with DOT Secretary John Volpe (left), Bertram Harding, Associate Administrator for Manpower, and William Flener (right), Director of the Air Traffic Service.

In 1960, there were 65 accidents among domestic scheduled operations, resulting in over 350 deaths—138 more than in 1959 and 235 more than in 1958. The midair crash of a United DC-8 and a TWA Super Constellation over New York City on Dec. 16, 1960, called into question once again the fundamental safety of the airways. None of this was lost on Quesada's successor **Najeeb E. Halaby,** following the election.

Jeeb Halaby, a California attorney and former World War II test pilot, had built a solid reputation in aviation circles for his work on the White House Aviation Facilities Study Group during the 1950s, and John F. Kennedy tabbed him as the New Frontiersman at FAA.

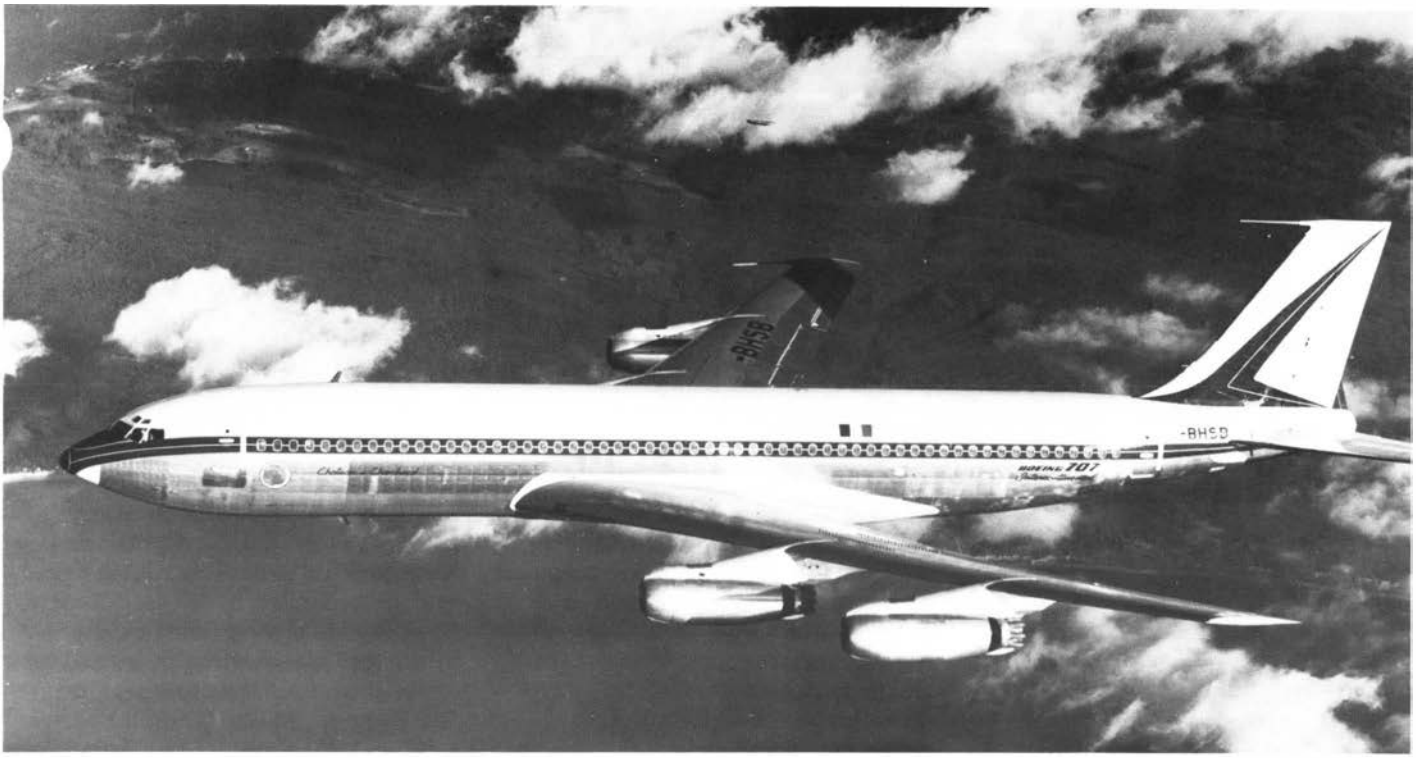
Seeking to put a new face upon the agency's research and development program, Halaby in 1961 established

Alexander P. Butterfield rides the back seat in a "Breezy" at an EAA fly-in.

"Project Beacon," which led to incorporating a radar beacon with FAA's surveillance radar as the best means for reducing controller dependence on voice communications. He also scrapped Data Processing Central—a computer system then under development—in favor of computer technology compatible with radar beacons.

In September 1961, Halaby was successful in convincing Congress to approve a three-year extension to the Federal Aid to Airports Program (FAAP), ending the annual funding authority arrangement of the past.

Halaby was determined to bring FAA decisionmaking closer to the aviation user. He did this by decentralizing the agency. He took line authority out of the hands of Washington bureau chiefs and



The first American jet to go into scheduled airline service was the Boeing 707 under Pan Am colors. It was certificated by the CAA on Sept. 23, 1958.

handed it to FAA's regional directors, who became responsible for all FAA programs within each of their regions.

By the time Halaby departed in 1965, he had also succeeded in consolidating the number of ARTCCs from 26 to 20 and in smoothing out some of the rough edges in FAA-Department of Defense cooperation.

Efficiency and flexibility in management were watchwords for Halaby's successor under President Johnson, **William F. McKee.** "Bozo" McKee, like Quesada a retired Air Force general, created the "Special Projects Office" to coordinate the shakedown and field testing of the emerging National Airspace System (NASSPO). This approach permitted the agency to assemble a temporary headquarters team that cut across organization lines and was able to push the development of automated ATC with contractors, the experimental center or the ARTCC field site. Once NASSPO was in place, McKee delegated much of the day-to-day FAA operations to Deputy Administrator **David D. Thomas.**

The McKee years at FAA, 1965-1968, saw FAAP funding for 1967 reduced to $54 million in spite of the fact that FAA was projecting that 234 more airports would be scheduled for jet service within five years. The general aviation fleet was also growing at an annual rate of 22 percent, and a substantial number of these planes were expected to be small executive jets.

Administrator McKee proposed the enactment of a user tax to shore up the slack in the FAAP program, but his efforts in this area, as well as in behalf of the federally supported supersonic transport program, fell upon deaf ears in a budget-conscious administration that was marching to the beat of the war in Vietnam. To make matters worse, FAA's budget for facilities, the financial backbone of the automated ATC system, fell from $160 million in 1961 to $28 million in 1967. No appreciable rise in facilities or R&D spending would occur until Fiscal Year 1970.

While proposals and arguments for an integrated transportation system under a unified Department of Transportation had regularly surfaced since World War II, it was President Johnson who espoused the cause and

FAA's Predecessor Agencies, 1926-1958

Organic Legislation: The Air Commerce Act of 1926

Aeronautics Branch, Department of Commerce Aug. 11, 1926—June 30, 1934

Bureau of Air Commerce, Department of Commerce July 1, 1934—Aug. 21, 1938

Organic Legislation: The Civil Aeronautics Act of 1938

Civil Aeronautics Authority Aug. 22, 1938—June 30, 1940

Civil Aeronautics Administration, Department of Commerce July 1, 1940—Dec. 30, 1958

John L. McLucas (left) chats with Southwest Region Director Henry Newman at the new Dallas-Fort Worth Tower.

J. Lynn Helms (center) with his deputy Michael Fenello (right).

pushed it through Congress, signing the reorganization bill on Oct. 15, 1966.

On Apr. 1, 1967, the DOT began operations and the Federal Aviation Agency became the Federal Aviation Administration.

Following Richard Nixon's election in 1968, the new man at the helm of FAA was **John H. Shaffer,** a former vice president at TRW, Inc. A veteran of 46 combat missions in World War II and past director of the Air Force's B-50 and B-47 aircraft programs, Shaffer's principal concern became the reduction of midair collision risks in the area surrounding crowded metropolitan terminals.

Unlike the midair threat of the 1950s and early 1960s, which centered on possible collisions between military jets and commercial transports operating under VFR flight conditions, the threat in the late 1960s was posed by the unprecedented growth in civil aviation and the mixture of jet aircraft flying under instrument rules and general aviation aircraft operating under visual rules.

The urgency to reduce the risk was underlined by the knowledge that the new generation of wide-bodied jets, capable of carrying two or three times the number of passengers on a Boeing 707, were already being flight tested. The Sept. 9, 1969, midair collision between an airliner and a small private plane near Fairland, Ind., punctuated that urgency.

The FAA's solution to the problem was the Terminal Control Area, or TCA. A TCA was an airspace area in the configuration of an upside down wedding cake within which control would be exercised over busy terminals. According to the proposed TCA rulemaking, issued on Sept. 29, 1969, and implemented in May 1970, any aircraft venturing into a TCA must be equipped with a two-way radio, beacon transponder, and a VOR or TACAN navigational receiver. These requirements greatly limited the potential number of general aviation aircraft at crowded terminals.

Within months, the Shaffer Administration had recorded a dramatic reduction in the number of near midair collisions, and the TCA went on to become one of the most important advances in air safety rulemaking since the agency's birth.

Another aviation milestone of the Shaffer era was passage in May 1970 of the Airport and Airway Development and Revenue Acts with a five-year term. Hailed by Richard Kent as "the beginning of a noble experiment in rational planning," this legislation established the Airport Development Aid Program (ADAP) and a Federal aviation trust fund derived from taxes on the various users of aviation facilities. Another important provision of the new law required all air carrier airports to meet FAA's safety standards for air navigation facilities, runways and fire-and-rescue equipment within two years of passage.

It was ironic that the Shaffer team had come up with the best funding arrangement in civil aviation history at the very moment when events completely outside its control were conspiring to alter the imperatives for such assistance. For what had begun in the late 1950s as citizen annoyance over jet-engine noise mushroomed 10 years later into a nationwide environmental movement destined to have far-reaching effects upon civil aviation.

The noise issue was transformed from a nuisance to a problem by the 1962 U.S. Supreme Court ruling in the case of *Griggs v. Allegheny County*. In that case, the high court

Langhorne M. Bond (in decorated Mexican shirt) poses with the team that put out the report on the crash of the DC-10.

ruled that airport operators were indeed liable for depreciation in the values of property owned by persons who lived beneath flight paths.

When the noise issue was heard from again, it was as part of a larger environmental movement. In 1969, environmental testimony at Senate hearings on a proposal to build a modern jetport in the Florida Everglades eventually caused the Nixon Administration to withdraw its support for the project. Despite the almost concurrent passage of ADAP, the Everglades controversy ushered in a new era of diminished construction for new airports. It also helped lead to passage of the National Environmental Policy Act of 1969.

By 1970, the environmental movement was in full stride, and the Federal program to support the development of an American version of the supersonic transport, which had received the backing of every FAA Administrator up to that time, felt the full weight of environmentalist opposition. In part because it was symbolic of years of neglect of the environment, the SST funding program was defeated following close votes in both the House and the Senate.

A mockup Boeing supersonic transport was under construction when the funding program was canceled by Congress.

One of John Shaffer's final initiatives as FAA Administrator was one of his most successful—the Dec. 5, 1972, emergency rule which required all U.S. air carriers to screen passengers and carry-on luggage for weapons and other dangerous objects.

