Fiftieth Anniversary of the First DC-8 Flight

By Tim Williams

Douglas DC-8, N8008D, "Ship One," lifts off the runway on its maiden flight from Long Beach Airport, Calif., May 30, 1958, launching Douglas into the commercial jet transport business. (Photo from the author's collection)

A brief history of an aircraft that made a significant contribution to profitable commercial jet transportation The scope of this article will cover the DC-8 program up to the time of certification of the first four models, the series 10, 20, 30 and 40. Other articles in preparation cover later aspects of DC-8 history.

While the DC brand mark was familiar to airline passengers for more than half a century, Douglas Aircraft may never have acted as a pioneer in commercial aircraft manufacture.

In the early 1930s the pioneering was left to Boeing with their Model 247. The 247 was the first modern airliner to reach series production. It produced what was, at the time, a relatively high level of passenger comfort, high speed and safety. The 247 possessed all-metal construction, retractable landing gear, reliable engines, and was a low-wing monoplane. Unfortunately for Boeing, their business model tied up production for United Air Lines which was a part of their company. Other airlines were put at a disadvantage by the superior performance, and attractiveness to the public, of the 247. This led other airlines, spearheaded by Transcontinental and Western, to seek other options in equipping their fleets.

Among the potential manufacturers approached was Douglas Aircraft Company. Douglas had been primarily a producer of military aircraft and a successful series of mail planes. Prior to this time Douglas Aircraft Co. had designed and manufactured three commercial aircraft. The lone *Cloudster* was modified and used by a California airline operated by Claude T. Ryan. It must be said that the *Cloudster* was not originally designed as a commercial aircraft. Rather, it was designed to attempt a non-stop trans-continental flight. Douglas was also responsible for the modification of several Martin flying boats for an airline that operated between Catalina Island and the mainland in the early 1920s. Two *Dolphin* amphibians were produced for chewing gum magnate, William Wrigley's Wilmington-Catalina Airline. Douglas did manufacture one more *Dolphin* for Wrigley and two for Pan American Airways. But these were produced after the design of the DC-1. So, the total Douglas production of commercial aircraft prior to the signing of the DC-1 contract with American was less than 10 aircraft!

Douglas Aircraft was a much smaller organization than United Aircraft, to which Boeing belonged. And that turned out to be an advantage for Donald Douglas' company. Donald Douglas was very trusting of those who worked for him. The environment was entrepreneurial and management was able to make decisions rapidly without interference from "above." And, they had access to a small pool of brilliant designers.

BOAC de Havilland Comet *4B, msn 06022. de Havilland launched the commercial jet age with the* Comet *series, but a design flaw and politics allowed Boeing and Douglas to catch and pass them. (Photo from the author's collection)*

Arthur Raymond, Jack Northrop, Bailey Oswald produced a design concept that would put the world in the air. With the DC-2, and the iconic DC-3, airlines could make a profit on the transportation of passengers without the benefit of mail contracts.

It is interesting that the last Douglas Aircraft product in which Donald Douglas was directly involved in designing was the *Sinbad/Dolphin* series of amphibians. (They were marketed as "amphibions.") And yet he is certainly responsible for what may be the most significant air transport ever designed. He put the team together and gave them the authority to propose an aircraft design that went well beyond what the airlines were seeking. Many DC-3s are earning profits for operators more than 75 years after they were conceived. This legacy of long-term economic viability of Douglas Commercial designs is certainly demonstrated by the subject of this article, the DC-8. Many are still earning their keep 50 years after its first flight.

In the late 1930s Boeing sought to meet the growing demand for pressurized aircraft that could "fly over the weather" with their revolutionary Model 307. Boeing sold 307s to Transcontinental and Western and to Pan American Airways. Douglas did not enter this market. Instead they continued to produce the DC-3. While Douglas had intended to develop pressurization for the DC-4 commercial transport, WWII produced the demand for the military C-54. So there was no pressurized DC-4 produced by Douglas Aircraft. The development of a pressurized DC-4 airliner was left to Canadair with the postwar *Northstar*. Douglas did not produce a pressurized commercial aircraft for the airlines until the DC-6.

When the idea of turbojet-powered airliners began to be realized, it was left to de Havilland with their *Comet*; Avro Canada with their C.102 *Jetliner* and Sud with their *Caravelle*, to do the pioneering. While the Avro Canada C.102 *Jetliner* first flew on August 10, 1949, it never went into production. The de Havilland *Comet* which first flew on July 22, 1949, went into series production. It entered BOAC freight service

Douglas-Sud Caravelle*, N420GE. Douglas explored licensing arrangements to produce the* Caravelle*, but abandoned these in favor of an in-house design that would become the highly successful DC-9. (Douglas photo EST C-2735B)*

Artist Renderings

During the marketing programs associated with the DC-8 are artist renderings of the aircraft outfitted in the livery to the targeted airline. Examples of some of these are shown below.