One year earlier, Shaffer had confessed that "Hijacking is the most perplexing dilemma I have faced during my tenure as administrator." And well he should have, for beginning with hijackings of American transports by Cuban exiles in May 1961, civil aviation had had to wrestle with an air safety issue not envisioned by the blue ribbon panels of the 1940s and 1950s. What is more, despite the legislation of a 20-year sentence to deter hijackers, adoption of various international conventions against the crime and the use of armed sky marshals, the hijacking problem actually seemed more out of control during Shaffer's last year in office than ever before.

Shaffer's issuance of the December 5 rule followed on the heels of the three-day, eight-city escapade involving a hijacked Southern Airways DC-9. This incident, which seemed to snap the patience of the flying public, also led to the signing of a memorandum of understanding between the U.S. and Cuba in February 1973. From this point on, would-be hijackers knew that they would face harsh punishments in whichever of the two countries they were apprehended.

Between 1973 and 1978, only one successful hijacking of an American airliner occurred in the United States. The nation would also witness brief waves of hijackings in 1980 and again this spring; however, the screening system imposed in 1972 represented a dramatic improvement in controlling the problem.

On Mar. 14, 1973, **Alexander P. Butterfield** succeeded John Shaffer as FAA Administrator. A retired Air Force colonel, a pilot with a distinguished service record and a former deputy assistant to the President for personal and administrative affairs, Butterfield would experience a tenure at FAA colored by tragic accidents and stigmatized by the political expose of the century—Watergate.

He had inherited the best four-year air safety record in the last 25 years in terms of the number of air carrier accidents and fatalities. The en route and terminal automation systems were being implemented in the field

and promised to afford even greater safety, reliability and efficiency in air traffic control. In May 1973, the ADAP provision requiring airports serving scheduled carriers to meet the agency's standards for certification went into effect. And FAA could take pride in the fact that 1973 marked the first year in recent memory without a successful hijacking in this country.

The well being of 1973 was shattered, however, by two horrendous, and, on the surface, inexplicable air disasters in 1974.

On March 3, in the worst airplane disaster up to that time, a Turkish Airlines DC-10 crashed shortly after taking off from Orly Airport in Paris, killing all 346 persons on board. The disaster occurred after a rear cargo door had popped open and separated from the fuselage, causing the floor over the cargo compartment to collapse from decompression and damage vital flight-control cables.

On December 2, a TWA B-727 crashed into the Blue Ridge Mountains near Berryville, Va., owing to a misunderstandng between the pilot and an FAA controller over the meaning of clearance instructions on the approach to Dulles Airport. All 92 persons on board perished.

Both disasters were painfully reminiscent of accidents which had occurred in 1972. The DC-10 crash was similar in cause to a nonfatal accident involving an American Airlines DC-10 flying over Windsor, Ontario, in Canada. Although both FAA and McDonnell Douglas had responded to the defect in the latching mechanism following the Windsor accident, they had resorted to a routine service bulletin rather than an airworthiness directive—which would have had the force of law—as the means to get the airlines to remedy the defect in the DC-10 fleet. Although the Turkish airline DC-10 was still in the factory when the service bulletin was issued, it had not been implemented.

Nevertheless, this non-regulatory approach subjected the agency to intense criticism and charges that it had become too cozy with industry.

The Berryville disaster, which might have been prevented had the airplane been equipped with a ground-proximity warning system, reminded observers of the cause of the crash of an Eastern Air Lines jetliner into a swamp near Miami International Airport. Preoccupied with a faulty landing-gear warning signal, the crew members on the Eastern flight had failed to notice that someone had inadvertently disengaged the autopilot until it was too late to prevent the jetliner from making a gradual, undetected descent into the swamp.

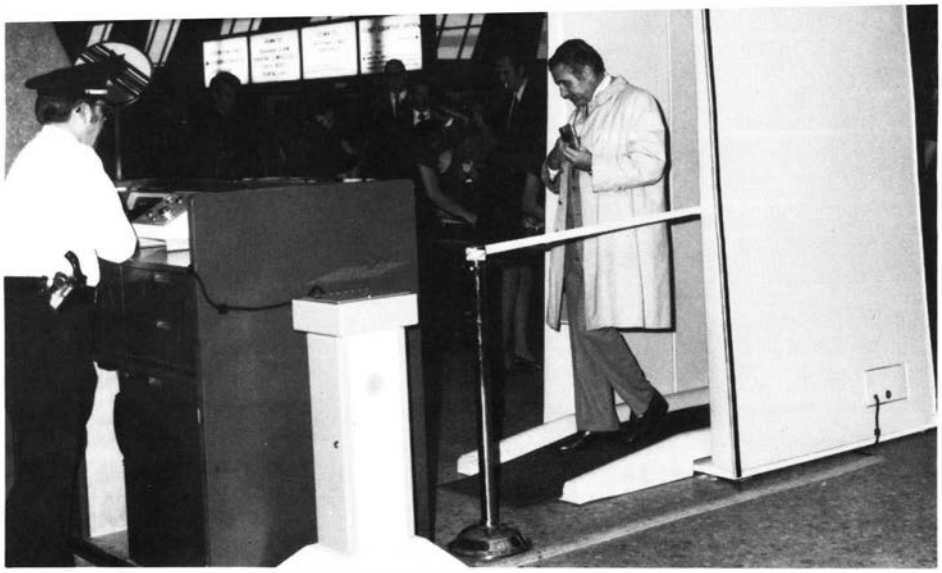
Although FAA was working on a rule to require Ground Proximity Warning Systems (GPWS) and a Minimum Safe Altitude Warning (MSAW) software enhancement to its ARTS III computer system at the time of the Berryville mishap, Congress pilloried Butterfield and the agency for footdragging on aviation safety.

Elwood Driver (left), then vice chairman of the NTSB, points to a faulty engine pylon forward support from the DC-10 that crashed in Chicago in May 1979.

Butterfield was the target of critics within his party, as well. His disclosure about the existence of White House tapes before the Senate Watergate Committee in July 1973, which ultimately sealed the fate of the President, had raised the ire of a number of diehard Nixon supporters. Following the crash of a general aviation turboprop on its approach to National Airport in January 1975—and amid published stories of sharp differences between the Administrator and Secretary of Transportation Claude S. Brinegar—President Ford asked for Butterfield's resignation.

During the interregnum of Acting Administrator **James E. Dow,** in August 1975, FAA announced that all 63 of America's busiest terminal facilities had been equipped with ARTS III and that every one of the 20 ARTCCs was fully operational with NAS En Route Stage A.

In November, **John L. McLucas** left his post as Secretary of the Air Force to assume the leadership of FAA. A former president of the MITRE Corp., McLucas brought recognized scientific qualifications to the job, and his 16-month tenure—the briefest of all Administrators—saw



Passenger screening requirements sharply curtailed airplane hijackings.

further technical advances.

In early 1976, a conflict-alert system at all 20 ARTCCs began warning controllers of potential high-altitude collisions. In June, the agency received the first prototypes of microwave landing systems. MLS promised to increase the safety of instrument landings, lower the decision height for pilots and reduce the stackup of traffic on their approach to busy terminals.

As chairman of a task force following a locker bombing at LaGuardia Airport, McLucas moved to require screening of checked baggage and to improve terminal security.

When the Democrats returned to Washington in 1977, FAA had begun to install a scaled-down version of its automated terminal system—ARTS II—at lower-density airports and was readying important software enhancements to NAS Stage A and ARTS, such as MSAW.

President Carter's choice to head up FAA was **Langhorne M. Bond.** An expert in aviation law, Bond had served in the office of the first Secretary of Transportation, Alan Boyd, prior to becoming the Secretary of Transportation for the State of Illinois.

Bond was to weather one of the most difficult tests of public confidence, where air safety was concerned, of any FAA Administrator.

As a prelude, Sept. 25, 1978, saw a midair collision between a Pacific Southwest Airlines B-727 and a Cessna 172 that killed all 135 aboard the jet, two in the Cessna and seven on the gound, making it the worst accident in U.S. aviation history—a record that lasted only eight months.

On May 26, 1979, Americans reacted with horror to the news that an American Airlines DC-10 had crashed on takeoff from Chicago's O'Hare Airport killing all 272 passengers. The impact of the DC-10 crash was heightened by memories of the Mar. 27, 1977, collision of two Boeing 747s on the runway of Las Rodeos Airport in Tenerife, Canary Islands, which had taken a toll of 574 lives. These two disasters—the worst in U.S. and world aviation history—illustrated only too well the huge stakes associated with an accident involving a wide-bodied jet transport.

Administrator Bond's response to the DC-10 accident was to ground the entire fleet—a step unprecedented in the annals of U.S. civilian jet aviation. The Administrator's decision to ground the DC-10 on May 28, 1979, was taken after inspections of various DC-10s turned up "grave and potentially dangerous deficiencies in many of the [engine] pylon mountings." This followed an earlier inspection that had not turned up pylon problems.

A second air safety issue to come into focus during Bond's term of office involved the commuter airline industry. Enjoying spectacular growth during the 1970s, commuters and air taxis promised to be in even greater demand following the deregulation of the industry by the Civil Aeronautics Board and the passage, in October 1978, of the Airline Deregulation Act. The new law, in particular, permitted commuters to employ bigger aircraft than ever before and made them eligible for the FAA equipment loan-guarantee program.

Bond's response to these changes was to have FAA issue on Dec. 1, 1978, a comprehensive set of new commuter airline regulations, revising FAR Part 135. The new regulations required commuters to upgrade their onboard safety devices, training and maintenance procedures.

In another regulatory action, Bond issued new FAR Part 125. This closed a loophole in the regulations in Part 91—which had allowed unscrupulous operators to evade strict safety standards—by making aircraft size rather than its service the criterion for determining which FAR should apply.

For the present FAA Administrator, **J. Lynn Helms,** the initial trial by fire came from within the agency itself—the strike of the Professional Air Traffic Controllers Organization (PATCO) on Aug. 3, 1981. Helms, the former president of Piper Air-

Strikers picket the New York ARTCC on Aug. 4, 1981, in defiance of the law, their oaths and a Presidential deadline.

Wide World Photos

craft, an aeronautical engineer and a Marine test pilot, inherited a problem whose roots were traceable to 1961.

It was at that time that Jeeb Halaby had attempted, without success, to obtain special recognition and compensation for air traffic controllers. Halaby had also sought to build esprit de corps among agency controllers and head off signs of trade unionism among Federal employees by proposing the establishment of a "Federal Aviation Service."

Later in that decade, the combination of dissatisfaction and militancy led many controllers to bolt their professional association (ATCA) in favor of the new union, PATCO.

During the 1970s, PATCO employed a variety of tactics, such as the "work-to-rule slowdown" and the sickout, which created backups in and over major airports, in order to convince FAA and/or Congress to grant concessions to its rank and file. Although these tactics were eventually declared illegal by the courts, the public airing of legitimate controller grievances did bring about genuine improvements in controller job conditions, such as those provided for in the Air Traffic Controller Career Act of 1972.

By 1981, PATCO and FAA were once again at loggerheads over a number of economic issues, including higher wage scales and other benefits. Although PATCO officials and Secretary of Transportation Drew Lewis did reach a tentative agreement, the PATCO membership's refusal to ratify the new pact led 12,300 controllers to walk out on their jobs in defiance of Federal law and their oath not to strike. When the majority of striking controllers disregarded a Presidential order to return to work, 11,400 were fired, PATCO officials faced enormous fines and the union was ultimately decertified by the Federal Labor Relations Authority.

Despite the fact that two-thirds of the controller work force remained on strike, FAA was able to keep a majority of the nation's 14,200 daily commercial flights in the air from the outset by appealing to the sense of dedication of the remaining controllers and supervisory personnel and by using its system of flow control and military controllers on loan.

Before the year had ended, a special team of National Transportation Safety Board investigators concluded that the scaled down work force had not compromised or changed any basic air traffic control procedures to keep the airways operating safely. These findings were echoed by the private Flight Safety Foundation in a second study. And 1981 marked the second consecutive year in which the nation's airlines did not lose a single passenger jet in an accident.

The so-called "Jones Report," a post mortem commissioned by Helms and Lewis, identified significant "people problems in FAA that have reduced both employee morale and effectiveness." The report concluded that FAA must dedicate itself to the development of its human resources. During 1983, as FAA continued its hiring and training of new controllers in order to restore the air traffic system to its pre-strike capabilities, the Helms administration was responding to the substance of "The Jones Report" by establishing an agency-wide human relations program.

Today, FAA's prospects for promoting civil aviation while safeguarding aviation safety are as bright as any time in its history. Unlike CAA, which, on the eve of the jet age, lacked the stature and resources to meet its challenge, FAA has prepared and is already carrying out a long-range plan for keeping pace with the projected air traffic of the 1980s and 1990s.

Under its new National Airspace System Plan, FAA plans to thoroughly modernize its ATC automation and navigation facilities, introduce an airborne collision-avoidance technology via the Mode-S beacon transponder, implement MLS at airports across the country, and automate and consolidate its flight service stations.

Congress has already endorsed the first year of funding for the National Airspace System Plan by including $625 million in facilities and equipment funds in the agency's FY 1983 budget. Passage of the Airport and Airway Improvement Act of 1982, with companion authority to fund the NAS Plan through a schedule of user charges, represents another important fiscal vote of confidence that, for the balance of this century, FAA will be able to fulfill its mission to keep aircraft "safe, separated and soaring." ■

—By Joseph Garonzik

Chronology of FAA's Era

1958

August 23—President Eisenhower signed the Federal Aviation Act into law.

September 2—The establishment of a program for the joint civil-military use of 31 new long-range radar facilities was announced.

November 1—Elwood R. Quesada became the first Administrator of the Federal Aviation Agency.

December 31—The Federal Aviation Agency assumed its statutory responsibilities.

1959

January 25—Transcontinental jet airliner service began with the inauguration by American Airlines of Boeing 707 flights between New York and Los Angeles. High-altitude radar advisory service was also established.

May—FAA instituted Project Friendship and began consultations with the Department of Defense to determine which military functions should be taken over by FAA and when.

August 31—The Douglas DC-8, a four-engine, long-range jet airliner with a capacity of 189 passengers was certificated.

October 8—FAA announced that under Project Friendship, it would assume air navigation and air traffic control services; military flight service; air traffic control training; and facilities flight inspections.

Calendar Year—Four additional long-range enroute radar facilities were commissioned, and the air traffic control radar beacon system was introduced.

1960

January 9—FAA made airborne weather radar required equipment for most of the country's airlines.

July 17—FAA made it mandatory for all turbine-powered air-carrier aircraft, including turboprops, to be equipped with flight recorders by November 1960.

August 25—FAA commissioned the first improved airport surveillance radar (ASR-4) at Newark, N.J.

September—The first ASDE (airport surface detection equipment) radar was commissioned by FAA at Newark.

October 15—Positive control on an area basis was successfully tested by the agency and launched as a regular service in the airspace between 24,000 and 35,000 feet over the enroute centers at Chicago and Indianapolis. Any aircraft entering this airspace had to be equipped with a radio and a radar beacon transponder. In addition, such aircraft had to fly on instruments regardless of weather and remain under control of the centers while in the positive control area.

December 31—Radar beacon equipment used in high-altitude jet-advisory service was in operation at 50 air traffic control radar sites.

1961

March 3—Najeeb E. Halaby was sworn in as the second FAA Administrator.

March 8—Halaby established a Project Beacon task force to recommend how the air traffic control system, using radar as a basis, could best be automated.

April 6—FAA established a three-layer airways system which lowered the floor of the continental control area from 24,000 to 14,500 feet.

September 11—The Project Beacon task force submitted its report to the FAA Administrator. Among other things, it specifically recommended that the Air Traffic Control Radar Beacon System (ATCRBS), with which the agency had already been experimenting, be adopted as the basis of the required automated system.

September 20—The Federal Airport Act was amended to extend the Federal Aid Airport Program through fiscal year 1964.

1962

January 1—Responsibility for enforcing the Federal Aviation Regulations was transferred to the seven FAA regions.

June 19—A standard regional headquarters organization was approved by the Administrator for FAA's seven regions. The organization was to be implemented by October 1962.

November 17—Dulles International Airport was opened with special ceremonies participated in by both President Kennedy and former President Eisenhower.

December 15—Simultaneous instrument approaches and landings on parallel runways were authorized by FAA at Chicago O'Hare International Airport to relieve traffic backup during peak activity periods.

December 31—To implement the semi-automated air traffic control system envisaged in the Project Beacon report, a design team called for the simultaneous use of digital alphanumerics and computerized secondary radar at both the centers and towers.

1963

January 16—FAA's Supersonic Transport Advisory Group recommended the development by the United States of a commercial supersonic transport as a top-priority Government-industry program.

July 1—A new rule requiring distance measuring equipment (DME) on all airline turbojets and all other civil aircraft flying IFR above 24,000 feet went into effect.

December 24—The Boeing 727, a three-engine jet airliner of short-to-medium range with a capacity of 119 passengers, was type certificated.

1964

February 4—A plan to modernize 150 flight service stations and close down the rest ran into so much trouble in the aviation community and Congress that it had to be abandoned.

June 30—A National Air Space (NAS) En Route Stage A System was authorized for installation at the Jacksonville en route center —the pioneer, semi-automated installation envisaged by Project Beacon.

September 7—A revised U.S. airway route structure substituted a simplified two-layer

system for the previous three-layer system. The lower layer extended generally from 700 feet above the earth's surface up to 18,000 feet above mean sea level, the upper layer from 18,000 to 45,000 feet above mean sea level.

October 6—The National Airspace System Special Projects Office (NASSPO) was established to provide management and coordination for the semi-automated air traffic control subsystem of the National Airspace System.

November—The first distance-measuring equipment (DME) unit combined with an instrument landing system (ILS) was commissioned at the John F. Kennedy International Airport.

December 14—The first FAA-designed-and-built airport traffic control tower was commissioned. Previously, tower structures were designed and constructed by the airport sponsors, with FAA participating in the financing.

December—Codification of all previous aviation regulatory issuances into a single body of rules, the Federal Aviation Regulations (FARs), was completed.

1965

February—The first nonradar or VFR control tower to be constructed according to an FAA standard design and built entirely with agency funds was commissioned at Lawton, Okla.

March 4—Positive control of the airspace in the contiguous 48 states between 24,000 and 60,000 feet was consolidated into a single area known as the continental positive control area.

May 24—The first field test of the terminal prototype of the automated radar terminal system, ARTS I, began at the Atlanta, Ga., airport.

July 1—General William F. McKee, USAF (Ret.), was sworn in as FAA Administrator.

September 26—A rule requiring biennial requalification of all flight instructors went into effect.

November 23—The Douglas DC-9, a twin-engine turbojet, designed for the short- to medium-haul market with a capacity of 99 passengers, was type certificated.

1966

January—The success of the ARTS I at Atlanta resulted in a contract between FAA and the Department of Defense for the development of an ARTS II, a smaller and less costly version of ARTS for use at military towers and low-density civil terminals.

April 25—FAA established the National Airspace System Program Office (NASPO) to replace NASSPO.

June 30—FAA created the New York common IFR room (CIFRR), which would control all traffic arriving and departing at JFK, La Guardia, Newark, Teterboro and their 12 satellite airports in the metropolitan New York area.

September 19—A new rule required U.S.-registered civil aircraft operating outside the United States to meet the same operational and maintenance standards as those prescribed for operations within the United States.

September 30—FAA's aeromedical research activities were transferred from Washington, D.C., to the Aeronautical Center's Civil Aeromedical Institute (CAMI) in Oklahoma City.

October 15—The President signed the Department of Transportation Act bringing FAA and other Federal agencies having to do with transportation under the new department.

1967

February 6—Cockpit voice recorders were required to be installed in all turbojets and four-engine, piston-powered civil aviation aircraft.

November 9—The floor of area positive control over northeastern and north central United States was lowered from 24,000 to 18,000 feet.

December 15—The Boeing 737, a twin-engine short-range jet transport with a capacity of 107 passengers, was type certificated.

1968

January 3—The Professional Air Traffic Controllers Organization (PATCO) was formed.

March 16—Visual flight rule operations at or above 1,000 feet above mean sea level were prohibited under a rule effective this date, unless the pilot had a minimum visibility of 5 miles and was at least 1,000 feet vertically and a mile horizontally from the nearest cloud formation.

July 31—General William F. McKee resigned as Federal Aviation Administrator, and Deputy Administrator David D. Thomas was named Acting Administrator.

December 30—The radar processing capability of the first operational field model of the NAS En Route Stage A subsystem at the Jacksonville en route center began operating on a part-time basis.

December 31—During the calendar year, aircraft hijacking reached near epidemic proportions in which 13 U.S.-registered air carrier aircraft were forced to land in Cuba.

1969

March 24—Retired Air Force Lt. Col. John H. Shaffer was sworn in as FAA Administrator.

June 1—The Common IFR Room at JFK, which had been serving the New York terminal area on a broadband, manual radar basis, shifted to a computerized digital alphanumeric system.

June 27—The first uninterruptable power system—known as the Power Conditioning System (PCS)—was commissioned at the Jacksonville en route center.

November 15—Air taxi operators of large aircraft became subject to the stricter operational requirements that applied to supplemental air carriers.

From World War II temporary buildings and an old hospital, the Washington headquarters staff moved into this building in November 1963. The square building with a central courtyard behind it is the Department of Transportation.

Photo by Lance Strozier

December 30—The Boeing 747, a 490-passenger, long-range airliner, was type certificated.

1970

February 28—The decision was reached that the NAS En Route Stage A automation should proceed in two successive phases: Flight Data Processing (FDP) first; then Radar Data Processing (RDP).

March 19—An air traffic control capability for coast-to-coast automated flight data processing (FDP) was demonstrated for the first time when the Denver and Los Angeles ARTCC computers were linked.

March 25-April 10—Some 3,000 PATCO enroute controllers and a few terminal controllers went on strike, claiming to be fatigued and to be acting in the interests of their health. The Government obtained temporary restraining orders against PATCO.

April 27—The Central Flow Control Facility was established at FAA headquarters.

May 5—The first NAS En Route Stage A computer update equipment (CUE) was commissioned at the Washington ARTCC.

June 25—Terminal Control Areas (TCAs) were established at 21 of the nation's busiest airports.

July 1—Under the Airport and Airway Development Act of 1970, FAA began accepting applications for Federal assistance for airport development under the Airport Development Aid Program (ADAP) and the Planning Grants Program (PGP).

July 17—New Orleans Moisant International Airport became the first U.S. airport to subject all passengers to screening by the FAA-developed anti-hijacking detection system.

December 31—With a passenger fatality rate of 0.0001 per 100 million passenger miles flown, U.S. airlines recorded the safest year in their history.