A 1953 rendering in Douglas colors. (Douglas 153687)

A 1954 rendering for Eastern Air Lines. (Douglas SM 159379)

A 1954 rendering for United Air Lines. (Douglas 157983)

Model 1865 in USAF markings. (Douglas 168784)

An undated DC-8 rendering in RCAF markings. (Douglas 277992)

A DC-8 shown in the markings of the Material Air Transport Servces (MATS) of the USAF. (Douglas SM 336379)

A 1956 photo of the DC-8 mock-up. (Douglas photo A69-17-1)

on January 22, 1952, and on May 2, 1952, achieved its first revenue flight with passengers. The Sud *Caravelle* which first flew on May 27, 1955, also went into series production. The *Caravelle*'s first service was with Air France on May 12, 1959.

The Sud *Caravelle* was a relatively successful design. Two-hundred eighty-two were produced for airlines around the world. It was not intended as a transoceanic transport, but as a short- and medium-haul craft. It served as the pioneer in the DC-9/737/A320 class. Indeed, Douglas had begun establishing an agreement with Sud Aviation and GE to market a fanjet version of the *Caravelle* before committing to the DC-9 program. Douglas eventually sold over 2,000 DC-9s. There are DC-9s operating which were manufactured more than 40 years ago. Again, Douglas was not the pioneer in developing this class of airliner, but was very successful.

After WWII, Douglas was busy producing DC-6s and later DC-7s. Douglas' viewpoint was that jets were not yet at a stage of development where they could be operated profitably. Douglas was moving toward turboprop-powered versions of its DC-6/DC-7 series aircraft. This viewpoint regarding turboprop propulsion being the next logical step in commercial airliner development was shared by the other major U. S. airliner manufacturer of the time, Lockheed.

The economically viable turbojet-powered commercial aviation began with Boeing's pioneering Dash 80/KC-135/707 series. These developed as high-capacity, high-speed aircraft which were quite different from the earlier jet transports. They produced a concept of putting more passengers in a larger aircraft and flying the aircraft more often to produce more attractive air-fares. This concept has transformed transportation. The DC-8 went further with this concept by designing the ability to

Another view of the fuselage mock-up of the DC-8. (Douglas photo A81-12-7)

The DC-8's passenger accommodations were unique at the time featuring many innovative design features such as fresh air outlets, reading lights, tray tables, stewardess call buttons and pop-out oxygen masks. Counter-clockwise from above: Coach class seating showing tray table and oxygen-mask deployment, coach class seating, first class seating, first class section, coach class section, and first class seat backs. (Douglas photos RAP 31-189, A712-2-5, A96-14-1, C8-2615-3, C8-2615-5, A96-14-2 in sequence)

Passenger seating included individual stewardess call buttons as seen being demonstrated here in the first class section. (Douglas photo EST-C-1598B)

stretch the size of the aircraft into the DC-8 from the first ship. Douglas had developed this "stretching" design strategy early on as a part of their commercial design philosophy.

Douglas joins the turbojet commercial transport market

While Douglas had been studying and discussing various DC-8 configurations with airlines as early as 1953, there was no commitment to produce. These studies were partially predicated on the possibility of Douglas sharing in the military jet tanker program. This obviously did not come to pass with the decision that the military tanker need would be fulfilled by the KC-135 alone. Douglas finally announced the DC-8 program on June 7, 1955. Boeing had committed to develop the Model 367-80 (which led to the 707/KC-135) on May 20, 1952. So Boeing had a three-year lead and the experience gained in developing and manufacturing the large, swept-wing, multi-engine B-47s and B-52s. In addition, Douglas would have funded the development of the DC-8 without the benefit of governmental support through participation in a military jet tanker program. Douglas records show the company investing approximately $300,000,000 in development and manufacturing by the time of the flight of Ship One. This would push the breakeven point for the DC-8 program further out than for that of its rival, the 707. This also put more pressure on unit cost for the DC-8. Market estimates for large jet airliners in the DC-8/707 class in 1953 were in the neighborhood of 200 aircraft. Douglas had committed to a huge gamble. In 1967 the total cumulative losses on the DC-8 program reached in excess of $400,000,000. Indeed, by 1972 with the 556th and final DC-8 delivery, sales of DC-8 aircraft alone had produced a cumulative $50,000,000 loss. Spares and interest income had produced total DC-8 program pre-tax earnings of over $200,000,000 by 1980, however.

Engine development drives aircraft design

As always, the availability of suitable engines was a limiting factor in the design of the first generation turbojet airliners. The primary engine available for the early large turbojet airliners was a civil development of the Pratt & Whitney J57, the JT3 series. The power and fuel consumption of these engines dictated four or six engines for the size aircraft that Boeing and Douglas were proposing. Other engines which were, or would soon be, available were the civilian development of the more powerful Pratt & Whitney J75, the JT4; the Rolls-Royce *Conway*; the civilian development of the General Electric J79, the CJ805.

Design Features

Passenger comfort and safety

After lengthy debate as to whether the DC-8 would offer five-abreast or six-abreast seating, United Air Lines' preference for a wider cabin led to the decision to set the upper cabin diameter of 147 inches. Douglas considered United to be the primary launch customer and United's preferences carried weight. The double lobe fuselage was of constant-section, allowing future stretching of the basic configuration.

The Douglas Aircraft interior design team, lead by Jack Graves, had more experience than any other commercial aircraft manufacturer. Historically, interiors of Douglas airliners were custom designed for the customer. Seats for the new DC-8 were designed for passenger comfort and flexibility for airlines. Douglas patented the award winning "Palomar unitized seat." The brand name "Skyloge" was also used by Douglas in marketing this design. These seats were designed

The DC-8's main gear bogies were designed to allow them to swivel, facilitating tight turns without scrubbing the tires. (Douglas photo C-8-2323-2)

Ship Two, N8018D, undergoing static testing at the Long Beach facility. (Douglas photo MSN 45278)

to incorporate fresh air outlets, reading lights, tray tables, stewardess call buttons, pop-out oxygen masks. Fresh air, electrical power and communications were connected through an umbilical cord from each seat row to sidewall manifolds. This, along with floor mounted seat tracks, provided flexibility in seat positioning while keeping passenger comfort and safety features functional at each seat. The reading lights and the stewardess call buttons were located in the fronts of the seat backs near the passengers' aisle-side shoulders. The tray tables, fresh air outlets and oxygen masks were located in the rear of the seat backs. The design of movable bulkheads added to the flexibility afforded the airline customers by the innovative Douglas interior concept.

After the unfortunate experience regarding metal fatigue in the de Havilland *Comet I*, design of jetliner windows became a major concern for designers of the first generation of large commercial aircraft. The DC-8 windows were triple paned and designed to withstand several times the expected pressure. With three panes, the middle pane could not easily be breeched. For passenger comfort the triple pane structure offered soundproofing equal to that provided by the fuselage walls. The windows were also much larger than the 707. This allowed reasonably good views from aisle seats.

A great deal of attention went into the design of the DC-8 restrooms. Another groundbreaking passenger comfort innovation was the provision of electro-mechanical flush toilets. These represented a significant comfort enhancement over the odiferous chemical airliner toilets used up to this time. The design of a flash heater placed under the lavatory allowed provision of hot and cold water from the single cold water source. A separate hot water storage capacity was no longer needed.

So why the 30-degree wing sweep? Why not 35 degrees, like the 707?

A goal in the design of the DC-8 was to produce low-speed flight characteristics similar to the DC-7. It was felt this was critical to ease the successful flight crew transition from piston-powered to turbojet-powered commercial aircraft. The 30-degree wing sweep was selected to produce excellent low-speed handling characteristics and to mitigate the Dutch Roll phenomenon experienced with swept wings. The DC-8 high speed airfoils were developments of the NACA four digit series. These would produce a drag divergence Mach number of 0.84 with only 30 degrees of wing sweep. A typical high-speed airfoil would require 35 degrees of sweep to produce a similar Mach number figure. The airfoils of the DC-8 wing varied from wing root, which were more curved on the bottom surface, to the mid-span and tip areas which had more curve on the upper surface. The curvature of the bottom of the root airfoil produced an area rule effect to deal with transonic wing-fuselage problems. The wing was also designed with a horizontal twist from the root to the tip. These features allowed the wing to maintain aileron effectiveness as the wing begins to stall. The DC-8 wing was designed to be relatively stiff, partly to provide good crosswind characteristics. It was of triple spar triple torque box design with Douglas-designed slotted flaps.

Landing gear with swiveling wheels for airport handling

The first-generation large turbojet transports were much larger and heavier than the aircraft that were operating from contemporary airports. In order to allow operation from facilities that had not yet been upgraded, both the DC-8 and the 707 were designed with double-bogie, four-wheel main gear units. These would distribute the weight over eight large

Ship One, N8008D, under construction at the Long Beach facility. (Douglas photo MSN 45252)

wheels. To allow the DC-8 to turn around on a five-foot radius, the rear main gear wheel pairs were designed to unlock and swivel. This facilitated maneuvering on taxiways designed for the older prop-driven airliners. The swiveling action of the main gear reduced the scrubbing of tires during tight turns.