1971

January 27—A standing Flight Service Station Modernization Committee was established by FAA to work on plans for the improvement of the FSS system.

January 29—An official finding by the Department of Labor that the 17-day strike in March and April 1970 was a strike against the Government caused PATCO to be divested of its union status. It was allowed to regain the status on vowing it would not permit the same sort of thing to happen again.

March 24—The U.S. civil supersonic transport development program was terminated when the U.S. Senate, as the House had done six days before, voted against the appropriation to continue with its development.

May 3—FAA's Management Training School at Cameron College, Lawton, Okla., admitted its first class.

June 8—FAA established a Quality Assurance System Review (QASAR) program to improve its oversight of quality control systems in use by aircraft manufacturers and their parts suppliers.

July 29—The McDonnell Douglas DC-10, a medium-to-long-range, 345-passenger airliner, was type certificated.

October 4—The first operational ARTS III was commissioned at Chicago O'Hare International Airport.

October 14—The base of area positive control over the contiguous 48 states was lowered from 24,000 feet to 18,000 feet.

December 31—FAA terminated its policy of granting immunity from enforcement action to airmen reporting near midair collisions.

1972

January 28—The Executive Development Program was established by FAA.

February 29—FAA issued a rule requiring the airlines to develop and implement anti-hijacking security measures.

April 14—The Lockheed L-1011, a short-to-medium range, 400-passenger airliner, was type certificated.

June 1—In the first nationwide agreement between FAA and a labor organization, the National Association of Air Traffic Specialists (NAATS) was certified as the exclusive national representative of approximately 3,000 flight service station specialists.

December 5—President Nixon ordered luggage inspection, passenger screening and the presence of guards during passenger enplanements.

1973

February 15—The U.S. and Cuba signed a memorandum of understanding under which the two nations agreed to extradite or punish hijackers.

February—All 20 en route centers had computerized update equipment (CUE) and full flight-data-processing (FDP) capability.

March 14—Alexander P. Butterfield, a retired Air Force colonel, was sworn in as FAA Administrator.

April 30—FAA and PATCO signed a nationwide agreement, following FAA recognition of the union as the exclusive bargaining agent for the controllers.

May 21—FAA had issued operating certificates to 498 airports serving CAB-certificated airlines.

June 18—The Airport Development Acceleration Act of 1973 increased the annual ADAP funding level.

July 8—The Flight Inspection National Field Office (FINFO) was established at Oklahoma City.

August 1—FAA began implementing the En Route Weather Advisory Service (EWAS) at four West Coast flight service stations.

September 22—The Dallas-Fort Worth Regional Airport, the world's largest, was dedicated.

September—Ten ARTCCs had become operational in radar data processing (RDP).

1974

February—The review on a biennial basis of the FAA airworthiness regulations began.

March 3—A Turkish airlines DC-10 crashed shortly after takeoff from Orly Airport in Paris because of a defective latch on its rear cargo door. All 346 people aboard were killed in the worst air disaster up to that time.

August 5—The Anti-Hijacking Act of 1974 gave the Federal Government additional authority to deal with acts of air piracy.

September—The last of 300 four-course radio ranges commissioned in the 1930s was shut down at Northway, Alaska.

September 1—A new rule requiring a biennial flight review of all certificated pilots went into effect.

November—The first of a new fleet of FAA jets made up of five Jet Commanders and 15 Sabreliners began taking over flight inspection duties from the fleet of DC-3s.

December 2—A TWA 727 let down too soon on a landing approach to Dulles International Airport and crashed into a peak, killing all 92 persons aboard.

1975

January 14—A new regulation setting maximum noise levels for propeller-driven small aircraft went into effect.

January—After 31 years of operation, the Fairbanks ARTCC was shut down and its functions assumed by the Anchorage Center.

February—FAA began a Biennial Operations Review.

April 1—James E. Dow, the Deputy Administrator and a long-time agency employee, became Acting Administrator.

August 13—FAA's program to implement the ARTS III automated radar terminal system at 63 of the busiest terminals was completed.

August 26—The final phase of FAA's NAS En Route Stage A program to automate and computerize the nation's en route air traffic control system was completed with the commissioning of the radar data processing (RDP) system at the Miami ARTCC.

November 23—Dr. John L. McLucas, previously Secretary of the Air Force, was sworn in as FAA Administrator.

December 29—The explosion of a bomb at New York's LaGuardia Airport caused FAA to intensify its bomb security program and require checked baggage to be inspected.

1976

January 2—A conflict-alert system capable of warning en route traffic controllers of less than standard separation of aircraft under their control was implemented at all 20 en route centers.

April—FAA restarted its Aviation Safety Reporting Program with the National Aeronautics and Space Administration's Ames Research Center in charge.

June 1—The first prototypes of the Microwave Landing System were delivered.

July 6—The Great Falls, Mont., ARTCC was closed and its functions transferred to the Salt Lake City and Minneapolis ARTCCs.

November 5—The first Minimum Safe Altitude Warning (MSAW) system was commissioned at Los Angeles International Airport.

1977

May 4—Langhorne M. Bond, previously Secretary of Transportation for the State of Illinois, was sworn in as FAA Administrator.

September 15—The last Dynamic Simulation (DYSIM) radar controller training program became operational at the Denver ARTCC.

October 18—All FAA-certificated airport operators were required to prepare emergency medical plans in the event of crashes.

December 30—A new National Airport System Plan (NASP) was issued by FAA, calling for the construction of 397 new general aviation airports, 53 new reliever airports and 28 new air carrier airports.

1978

February—FAA received the first of 27 new long-range air route surveillance radars (ARSR-3s).

April 17—Thirteen of the 20 centers had received an allotment of meteorologists under an agreement between FAA and the National Weather Service to provide en route, terminal and FSS weather information.

April—The International Civil Aviation Organization (ICAO) picked the time-reference scanning-beam microwave landing system (MLS) for the international standard.

June 21—PATCO agreed to pay a fine of $100,000 for having engaged in a slowdown in May and June because airlines refused controllers international "fam" flights.

September—The agency began installing and commissioning Low-Level Wind Shear Advisory Systems (LLWSAS) at airports, the first at Chicago O'Hare.

September 25—A total of 139 people were killed as the result of a midair collision over San Diego of a Pacific Southwest Airlines B-727 and a Cessna 172.

September 30—The master plan and acquisition schedules for the automated flight service station system were approved. A request for proposals (RFP) for the automated system was issued.

October—Conflict Alert became operational at 51 ARTS III terminals in the contiguous 48 states.

November—The first ARTS II was commissioned at Toledo, Ohio.

December 1—FAA revised and updated FAR Part 135 to bring the operational and maintenance standards of the commuter airline and air taxi industry in line with those of the trunk and local service air carriers.

1979

March—FAA signed a contract for the development of the Electronic Tabular Subsystem (ETABS) for automating flight progress strips in the ARTCCs.

May—A contract for the development of a Terminal Information Display Subsystem (TIDS) to automate flight strips in terminals was signed.

May 25—At Chicago O'Hare, the left engine and pylon separated from an American

Airlines DC-10, causing the plane to crash on takeoff, killing all 273 persons aboard in the worst air disaster in American aviation history.

July 30—Delivery began of the first of 20 Direct Access Radar Channel (DARC) subsystems to be installed at all 20 enroute centers to provide backup.

August—The prototype of a new airport surface detection radar, the ASDE-3, was delivered to NAFEC for test and evaluation.

1980

February 20—Filtering equipment designed to reduce the concentration of ozone in the cabins of high-flying aircraft was made mandatory by an FAA regulation.

April—FAA began implementing a revised plan for the establishment of 61 automated flight service stations in 45 states and Puerto Rico with the letting of contracts for prototype computers.

April 15—PATCO distributed a "strike plan" to its membership.

August 15—PATCO controllers at Chicago O'Hare conducted a one-day slowdown because FAA turned down a demand for an annual tax-free bonus of $7,500.

August—The Anchorage en route center became the first of three centers outside of the contiguous 48 states to have in operation an En Route Automated Radar Tracking System (EARTS).

October 20—FAA commissioned the first En Route Minimum Safe Altitude Warning System (E-MSAW) at the Cleveland ARTCC.

December 31—NTSB reported that 1980 was the safest year in history for U.S. certificated route and supplemental carriers.

1981

April 22—J. Lynn Helms, former chief executive officer of Piper Aircraft Corp., was sworn in as FAA Administrator.

June 23—The agency decided to implement the airborne Traffic Alert and Collision Avoidance System (TCAS).

July—A Presidential task force on aircraft crew complement decided that the DC-9-80 had been appropriately type certificated by FAA and could be safely flown by a crew of two pilots.

August 3—The nationwide PATCO strike began, preceded by a six month round of negotiations between FAA and the union for a new labor agreement. When a tentative agreement was reached, the union's national officers advised union members to reject it, which 95 percent of them did. President Reagan reminded the strikers that they had signed an oath not to strike against the Government and gave them 48 hours, or until Wednesday, August 5, to get back to work or be fired. A total of 11,438 strikers ignored the President's ultimatum and were fired by FAA.

August 5—FAA put into effect Special Federal Aviation Regulation (SFAR) 44, an air traffic control interim operations plan.

September—The agency awarded a contract to manufacture 16 Model I automated FSS systems for immediate installation and 23 Model 2s over the next seven years that would add graphics and direct user access.

September 30—FAA reduced the number of its regions from 11 to 9 by consolidating the Pacific Region into the Western-Pacific Region and the Rocky Mountain Region into the Northwest Mountain Region.

October 22—PATCO was decertified by the Federal Labor Relations Authority.

December 31—During calendar year 1981, scheduled air carriers enjoyed their second consecutive year without a crash.

1982

January 28—FAA issued a National Airspace System (NAS) Plan, which set forth what the agency proposed to do in updating its air navigation and air traffic control system in the two decades ahead.

June—FAA established the National Airspace Review Program, a joint FAA-industry project which allowed industry representatives to recommend NAS changes.

June 30—With the acceptance of the ARTS II at Bismarck, N.D., the delivery of all 84 ARTS II systems was complete.

August 31—The agency certificated the Boeing 767, a wide-body, 211-passenger, short-to-medium range, two-engine jet.

September 2—FAA issued a final rule governing the operation of ultralights.

September—The agency implemented the Aircraft Certification Directorate System: the Central Region manages small airplanes; the Northwest Mountain Region, transport airplanes; the Southwest Region, rotorcraft; and the New England Region, engines and propellers.

October 23—The first fully functional ARTS IIIA, including Conflict Alert, was commissioned at the Seattle-Tacoma (Wash.) Tower.

November—The first microwave landing system (MLS) in the world was commissioned and went into operation at Valdez Airport in Alaska.

December 20—FAA issued a request for proposals (RFP) for the initial phase of the program to acquire a new "host" computer to replace the IBM 9020s at its en route centers.

December 21—The agency certificated the Boeing 757, a narrow-body, medium-haul jet for a maximum of 219 passengers.

1983

February 11—The first two of 120 second-generation, dual-channel Common Digitizers were delivered to the FAA Academy.

March 31—FAA issued a request for proposals (RFP) for 137 Mode S ground radar beacon stations.

April 11—FAA announced that the National Airspace System Plan would be revised, increasing the number of ARTCCs to 23 and redesignating them as Area Control Facilities.

April 22—After 40 years in Panama, FAA turned over to the government of Panama, the center and radar approach control (CERAP) at Balboa.

May—The agency issued a request for proposals (RFP) for the advanced automation system, which will include new sector suites, new computer software and new processors to augment the new "host" computers.