Selling the DC-8

The DC-8, as initially offered, had a span of 134 feet 6 inches, a length of 140 feet 6 inches, a maximum gross take-off weight of 257,000 pounds and powered by four Pratt & Whitney JT3, 11,000-pound thrust engines. This configuration could not produce adequate transatlantic headwind nor "hot and high" airport performance.

Examination of the engine nacelles on Ship 1 (N8008D) reveals the lack of thrust reversers. These were not added until Ship 3 and subsequently installed on all airframes. (Douglas photo SM255626)

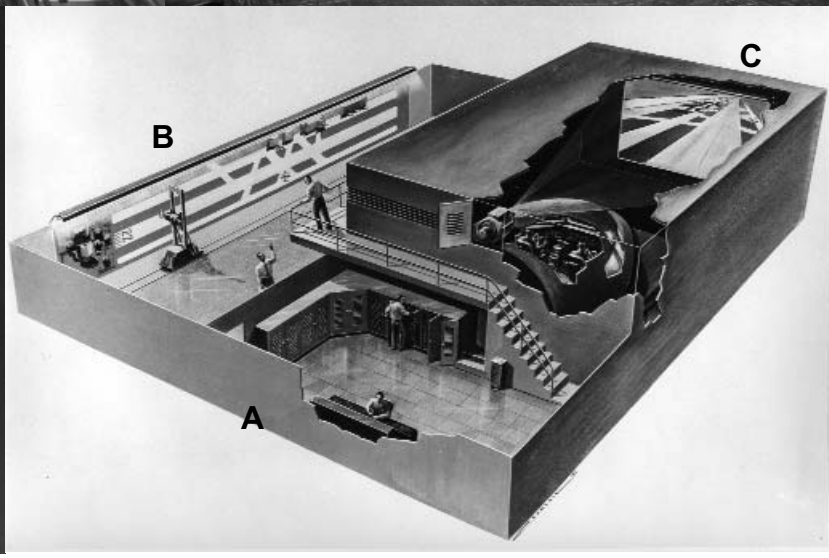
The first DC-8 order was announced by Pan American President Juan Trippe on October 13, 1955. Pan American's order was for 25 overwater versions powered by Pratt & Whitney JT4s. At the same time Trippe announced Pan American's order for 20 707s. Douglas got the larger order based on their reputation and because of the greater fuselage width of the DC-8. Because the JT4-powered DC-8s were going to be available after the JT3-powered DC-8s, Pan American would not receive the first deliveries, even though they were the launch customer.

On October 25, 1955, Donald Douglas and United President, Pat Patterson, announced United's order for 30 domestic DC-8s. At the time, this $175 million order was the largest individual airliner order. On November 7, 1955, National signed an order for six domestic DC-8s.

The first foreign airline to order DC-8s was KLM with a buy of eight JT4-powered overwater versions. The KLM order was announced on November 16, 1955. KLM would be the only airline to operate DC-2s, DC-3s, DC-4s, DC-5s, DC-6s, DC-7s, DC-8s, DC-9s, DC-10s and MD-11s.

In December, Eddie Rickenbacker of Eastern Air Lines announced an order for 26 domestic DC-8s. On December 15, 1955, Japan Air Lines announced its order of four overwater DC-8s which would be used on the San Francisco-Hawaii-Tokyo route. SAS announced an order for seven overwater versions and options on three more DC-8s. On December 29, 1955, Pan American announced that four of the 25 DC-8s ordered in October would be allocated to Panagra (Pan American Grace).

On January 30, 1956, Swissair ordered three overwater versions. Delta placed an order for eight JT4-powered domestic versions on February 13, 1956. Delta became the ninth airline to order DC-8s, but through a series of circumstances would be the first to operate a DC-8 revenue flight.



Douglas contracted with Link to build a DC-8 simulator that would provide test pilots with flight experience prior to first flight. This would allow Douglas to pursue an accellerated flight test program in its efforts to catch up with Boeing's 707 program. Top (L to R): cockpit with projection screen in front, view from the cockpit. Middle (L to R): The analog control computer, moving map display, central control room. Bottom (L to R): View of the terrain projection from the cockpit, The simulator system layout; A - control room, B- moving map system, C - cockpit and projection room. (Douglas photos A88-14-1, A88-14-5, A88-14-2, A88-14-3, A88-14-5, SM210465, SM210158 in sequence)

Roll-out ceremony for the first DC-8, N8008D, in the company of a Stewart Air Service DC-3, and three DC-7s (PSA N83387, USAF MATS (#?) and United N6353C). A second, unidentified DC-8 under construction is in the upper right corner. (Douglas photo SM 255666)

Stewardesses from many of the airlines that had placed orders attended the roll-out ceremony. (Douglas photo EST C-154B)

After the flurry of orders in late 1955 and early 1956 orders slowed significantly through the rest of 1956. In February, Pan American announced that four more of the 25 DC-8s they had ordered in the previous October were to go to Panair do Brazil. Trans-Canada became the tenth customer when they ordered four of the Rolls-Royce powered series 40s in May 1956. The independent French airline, Union Aeromaritime de Transports (UAT) ordered two overwater versions on November 19, 1956. Another independent French airline, Transports Aeriens Intercontinentaux (TAI), closed out 1956 orders on December 20, 1956, with an order for four overwater DC-8s.

An order for four Rolls-Royce *Conway* powered DC-8-40s was placed by Alitalia on March 6, 1957. These were followed by an Iberia order for two overwater versions powered by advanced JT3s.

The configuration of the DC-8 had, by 1958, grown to a span of 139 feet 7 inches, a length of 150 feet 6 inches. The maximum gross takeoff weight of the JT3C-powered domestic version was 265,000 pounds. The JT4A-powered long-range version had a maximum gross takeoff weight of 287,500 pounds.

Douglas airliner production moves from Santa Monica to Long Beach

With the decision to go forward with the DC-8 program came a need to find a new production facility. The DC transport production facility had always been Clover Field in Santa Monica. (The DC-5 was produced at the El Segundo plant.) While the Santa Monica facility had been expanded before and during WWII, it was cramped for DC-6 and DC-7 production. One of the challenges large turbojet airliners brought was the need for longer runways. There would not be enough room to build and fly DC-8s from Clover Field. Even if acreage could be found for the extensive manufacturing and flight ramp facilities could be found, the airport's hilltop location made runway extension highly impractical.

During the ramp up to WWII Douglas built a large state-of-the-art facility at Daughtery Field in Long Beach. This facility produced A-20s, C-47s, B-17s and A-26s for the war. After the war the largely unused facility was used by Douglas to finish the 14 ship C-74 program and to modify A-26s. Parts of the facility were leased to North American Aviation to build B-45 jet bombers and to Kaiser-Frazer to build automobiles. In the late 1940s and early 1950s the C-124, C-133 and part of the

Ship One, N8008D, climbs away from Long Beach airport on its first flight May 30, 1958.
(Douglas photo from the author's collection)

B-66 programs were housed at Long Beach. The site had large underused facilities and plenty of room for expansion. The only thing lacking was a large turbojet length runway. Douglas reached an agreement with the City of Long Beach for the extension of the long diagonal runway. This required the rerouting of Spring Street and Lakewood Boulevard through tunnels created under the runway extension. In addition to having a longer runway, this change expanded the usable area on airport property. This was a controversial decision on the part of the local government. It has resulted in over 50 years of significant economic benefit to the region. At the writing of this article, Long Beach is the only place in California still producing large fixed-wing aircraft.

With the potential for adequate facilities assured, the decision to establish DC-8 production at Long Beach was made. A production facility of more than a million square feet was planned and built on the east side of Lakewood Blvd. in what had been the massive parking lot for the WWII defense plant. These were designated as the 80s Buildings. The largest two were Buildings 80 and 84. The new facility included a large separate paint booth/building and extensive ramp space.

Flight testing and certification

In order to reduce the lead the 707 program held, Douglas planned an accelerated flight testing program. This involved eight aircraft and 26 DC-8 rated pilots. Douglas had Link produce a DC-8 simulator. Each of the 26 flight test pilots had at least 15 hours of simulator time before being qualified for commanding DC-8 flights.

DC-8-12 Prototype, N8008D

The first DC-8, msn 45256, N8008D, made its first flight on Memorial Day, May 30, 1958, at Long Beach, Calif. The flight date had been planned to allow the maximum number of workers to be able to witness the event. It was estimated that nearly 100,000 viewers were present for the first flight. The crew for the maiden flight included Heimie Heimerdinger, chief pilot; Bill Magruder, copilot, Paul Patton, flight engineer; and Bob Rizer, flight test engineer. The aircraft was equipped with an emergency escape chute and hatch. This emergency exit was installed in the main cabin on the port side, just aft of the forward main entry door. The location of the exit hatch was indicated on the outside of the fuselage with crosshatched heavy red warning markings. This initial flight lasted two hours and seven minutes and, primarily, took place over the Pacific Ocean. The takeoff weight was 198,000 pounds. The DC-8 attained 350 knots and 21,000 feet altitude. An Air Force T-37 was used as chase plane throughout the flight. A United DC-7, carrying photographers, joined up with the DC-8 and T-37 for much of the flight. The DC-8 and crew were greeted at Edwards Air Force Base where it made a smooth first landing. Ship One had completed one cycle (a takeoff and landing), with a total time of 2 hours, 7 minutes and smiles all around.