June 7—Two contractors were chosen to proceed with the validation of preproduction models of the next generation of weather radar (NEXRAD).

August 23—The twenty-fifth anniversary of the Federal Aviation Act.

Closing the Technology Gap

FAA and the Industry Have Come a Long Way

At the time of the Grand Canyon crash, America was facing an airways crisis of critical proportions. Air traffic control technology was two generations behind aviation technology.

Controllers at the nation's ARTCCs, lacking radar to track aircraft, had to be in virtually constant voice contact with pilots or ground communication points to keep tabs on flights within their traffic sectors.

Each controller had to calculate the estimated position of flights over his sector, record them on flight data cards, post them on boards and pass them on to the controller with responsibility for the next zone. Flight data was subsequently telephoned from one ARTCC to the next until the plane had reached its destination. It is no wonder that to keep them safe, commercial aircraft had to be draped in a "cocoon of air," CAA Administrator Frederick Lee explained, "because neither pilot nor controller can pinpoint the plane's position with sufficient accuracy to allow a narrower margin."

Although many of America's terminal control facilities had been equipped with precision radar by the late 1950s, communications were still, according to one pilot, "like trying to talk over an old-fashioned party line telephone with everybody on the line at once hollering 'Fire!' "

During FAA's early years, long-range radar coverage was expanded. The first non-military was the ARSR-1, here in Benson, N.C., with a beacon "hog trough" atop it and a radar microwave link tower next to it.

In the FAA era, many instrument landing systems were installed around the country. Here, a DC-10 flies down the approach lights into O'Hare at dusk.

Photo by Neal Callahan

Adverse weather conditions brought out the worst in the system. Since poor visibility compelled planes to fly under instrument flight rules (IFR) and since they could proceed to their destinations only as rapidly as controllers could handle them, flight delays were commonplace. On one such occasion, Sept. 15, 1954, later called "Black Wednesday," record instrument traffic caused 45,000 passengers to be detained for hours in the New York City area.

To make room for the jet age in civil aviation, the infant Federal Aviation Agency pressed forward with many new research and development projects and a substantial investment in modern airway facilities. Improved lighting and other visual aids for pilots, longer and parallel runways, high-speed airport turnoffs and multiple Instrument Landing System facilities were numbered high among its procurement priorities.

Most of all, FAA planned to automate the controller's flight-data-processing and radar-tracking functions, for only automation—the longed-for Third Generation of ATC—ultimately promised to provide the safety margins required for jet travel.

During the first years of its existence, FAA was able to expand its air route structure simply by placing additional state-of-the-art equipment in the field. Between 1958 and 1961, it increased the number of its long-range radar units from four to 41, thereby blanketing about half of the U.S. The ground components of the common VORTAC short-range navigational system, so crucial for keeping aircraft on their stated flight paths and maintaining aircraft separation, were also mostly in place by 1960.

Flight Data Processing at the Memphis ARTCC in 1973 brought the controller a flight-strip printer and Computer Update Equipment, including input keyboards and computer readout devices (left).

A Computer Update Equipment display at the Indianapolis ARTCC. If the computer message shown on the screen is correct, it can be entered into the computer by the push of a single button.

Surveillance radar, however, the second generation of air traffic control technology, was no longer enough. Even with radar in hand, a controller still had to follow an

Today's long-range radar is the ARSR-3, which was introduced in 1977.

aircraft's flight progress by moving tiny pieces of plastic, called "shrimp-boats," inscribed with flight data, across his radarscope until the aircraft left his sector. Nor did radar free him from performing time-consuming voice communication handoffs to the adjacent sector or ARTCC or from the calculations which would enable him to estimate the aircraft's next position. A December 1960 midair collision over New York City was evidence enough that something more was needed.

NAS Stage A

The next milestone in ATC automation occurred in 1961 with the report on "Project Beacon." Prepared by a blue-ribbon panel of experts appointed by Administrator Halaby, the Beacon Report defined the configuration of ATC automation that FAA would go with in the 1960s and 1970s. FAA opted for digital automation of the beacon tracking function, which would be compatible with the Air Traffic Control Radar Beacon System (ATCRBS).

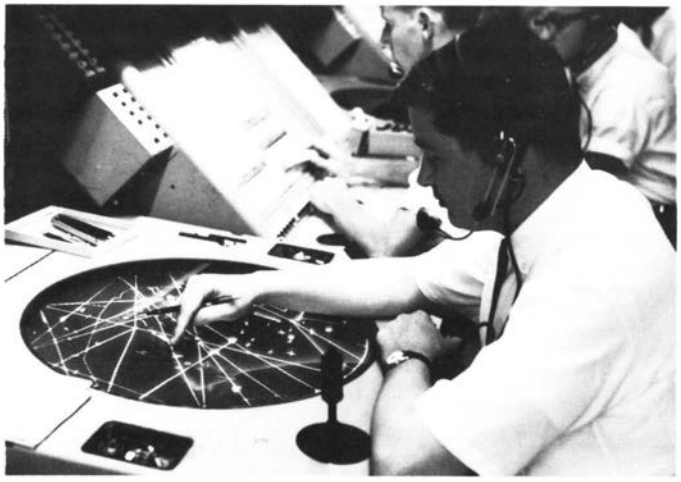
ATCRBS consisted of an airborne transponder and a ground interrogator. The latter could be positioned at radar or ground navigation sites throughout the FAA network. When a transponder-equipped aircraft was interrogated, ATCRBS would flash a signal on the controller's radar display. With computer automation in place, the signal could be digitized to disclose the aircraft's identity and altitude in alphanumeric form, thereby eliminating the pilot's requirement to perform time-consuming identification maneuvers.

Computerization of flight data processing, which promised to reduce substantially the controller's paperwork responsibilities, as well as the development of improved pilot-controller communication channels, all-weather landing systems and airport lighting figured prominently in the Beacon Report.

For most of the 1960s, FAA's research and development effort focused on the automation of air traffic control at its 20 en route centers, which it dubbed NAS En Route Stage A.

FAA leadership believed that Stage A could be developed as a relatively homogeneous system for the 20 ARTCCs, which resembled each other more closely than large metropolitan terminals. The priority placed upon automation of the en route portion of flight also dovetailed with FAA's desire to establish positive control throughout jet airspace. To have begun by automating the terminals, it was claimed, would have resulted in the creation of "islands of automation."

Prior to the FAA, the Washington ARTCC in 1955 was the first center with radar, albeit a discarded military one.



Above left: A radar controller at the Washington ARTCC in 1963 had shrimp-boats and a joystick.

Thirteen years later, this scene at the Los Angeles ARTCC was typical. Controller Jacque Feister went on to become manager of the Boston Center (above).

Photo by Fred Farrar

NAS En Route Stage A was the most ambitious R&D undertaking in air traffic control history. The total cost of the systems installed at the 20 ARTCCs by 1974 came to $640 million, or three times the original estimate. It was, nonetheless, a singular technological achievement.

NAS En Route Stage A had to surmount financial and conceptual problems. For starters, FAA's budget for R&D and aviation facilities fell dramatically throughout the 1960s, thereby undermining the 1961 assumption that FAA could continue to count on the level of funding it had enjoyed in the wake of the Grand Canyon accident.

IBM, which also wrote the software for the en route system, had to double the amount of memory it had originally anticipated before it could deliver the operational prototype of the 9020 computer installed at the Jacksonville ARTCC in 1967. The giant computer firm, which was dividing its energies between Stage A and the Apollo project, at one point had 500 programmers on site at the Technical Center trying to debug the software. By the time the original Stage A software program was finished, it contained over 475,000 instructions, far more than any previous computer program.

Despite the virtue of operating a complete Stage A system at Jacksonville, it proved unrealistic to expect controllers to perform their normal jobs *and* learn the intricacies of an automated system still undergoing development. As it turned out, the less-complex flight data processing function was ready first, and the controllers at Jacksonville—and eventually at every ARTCC—could get the benefits of one phase of automation sooner.

By 1970, most of the problems had been resolved, and NAS En Route Stage A was on its way to the remaining ARTCCs. In February 1973, the Memphis ARTCC became the last center to be equipped with Flight Data Processing (FDP).

Radar Data Processing (RDP) became a reality at all 20 centers in August 1975. The Miami Center was the last ARTCC to acquire the capability of displaying alphanumeric readouts of aircraft positions, tracking aircraft precisely, and performing automatic radar handoffs from sector to sector and from center to center.

RDP liberated the controller from much of the voice communication

The New York ARTCC in 1970. It was the second center to get radar. NYT Pictures

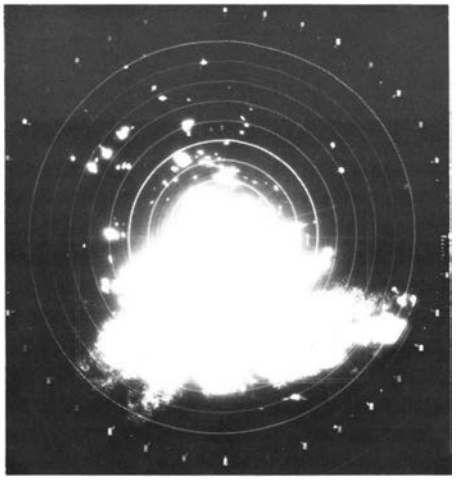
which had been required to identify aircraft and transfer control within the ATC system. One veteran controller summed up the difference between surveillance radar and RDP as, "like comparing a World War I biplane and a modern jet."

ARTS

Conceived as a simple modular system capable of displaying Mode C radar beacon signals in alphanumeric form, the original ARTS was installed at the Atlanta terminal in 1965.

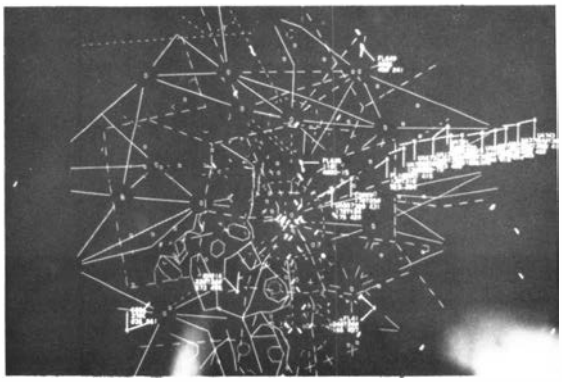
IN 1968, ARTS was augmented by equipment from an experimental en route system (SPAN), which had auditioned at the Indianapolis ARTCC and later at the New York ARTCC; the combined system was reconfigurated as ARTS I. When ARTS I proved a quick experimental success, FAA contracted with Univac for production of the data acquisition, data processing and data-entry display functions of a larger version which could accommodate the nation's busiest terminal control facilities, ARTS III.

By the late 1960s, the demands of jet age air traffic were compelling FAA to focus more and more of its attention upon the terminal areas.



Broadband radar showing weather and ground clutter, versus ARTS III (right)—*the difference was like night and day.*

The Air Traffic Service incorporated ARTS I's automatic tracking system into the New York Common IFR Room (CIFRR), the first such facility built to control flights into and out of a multiplicity of airports within the same metropolitan area. By combining the coverages of independently situated radars and feeding their signals into a single room, FAA succeeded in developing a computerized alphanumeric system, ARTS I-A, which flashed an aircraft's altitude, heading and position directly on the radarscope. Although ARTS I-A had only one-fifth of the tracking capability of ARTS III that was yet to come, even limited automation at the New York CIFRR was of critical importance.