Flight two took place on June 4, 1958, lasting two hours and five minutes. Ship One had made 13 flights by the end of July. In these 45 hours of flights the DC-8 had achieved its design cruise speed of Mach 0.85 and its long-range cruise altitude of 36,000 feet and a maximum takeoff weight of 255,000 pounds. Ship One did not return to Long Beach until August 22, 1958. This was for scheduled inspection and installation of additional test equipment. By this time the DC-8 had logged 72 hours and 23 flights.

Ship One was equipped with Pratt & Whitney JT3C-6 engines of 13,000 pounds thrust. N8008D later served as the prototype for the DC-8-51.

Ship One was retained by Douglas until it was leased to National Airlines June 21, 1961, to May 26, 1962. Trans International Airlines bought N8008D June 20, 1962. Trans

First three DC-8s fly in formation. Left to right, N8028D, N8018D, N8008D. (Douglas photo EST C-1350B)

International leased Ship One to Lufthansa who operated it as N8008D from May 11 to December 1965. Canadian Pacific Airlines leased this aircraft as CF-CPN, "Empress of Santiago," from October 2, 1966, to October 1, 1967. Upon completion of the Canadian Pacific lease, Ship One was sold to Delta Air Lines, again as N8008D, # 800. Delta operated N8008D for over 11 years, putting approximately 31,000 hours and 8,000 landings on the airframe. Delta sold the aircraft to ITL Incorporation March 23, 1979, who sold it to F.B. Ayer the same day. F.B. Ayer leased Ship One to its final operator, Aeromexico as XA-DOE on April 1, 1979. Aeromexico returned XA-DOE to F.B. Ayer July 1, 1982. While its ownership changed several times after return from the Aeromexico lease, it was only operated for three more hours and two more landings. When N8008D was finally parked at the Evergreen facility near Marana, Ariz., it had accumulated 60,921 hours and 32,413 landings.

DC-8-21, N8018D

Ship Two, N8018D, msn 45278, was initially used as a static test article. Its first flight did not take place until November 29, 1958. As the first DC-8-21, Ship Two was equipped with Pratt & Whitney JT4A-9s of 16,800 pounds thrust. These were a civilian development of the J75 engine. The DC-8-21 had a maximum gross takeoff weight (MGTOW) of 276,000 pounds. Its still air range with a maximum payload of 34,500 pounds was 4,050 miles. Ship Two was modified with extended wing tips, cambered engine pylons and leading edge slots. The purpose of the wing tip and pylon modifications was to improve speed and range. The slots were aimed at improving low speed flight characteristics which had been negatively affected by the pylon modifications. These three modifications proved successful and were incorporated as standard features. Ship Two testing also led to another modification to future DC-8s. A hard landing caused a failure of the fuselage aft of the wing and so the fuselage keel was strengthened. Ship Two wore Douglas house colors while in the testing role. Ship Two was later delivered to United as N8001U. It was delivered to United as a DC-8-21 on November 1, 1960.

N8001U was retired January 23, 1978. It traded in to Boeing, who stored it at Kingman, Ariz., with 52,058 hours and 17,903 landings. It was broken up at Kingman.

DC-8-12, N8028D

Ship Three, N8028D, msn 45279, did not fly until December 28, 1958. Ship Three was the first DC-8-12. It was equipped with the same type engines as Ship One, JT3C-6s, but its MGTOW had been increased to 273,000 pounds. Its initial flight had been delayed in order to equip the aircraft with new silencer and thrust reverser systems. These systems were installed on all subsequent DC-8s. N8028D was also used to test flight controls and fuel systems. Ship Three operated in United Air Lines' color scheme. It was eventually delivered to United as N8002U, a DC-8-12, on May 11, 1961. It was named "Mainliner Long Beach."

N8002U was converted to series -21 standards April 21, 1965. United sold N8002U to Plymouth Leasing Corp. on February 22, 1978. Plymouth retired N8002U at Willow Run Airport, Mich., the same day with 50,043 hours and 17,210 landings. The aircraft was broken up in May 1983.

Ships One through Three operated out of Edwards AFB for the first six months of the test program.

DC-8-11, N8038D

Ship Four, N8038D, msn 45280, made its first flight on January 2, 1959, as a DC-8-11. It was equipped with JT3C-6s at a MGTOW of 265,000 pounds. Ship Four was used to test

Ship One was equipped with speed brakes which were eliminated because they were ineffective. (Douglas photo A811-7-9)

anti-icing systems, pressurization systems and interior noise levels. Ship Four operated in Douglas house colors. It was delivered to United as N8003U, a DC-8-11, on June 16, 1960.

United donated N8003U to the Orbis charitable group on March 12, 1980. The aircraft was converted by Orbis as an opthalomogical hospital for use in developing countries. Orbis registered the aircraft as N220RB. Orbis operated the DC-8 for a little over 14 years, accumulating 651 hours with 247 landings. When Ship Four was retired by Orbis on April 15, 1994, it had flown 53,771 hours and made 25,784 landings. Today it resides in a Chinese air museum.

The FAA certification program began with a flight on January 29, 1959.

DC-8-32, N800PA

Ship Five, N800PA, msn 45253, made its first flight on February 20, 1959, and joined the flight test fleet as the first DC-8-32. It was equipped with Pratt & Whitney JT4A-12s of 17,500 pounds thrust. The DC-8-32 had a MGTOW of 310,000 pounds. It operated in Pan American Airways colors. The "Clipper Flying Cloud" was delivered as a DC-8-33. The DC-8-33 had its MGTOW increased to 315,000 pounds.

The aircraft was leased to Panair do Brazil September 26, 1962, as PP-PEA. It was sold to Varig July 2, 1964. On March 4, 1967, PP-PEA crashed on approach to Roberts Field International Airport in Monrovia, Liberia. At the time of the accident Ship Five had flown 16,776 hours with 5,769 landings.

DC-8-32/33, N801PA

Two more Pan American DC-8-32s joined the flight test fleet. Ship Six, msn 45254, N801PA, first flew on June 30, 1959. This aircraft was delivered to Pan American on April 8, 1961, as a DC-8-33.

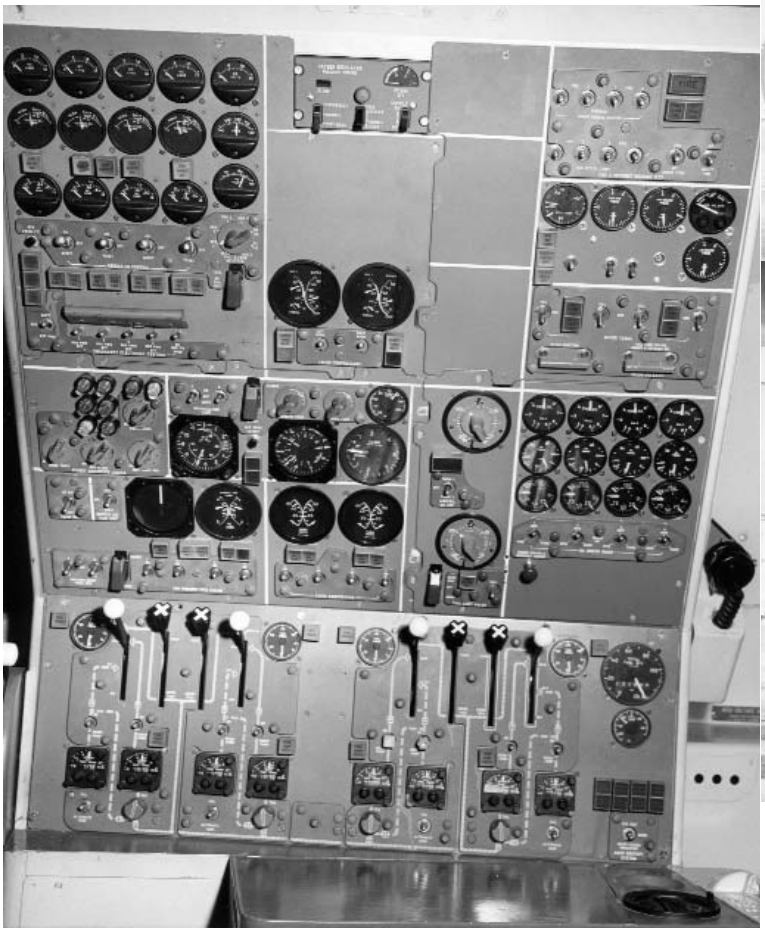
Pan American sold Ship Six to Delta Air Lines on September 17, 1969, as N8016, # 836. Charlotte Aircraft Corp.

The early JT3 engines generated a large amount of smoke on takeoff due to water/alcohol injection. The replacement of these engines by JT4As allowed the elimination of this cooling system resulting in a weight saving of around 5,000 lbs. (Photo from the author's collection)

bought N8016 January 22, 1974. Charlotte leased the aircraft to Ranger Air Cargo from August 28, 1975, to March 1976. It was leased to Ghana Airways from March to October of 1976. Ranger Air Cargo leased N8016 again from November 1976 to October 21, 1977. Loftleidir Icelandic from October 21 to December 17 of 1977. On April 20, 1978, Ship Six went to Intercontinental Airways. It was leased to Overseas National Airways in May 1979 and sub-leased to Saudi Arabian Airlines in July 1979. It was leased to Overseas National in March 1980. N8016 was sub-leased to Saudi Arabian Airlines in July 1980 and returned to ONA in March 1980. Charlotte Aircraft withdrew N8016 from use on August 24, 1981. Msn 45254 was officially retired January 1, 1984, with 43,244 hours and 21,429 landings. The aircraft was broken up at Laurinburg, North Carolina, in 1988.