Installation of ARTS III and the updated ARTS III-A pushed the bill for automation of air traffic control over the $1 billion figure by 1980. Between the end of 1970, when Chicago's O'Hare Airport received the first ARTS III, and August 1975, when ARTS III was installed at Dallas-Ft. Worth, 63 metropolitan terminals acquired the basic ARTS III system. ARTS III-A, first tested at the Tampa Tower in 1979 and later installed at the New York TRACON (successor to the CIFRR), possessed two characteristics not present in its predecessor. ARTS III-A can generate alphanumeric data on all targets, both beacon and primary radar, and the electronic impulses from its computer can be remoted to satellite airports.

Hoping to acquire as much ATC automation as possible from a finite amount of dollars, FAA developed a similar system for smaller commercial airports known as ARTS II. Driven by minicomputers, rather than a

mainframe, ARTS II generates alphanumeric readouts of identity and altitude but not ground speed. Eighty-four smaller airports have acquired ARTS II to date.

Avoiding Unplanned Contact

During the 1970s, both ARTS III and NAS En Route Stage A were enhanced to further reduce the margin for error in civil aviation.

The bizarre crashes of an Eastern Air Lines Lockheed L-1011 into the swamp near Miami International Airport on Sept. 29, 1972, and of a TWA Boeing 727 into the Blue Ridge Mountains on its approach to Dulles Airport on Dec. 2, 1974, dictated the development of a software enhancement to ARTS III known as Minimum Safe Altitude Warning (MSAW). MSAW alerts the controller whenever a plane has descended below an appropriate altitude by flashing a "LOW ALT" message on his radar console. MSAW was on line at all 63 ARTS III sites by November 1977. A more sophisticated MSAW package, which accounts for changes in topography over the continental U.S., was in place at the 20 ARTCCs by 1981.

The recurrence of near midair collisions, such as one involving two wide-bodied jets over Lake Michigan in November 1975, led to the development of the Conflict Alert software package. Conflict Alert warns the controller of a potential collision course between aircraft by continuously calculating the projected flight path of all aircraft under his coverage. Whenever the paths of two or more aircraft are projected to be closer than 375 feet in altitude (1,000 feet for en route Conflict Alert) and 1.2 miles horizontally (five miles), the aircraft's data blocks display a flashing "CA" on the radar screen. Conflict Alert is now in place at all centers and 63 metropolitan terminals.

FAA has implemented several other enhancements to the Third Generation ATC system over the last few years. To provide a superior back-up system to primary radar during computer outages of the IBM 9020, the agency has developed a Direct Access Radar Channel (DARC). Consisting of a series of microcomputers at each center, DARC can display identity and altitude for transponder-equipped aircraft. This provides a much clearer representation of air traffic than broadband radar until the main computer system can be restored.

Other enhancements include the "quick look" weather advisory, which allows a controller to clear the scope of weather data while monitoring traffic, yet store it for a "quick look" should he wish to announce a weather advisory; and the system of Flow Control, which was so helpful in keeping air traffic moving and delays confined to the ground during the recent controllers' strike.

The Landing Phase

The goal of FAA's landing and lighting system programs was to "lower the minimums," that is, the altitude and runway visual range below which a pilot had to abort his approach to the runway. With respect to landings, the point at issue was the present Instrument Landing System (ILS).

ILS, which had been developed during the 1940s, had two drawbacks which limited its usefulness in the jet age. The system emitted only a single, narrow beam, hence it required aircraft to stack up behind one another on their approach to the runway. At very low altitudes, the ILS signal was subject to reflections, which, unknown

Airport surveillance radar came in earlier than long-range radar. This ASR-3 was already being supplanted by the ASR-4 when photographed in 1961.

This was radar training at the FAA Academy in 1965. The classroom was in the configuration of a terminal IFR room.

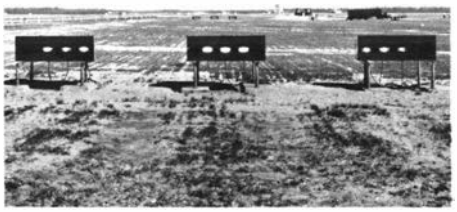
to the pilot, could distort the reading on his instrument panel.

After experimenting with a series of prototypes, FAA concluded that what was needed was not an improved ILS but a new technology—the microwave landing system (MLS). MLS represented an advance over ILS because it could generate elevational guidance, as well as distance, in one system. MLS was less susceptible to reflection than ILS. And it was far more efficient besides, since MLS radiated a wide scanning beam of possible multiple approach paths to the touchdown. MLS thus promised to clear up the "mixing bowl" over crowded terminals, while enabling the airlines to realize substantial savings in fuel consumption.

FAA began its development program for MLS in 1971. In 1978, the International Civil Aviation Organization (ICAO) approved the U.S. time-reference scanning-beam version of MLS as the international standard. The agency expects to award a production contract for the first 172 units later this year.

In 1959, following some dramatic tests at the Technical Center, FAA discarded the runway edge lighting standard in favor of a narrow gauge system (center of runway lighting). The following year, FAA adopted the British Visual Approach Slope Indicator (VASI), which allows a pilot to gauge his glide path from an arrangement of white and red lights. This was of great importance in guiding planes into airports not equipped with ILS. FAA eventually developed configurations for more than a dozen airport lighting systems, including the taxiway centerline and Category II Approach Lighting systems.

To make approach lighting less dangerous in a crash landing, rigid support structures were replaced with frangible ones.



Early in FAA history, the agency adopted the British Visual Approach Slope Indicator (VASI) system for VFR landings.

The NAS Plan

At a time when civil aviation is enjoying unprecedented safety, FAA has unveiled a master plan for overhauling all of its technology by the year 2000. The shape of things to come was laid out by Administrator Helms in January 1982 in a 450-page document entitled "The National Airspace System Plan."

Among its highlights are plans for new levels of automation for the en route and terminal portions of air traffic control, the implementation of a new generation of secondary radar (the Model S transponder), the procurement of MLS and other advanced landing aids, the replacement of vacuum-tube communication and navigation equipment with solid-state technology, the consolidation of the existing network of centers and TRACONs into a much smaller network of regional or dual-function facilities and the modernization of the FAA's flight service stations.

With its passage of the Airport and Airway Improvement Act, with companion authority for passenger, fuel and other user taxes, Congress in 1982 has already given the green light for the first stages of the National Airspace System Plan.

This is the antenna for the Third Generation: The five-foot open array atop an ASR-7 provides improved beacon performance and makes possible the Mode S capability for data link.

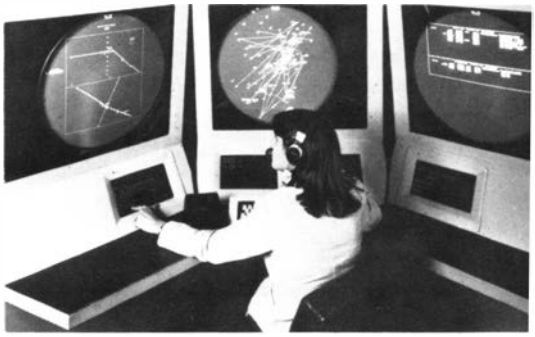
One of the first items on the agenda is replacing the 1960s-vintage IBM 9020 computers with new "host" computers capable of handling 9020 software with only a few alterations.

While the new host computers will continue to perform centralized processing, by the intermediate phase (c. 1990), minicomputers located at each controller's sector suite are expected to assume much of the specific data processing for that sector. Each sector suite would also have its own backup capability via an upgraded version of DARC. This will permit the consolidation of en route and terminal facilities into fewer mixed-use facilities.

Over the long term (the year 2000), automation of air traffic control is expected to yield "higher levels of safety and efficiency through the use of automated conflict-probe-and-resolution, system-wide direct routing and the capability to operate a sector with one person."

The most novel piece of technology associated with the National Airspace System Plan is the Mode S transponder. Mode S differs from the current Mode C transponder in that it can be interrogated and respond individually, permitting discrete communication between controller and aircraft or between two aircraft. By 1990, Mode S is expected to allow pilots and controllers to communicate without voice, owing to its data-link feature.

The success of the Mode S transponder has persuaded Administrator Helms to give the go-ahead for the development of the airborne Traffic Alert and Collision Avoidance System (TCAS) for both general aviation and large transport aircraft. Mode S has thus put an end to more than a two-decade debate over the feasibility of airborne collision-warning systems to back up the ground-based safeguards in the Third Generation ATC System.



The controller's sector suite of tomorrow being tested at the Mitre Corp. At left is the "planning display"; at right is flight data; at center is the usual plan view display. All are shown with touch entry.

The first microwave landing system commissioned in the country was at Valdez, Alaska, in November 1982. MLS provides a cleaner signal, as well as the potential for multiple glide slope angles and segmented and curved approaches.

Photo by Bendix Corp.

This year the agency will issue an RFP to substitute Mode S for its present secondary radar.

FAA has also commenced the changeover from vacuum tubes to solid-state parts for its VOR navigation system. This will increase system reliability and result in a savings of more than $500 million over a 20-year period.

Cost savings are anticipated as well from the intention to co-locate communications equipment with VORs or en route surveillance radar, as well as from the capability for remote maintenance monitoring of most "ground-to-air systems." In the long run, the agency hopes to realize still other cost savings, such as by reducing the number of VOR-DME stations through increased reliance upon area navigation. At the end of the century, FAA expects to phase out primary radar when Mode S is in wide use and the awaited NEXRAD (Next Generation Radar) Doppler weather radar system is in place.

FAA's flight service stations also figure prominently in the changes mandated by the National Airspace Plan. The flight service stations, whose primary audience is general aviation, are dedicated to flight plan processing, weather briefings and assistance to pilots in distress. FAA plans to scale down the size of the FSS network from more than 300 to 61 stations by automating most FSS services.

During the next several years, the FSS computer system will be installed at 41 sites, which will enable flight service specialists to call up weather and related data for immediate display at their positions. Also destined for obsolescence are the FSS's low-speed teletypewriters, which will be superseded by data-terminal equipment.

Flight Service Stations have come a long way—from the airway radio station to this view of the Charlottesville, Va., FSS and specialist Ralph Hill in 1970 (above) *to the automated stations now being built, like the Washington FSS of today that shows (l-r) William Arvelo, Robert McAree, Norman Cornelius and William Cecil at preflight.* (top).

Photo by Robert Laughlin

During the intermediate phase of FSS modernization, general aviation aircraft flying above 12,500 feet and possessing the data-link feature of the Mode S transponder will be able to call up weather reports on their instrument panels from the FSS data base. By the year 2000, the same service will be available for aircraft flying above 6,000 feet.

FAA has projected a $7.16 billion price tag for the capital investment costs of the National Airspace System during its initial phase (1982-1987), and $9 billion overall. More than making up for the required Federal outlay is a projected cost savings to the taxpayer of $22 billion by the year 2000 resulting from cheaper maintenance and the consolidation of present facilities. FAA also believes that the NAS Plan should save airways users an additional $25 billion over the cost of new avionics.

Today, as FAA celebrates its 25th birthday, the "airways crisis" facing America on the dawn of the jet age is no longer. Its disappearance must be attributed, in large part, to the automated technology, which, in the hands of FAA's dedicated band of air traffic controllers, has painstakingly whittled away at the margin for error in air traffic. ■

—By Joseph Garonzik

The Thunder Recedes

Improving Safety Has Been FAA's Legacy

More airplanes transport more Americans at greater speed to more destinations on better schedules and with less risk today than at any other time in the history of civil aviation. And the American civil aviation safety record is the envy of the international aviation community.

It didn't just happen. Aviation safety has come a long way, albeit kicking and scratching, since the FAA was established in 1958. The accident rate for the 1970s was less than one-third that of the sixties, capping two decades of dramatic improvements in air safety. The average U.S. air carrier accident rate per one million aircraft miles flown fell from .033 for 1962-1971 to .010 for 1972-1981. The average fatal accident rate for the same periods fell from .005 to .002 per million aircraft miles flown.

A "ghost pilot" at the Radar Training Facility at the Aeronautical Center tests the mettle of controller trainees by using a computer to simulate increasingly heavy air traffic on their radar screens.

The cap to that period was the findings of the National Transportation Safety Board for the years 1980 and 1981 that regularly scheduled airlines had 39 accidents with no deaths attributable to flying. There were four deaths, but they were from accidents that one might have elsewhere. One was from injuries a flight attendant suffered from a galley elevator, for example; another was from a passenger falling off the boarding ramp to an airliner.

Another way of looking at it may be blatant hyperbole, but it might make a point in comparison to auto-

The latest to go through the rigors of FAA's certification process ending in 1982 were Boeing's medium- and long-range 757 and 767 widebodies.

mobile travel. If all the regularly scheduled airline flights for the period 1972-1981 were combined into the operations of a single aircraft, that aircraft would have flown for 6,895 years. A passenger on it would have died of boredom, if not old age, before he had a fatal accident in 164 years.

Although the general aviation safety record has not met agency expectations, accidents were about 10 percent lower at the beginning of the 1980s than 10 years earlier, and the fatality rate was down by one-third. Administrator Helms has pledged "to put more emphasis on the general aviation safety program."

Overall, the airways are three times safer today than when FAA came into existence, even though domestic and international carriers now transport over five times as many persons and fly 1.6 times as may miles as in 1960 and air-taxi operations have doubled just since 1966.

Technological improvements and automation in air traffic control enabled the agency to keep pace with the burgeoning aviation industry. Automation permitted controllers to handle a far greater volume of traffic than was possible before by being freed from record keeping and routine communication chores.

The automation envisioned in the National Airspace System Plan promises to further increase controller productivity by giving more responsibility to the computer and upgrading the controller's job to that of system manager.

The introduction of the Terminal Control Area at 22 metropolitan airports and Terminal Radar Service Areas at 127 others during the 1970s substantially reduced the risk of midair collisions in terminal areas, as did the introduction of both terminal and center Conflict Alert.

Safety was also enhanced by increases in system reliability, most particularly now with the "Maintenance Concept for the '80s"—which involves the replacement of vacuum tubes with solid-state technology and the use of remote maintenance monitoring. Another factor was the tightening of regulations for commuter airlines and air taxis and for leased transport aircraft.

Flight safety really begins not on the runway but on the drawing board at the factory. So Aviation Standards has had the job of ensuring that each new airplane to roll off the assembly line has met the agency's strict standards. Since 1958, FAA has subjected successive generations of jet and other aircraft to the rigorous criteria found in FAR Parts 21 and 25 for the design, manufacture and maintenance of aircraft.

Each new generation of aircraft has featured novel technologies, requiring FAA to devise ever-more-painstaking procedures. One of the latest is the use of composite materials in parts of airplanes and, so far, in one complete airplane. Composite materials—man-made fibers bonded in an epoxy resin—permit light, rivetless contruction.

FAA's airworthiness standards are so rigorous now that FAA officials say the DC-3—one of the most successful airplanes of all time—could not be type certificated today. The prestigious National Research Council affirmed the soundness of FAA's type certification process following the DC-10 disaster in Chicago, when it reported that "nothing in the course of this study . . . would lead us to conclude that the confidence gained in the airworthiness of our nation's transport aircraft is unwarranted."

In the wake of the DC-10 crash, however, FAA moved to strengthen

In 1980, Boeing tested this 737 with a graphite-epoxy composite horizontal stabilizer, which weighed 22 percent less than the conventional structure. Boeing photo

its certification system even further by reorganizing field personnel into "lead regions" for various type certifications so as to coalesce the agency's expertise.

Although FAA's research and development has emphasized improvements to air traffic control, communications, landing and lighting systems, the agency has also investigated how to prevent crashes and how to increase survivability when a crash does occur.

For seven years following the crash on takeoff of a Lockheed Electra at Boston's Logan Airport in 1960, FAA conducted bird-ingestion studies, involving configurations of both birds and engines. The tests showed which engine designs could centrifuge out bird remains or resist ingestion altogether.

Following a survivable crash in 1962 in which many persons died because they were unable to get out of the plane before the flames reached them, FAA issued stricter rules for airline emergency-evacuation systems and procedures. Evacuation slides, for one, are repeatedly scrutinized for improvements in materials and deployment. Over the years, the agency has looked into rupture-resistant fuel tanks, combustion-resistant fuels and, most recently, a fuel additive that may reduce the risk of igniting leaking and misting aviation fuel during a crash landing.

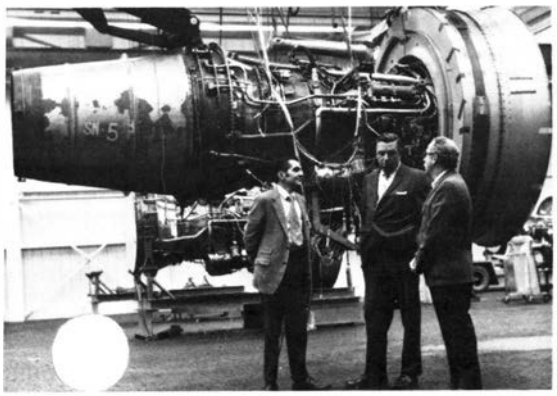
FAA has put in years of study, much of it in conjunction with the National Bureau of Standards, on the thorny problem of reducing the flammability of passenger cabin materials at the same time as reducing smoke and the toxic gases that many of the less-flammable materials produce. The agency has taken steps to require self-extinguishing upholstery and better emergency lighting in aircraft cabins.

Machines and procedures are only as reliable as the people who use them, however, and that is why FAA is increasingly focusing on human factors, whether on the front line of the cockpit and the controller's chair or in general human relations.

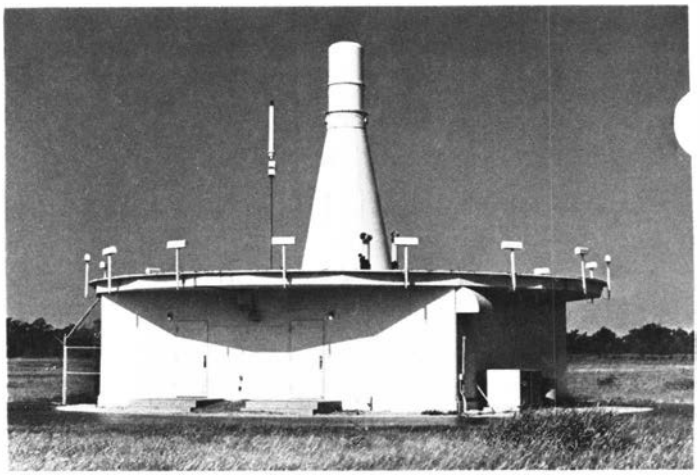
The agency has sought to ensure that persons entrusted with the responsibility for transporting the public and themselves are sound in mind and body. In 1959, FAA initiated the "Age 60" rule for pilots and the close inspection of airline crew operations. In 1973, the agency substantially increased the proficiency quirements and minimum flight hours for commercial, private and student pilots. This summer, FAA proposed to lower the minimum flight time requirements for an instrument rating to encourage more pilots to obtain this rating and, thus, cut the number of weather-related accidents.

Most of today's controllers are products of the FAA Academy in Oklahoma City, one of the best technical training institutions in the world. Here, as at the Technical Center in Atlantic City, N.J., the agency has adapted computer simulation to its ATC training procedures to expose fledgling controllers to real-time air traffic scenarios, as well as to shakedown

Safety research is ongoing at the Technical and Aeronautical centers. Here, an escape slide and evacuation procedures are tested the Civil Aeromedical Institute.



FAA inspectors discuss engine assembly with a Pratt & Whitney designated manufacturer inspection representative for FAA at the company's East Hartford, Conn., plant.



The first of a new generation of navaids is this solid-state VORTAC. The only discernible difference on the building is the built-in ground-check detectors.

Photo by Paul B. Southerland

equipment, look into the equipment-employee interface and help in the design of airports and FAA facilities.

Training and retraining are important aspects of maintaining an effective work force, particularly as automation takes us further from hands-on work. We must be sure that pilots still know how to fly their planes and controllers still know how to separate traffic when the physical operations are mostly automated.

During the rigorous questioning that followed the crash of the DC-10 in Chicago, former Administrator Bond said, "It's a defeat every time an accident of this kind happens. It's a defeat for the FAA, for the designer and for the air carrier. . . . Somewhere, somehow along the way, something was not done that should have been done. It's a personal loss for all of us."

As we improve the machines, that "somewhere, somehow" increasingly points to human error—to the ability or inability of the human to adapt to the machine or system being used. The magnitude of the improvements to the machines will be in smaller increments, while the problems of understanding the machines and managing them will grow and will become an increasing part of FAA's regulation and oversight to ensure the safety of the airways.

Although the complexities of today's system may not have been dreamed of by the framers of the Federal Aviation Act a quarter century ago, like the Constitution, the act was framed well, with the agency capable of adapting to the changing times and continuing to fulfill its charter.

That, in the words of Administrator Helms, is ". . . to make sure that FAA fulfills its function in providing transportation to the traveling public with the sense of confidence that it's going to be safe and, as near as possible, that they're going to arrive on time."

FAA has been doing that better and better for 25 years. ■

—By Joseph Garonzik

Photo by Neal Callahan

People

Aeronautical Center

■ **David E. Campbell,** manager of the Navaids/Communications Systems Engineering Branch, Maintenance Engineering Div.

■ **Clarence L. Finchum,** supervisor of the Printing Section, Management Services Division.

■ **Byron C. Hood,** instructor in the Special Services Section, Air Traffic Branch, FAA Academy, from the Great Lakes Plans and Programs Branch, Air Traffic Div.

■ **Jerry R. Hordinsky,** manager of the Aeromedical Research Branch, Civil Aeromedical Institute.

■ **Charles E. Hough,** unit supervisor in the Special Services Section.

■ **Sig A. Illing,** instructor in the Flight Service Section.

■ **Marvin L. Julian,** supervisor of the Storage and Distribution Section, Storage and Transportation Branch of the FAA Depot.

■ **Chiquita A. Meier,** chief of the Accounting and Analysis Section, Payroll Branch, Accounting Division.

■ **William M. Pyron,** manager of the Radar Systems Engineering Branch, Maintenance Engineering Division.

■ **Robert D. Stephens,** unit supervisor in the Inventory Control & Transportation Section, Storage and Transportation Branch, FAA Depot.

■ **Nora I. Walkup,** supervisor of the Aircraft Examination Section, Aircraft Registration Branch, Airmen and Aircraft Registry.

Alaskan Region

■ **Bennie L. Hutson,** unit supervisor in the Anchorage Central Maintenance Facility—South Unit, Anchorage Airway Facilities Sector.

■ **Paul A. Larson,** manager of the Safety and Standards Branch, Airports Div.

■ **Ray E. Marley,** assistant manager of the Fairbanks AF Sector, from the Planning/Establishment Branch, Airway Facilities Division.

Central Region

■ **William J. Benne,** supervisor of the F&E Environmental Communications Section, Establishment Engineering Branch, AF Division.

■ **James L. Doyle,** assistant manager for training at the Kansas City ARTCC, from the Air Traffic Service.

■ **Duane E. Earl,** manager of the Kansas City Aeronautical Quality Assurance Field Office, Flight Standards Division, from the Kansas City GADO.

■ **Calvin F. Fields,** manager of the Resource Management Division, from the Budget Division.

■ **Leon Hogan,** supervisor of the Special Projects Section, Establishment Engineering Branch, AF Division.

■ **Gene T. Schumacher,** manager of the Grand Island, Neb., AF Sector Field Office.

Eastern Region

■ **Patrick T. Corkery,** unit supervisor in the Newark, N.J., AF Sector, promotion made permanent.

■ **Calvin S. Fischer,** manager of the Baltimore, Md., AF Sector Field Office.

■ **Norbert Flatow,** assistant manager for training at the Washington National Airport AF Sector, from the Washington headquarters AF Field Office.

■ **Hector Gonzalez-Sanchez,** manager of the Civil Aviation Security Division, from the Washington headquarters Aviation Security Division.

■ **Robert J. Howard,** assistant manager for training at the New York ARTCC.

■ **Hugh C. McGinley,** manager of the Labor Relations Branch, Personnel Management Division.

■ **Eugene Metz,** supervisor of the Interfacility/Frequency Management Section, Electronics Engineering Branch, AF Div.

■ **Warren Lee Morris,** manager of the Washington headquarters AF Sector Field Office, Washington National Airport AF Sector.

■ **Oscar F. Nuckols,** assistant manager for program support in the Norfolk, Va., AF Sector.

■ **John Poidomani,** supervisory security specialist in the Investigations and Internal Security Branch, Civil Aviation Security Division.

■ **Albert Sciscione, Jr.,** manager of the Dulles Airport AF Sector Field Office, Baltimore AF Sector, promotion made permanent.

■ **Thomas E. Slocum,** unit supervisor in the Teterboro, N.J., Flight Standards District Office.

■ **Daniel J. Turcovsky,** area supervisor at the Pittsburgh, Pa., Flight Service Station.

For his modification to runway visual range equipment that will save thousands of dollars every year and eliminate failures, Jimmy Wilkinson, staff engineer at the Sacramento, Calif., Airway Facilities Sector, was named national Suggester of the Year. From Western-Pacific Region Director Mac McClure (right), he received a personal plaque, a perpetual plaque and a letter from Administrator Helms. Photo by Henry Bertuleit

■ **Francis R. Urbanski,** manager of the White Plains, N.Y., AF Sector Field Office, Newark, N.J., AF Sector, from the Albany, N.Y., AF Sector.

Great Lakes Region

■ **Joseph Bloch,** manager of the Maintenance Branch, Flight Standards Div., from the Ypsilanti, Mich., ACDO.

■ **Teddy W. Burcham,** deputy manager of the Air Traffic Division.

■ **Eugene J. Hall,** manager of the Carbondale, Ill., Tower, from the Evansville, Ind., Tower.

■ **Jack L. Keehn,** assistant manager of the Cleveland Hopkins (Ohio) Tower.

■ **Arnold E. Miller,** area supervisor at the Evansville Tower, from the Indianapolis, Ind., Tower.

■ **Terence E. Miller,** area supervisor at the Moline, Ill., Tower, from the Chicago O'Hare Tower.

■ **Darrel L. Pittman,** area supervisor at the Kalamazoo, Mich., Tower, from the Bismarck, N.D., Tower.

■ **Terry C. Riggs,** area supervisor at the Port Columbus, Ohio, Tower, from the Flint, Mich., Tower.

■ **Bruce E. Wagoner,** manager of the Flint Tower, from the Air Traffic Operations Branch, Air Traffic Division.

Metropolitan Washington Airports

■ **Kenneth C. Jacobs,** manager of the Engineering Branch, Engineering and Maintenance Division.

New England Region

■ **Raymond J. Borowski,** manager of the New York Aircraft Certification Office.

■ **Willie F. Card,** area supervisor at the Boston Logan Tower, from the Greater Pittsburgh, Pa., Tower.

■ **Robert J. Dame,** manager of the National Flight Procedures Review Branch, Flight Standards Division, from Washington headquarters Fleet Management Branch, Office of Flight Operations.

■ **Derwin R. Hammond,** manager of the Portland, Maine, Tower, from the Alaskan Region Airspace & Procedures Branch.

■ **Ronald E. Johnston,** area manager at the Bradley Field Tower, Windsor Locks, Conn.

■ **Kermit L. Wieselquist,** assistant manager of the Airway Facilities Div., from the Flight Standards Division.

Northwest Mountain Region

■ **Walter G. Allard,** manager of the Cedar City, Utah, AF Sector Field Office, Salt Lake City AF Sector.

■ **Donavon C. Arneson,** area supervisor at the Colorado Springs, Colo., Tower.

■ **Ronald F. Bernstein,** manager of the Seattle, Wash., Flight Standards District Office, from the Operations Branch, Flight Standards Division.

■ **James H. Birchfield,** engineering equipment operator foreman in the Denver, Colo., Field Maintenance Party, from the Dallas, Ore., Field Working Group.

■ **James D. Bishop,** supervisor of the F&E Program Section, Program and Planning Branch, AF Division.

■ **David W. Cain,** manager of the Program and Planning Branch, AF Division.

■ **David A. Field,** chief of the Standards Section, Safety and Standards Branch, Airports Division.

■ **Preston C. Gardner, Jr.,** supervisory airspace system inspection pilot, Flight Inspection and Procedures Staff, Flight Standards Division.

■ **James R. Lockhart,** manager of the Logistics Division, from the AF Div.

■ **Lewis E. Sparkman,** supervisor of the Technical Support Section, Maintenance Operations Branch, AF Division, from the Seattle AF Sector.

■ **Robert L. Wheeler,** area supervisor at the Denver Tower.

Southern Region

■ **Jerry C. Baker,** manager of the Benson, N.C., AF Sector Field Office of the Raleigh, N.C., AF Sector, from the Pico Del Este, Puerto Rico, AF Sector Field Office.

■ **Drummond J. Brown,** assistant manager for technical support in the Charlotte, N.C., AF Sector, from the Greer, S.C., AF Sector.

■ **Victor C. Byrd,** manager of the Montgomery, Ala., Flight Service Station, from the Tri-City FSS, Bristol, Tenn.

■ **Joe R. Carter,** assistant manager of the Charlotte Tower, from the Myrtle Beach, S.C., AFB.

■ **Bryant M. Chestnutt,** assistant manager of the Miami, Fla., Flight Standards District Office, from the Atlanta, Ga., ACDO.

■ **Sanford S. Minchew,** chief of the Radar Unit at the Covington, Ky., AF Sector, from the San Juan, P.R., Sector.

■ **Randy D. O'Neal,** unit supervisor in the Savannah, Ga., AF Sector Field Office, Columbia, S.C., AF Sector, from the Memphis, Tenn., Hub AF Sector.

■ **Roy C. Pace,** manager of the Alma, Ga., FSS, from the Albany, Ga., FSS.

■ **A.L. Ross,** unit supervisor at the Atlanta, Ga., ARTCC AF Sector.

■ **Louis Ruiz, Jr.,** operations officer at the Miami International Flight Service Station, from the Dyersburg, Tenn., FSS.

■ **David E. Vergason,** manager of the Sarasota, Fla., Tower, from the Tampa, Fla., Tower.

■ **Bernard W. Wenning,** programs officer at the Charlotte Tower.

■ **Herman E. Williams,** manager of the Knoxville, Tenn., AF Sector Field Office, Covington, Ky., AF Sector.

■ **Raymond Ybarra,** FAA representative in Rio de Janeiro, Brazil, from the Jacksonville, Fla., Tower.

Southwest Region

■ **Raymond C. Hollemon,** assistant manager for training at the Dallas-Fort Worth, Tex., Tower.

■ **Louis E. Moss,** unit supervisor in the Houston, Tex., ARTCC AF Sector.

■ **Ronald E. Noe,** area supervisor at the Brownsville, Tex., Tower, from the Parkersburg, W. Va., Tower.

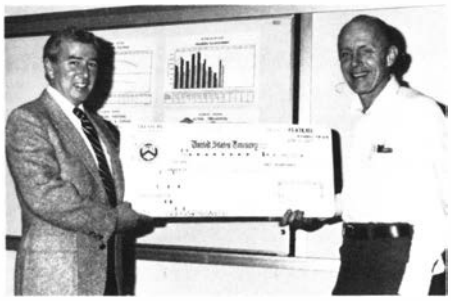
■ **Rosendo A. Vasquez,** area supervisor at the El Paso, Tex., Flight Service Station, from the Dallas FSS.

Technical Center

■ **Theodore J. Bolich,** supervisor of the Printing Section, Graphic Arts Branch, Communications Resource Staff.

■ **Martin Holtz,** manager of the Systems Requirement Branch, ATC Systems Technology Division.

■ **John B. Young II,** supervisor of the Building Management Section, Plant Operation & Maintenance Branch, Facilities Division.



Robin J. Masek (right), electronics engineer received a giant facsimile of a $3,965 check from Alaskan Region Director Frank Cunningham for a suggestion that will save FAA at least $153,000. Masek recommended a $50 radar antenna support beam as a substitute for a commercially priced support of $7,000.

Washington Headquarters

■ **Bernard M. Batchelder,** assistant manager of the General Aviation & Commercial Div., Office of Flight Operations.

■ **Ralph A. Cooper,** manager of the Plans Branch, System Programs Div., Air Traffic Service, promotion made permanent.

■ **Richard E. Livingston, Jr.,** rotorcraft programs officer, Rotorcraft Program Office.

■ **Michael D. Zywokarte,** manager of the Research & Development, Medical & Security Div., Office of the Budget.

Western-Pacific Region

■ **Sheryl D. Becker,** manager of the Hawthorne, Calif., Tower, from the Santa Monica, Calif., Tower.

■ **Frederick E. Brandt III,** area supervisor at the Oakland, Calif., ARTCC.

■ **Thomas E. Carman,** area supervisor at the Hayward, Calif., Tower, from the Oakland Tower.

■ **Dean C. Deshazo,** manager of the Las Vegas, Nev., AF Sector, from the Reno, Nev., AF Sector.

■ **Norman D. Doetsch,** area supervisor at the Phoenix, Ariz., TRACON.

■ **Jerome R. Egan,** area supervisor at the Oakland Tower, promotion made permanent.

■ **Ronald D. Gerber,** area supervisor at the Santa Monica Tower, from the Burbank, Calif., Tower.

■ **Susan M. Gygax,** supervisory operating accountant, Accounting Operations & Analysis Branch, Accounting Division, promotion made permanent.

■ **Gilbert E. McCoy,** area manager at the Honolulu, Hawaii, Tower, from the Honolulu ARTCC.

■ **Marianne Sommer,** administrative officer, Sacramento, Calif., General Aviation District Office.

■ **Francis T. Torikai,** area supervisor at the Honolulu ARTCC, from the Air Traffic Branch, FAA Academy.

DOT Secretary Elizabeth Dole checks out the local traffic with binoculars at Boston's Logan International Airport Tower, as assistant controller Gary Layne looks on. She toured the facility for National Transportation Week in May.

Wide World Photos

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