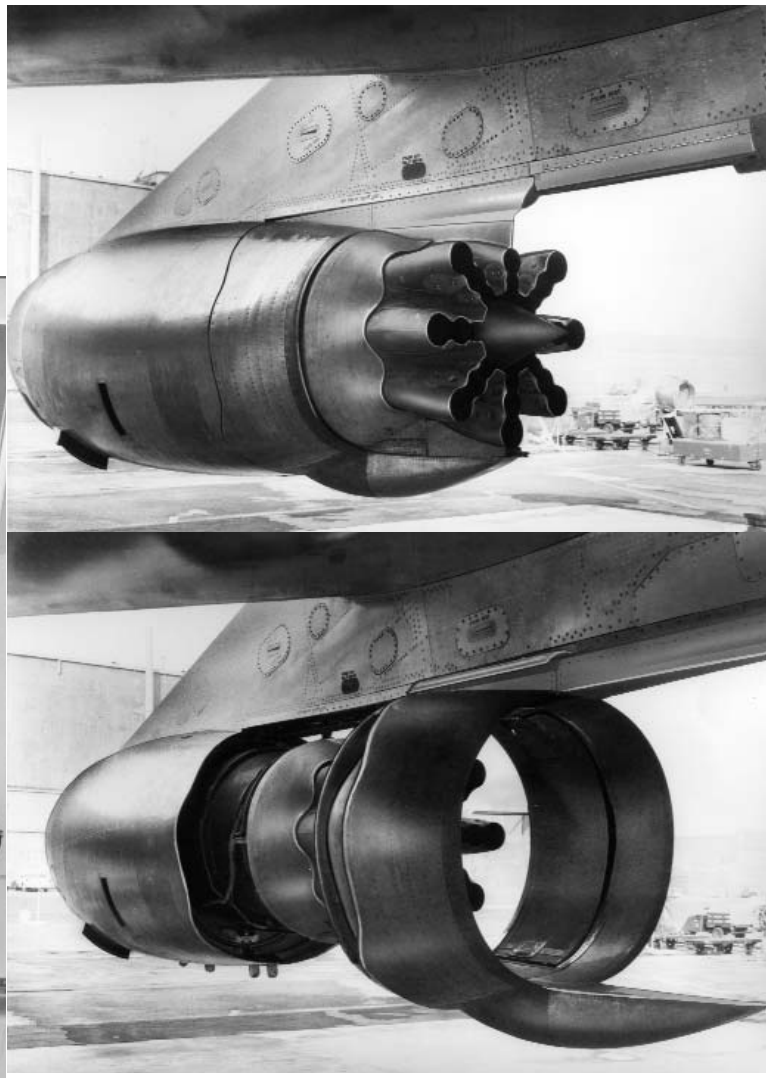
DC-8-33, N8068D

Ship Seven, msn 45255, N8068D, joined the flight test fleet with a first flight on March 25, 1959, as a DC-8-32. This Pan American DC-8 was delivered on February 15, 1961, as a DC-8-33. Registered N802PA, it was operated with name "Clipper Cathay." Delta bought this DC-8 August 25, 1969. Delta operated it as N8027, #837. Delta sold N8027 to Charlotte Aircraft Corp. on January 23, 1974. Charlotte stored N8027 for over two years before selling it to TRAFE, an Argentine company, April 9, 1976, as LV-LTP. LV-LTP was retired by TRAFE June 1, 1982, having accumulated 42,852 hours and 20,674 landings.



Flight engineer's station. (Douglas photo SM 304489

The DC-8's front office. (Douglas photo SM 474840)



The DC-8 was equipped with a thrust ejector ring incorporated into the engine nacelle. The top picture shows this ring in the stowed position; the bottom with the ring deployed. These rings could be deployed in flight as well as on landing. (Douglas photos A91-2-1 and A91-2-2)

DC-8-41, N6577C

The first Rolls-Royce *Conway* powered DC-8-41, Ship Nine, joined the flight test fleet on July 23, 1959, as N6577C, msn 45442. The DC-8-41 was powered by four Rolls-Royce *Conway* 12 engines of 17,500 pounds thrust. DC-8-41s operated at a MGTOW of 302,000 pounds and had a still air range with a maximum payload of 37,300 pounds of 5,450 miles. This aircraft was delivered to Trans-Canada Air Lines as CF-TJA, on September 25, 1960. CF-TJA was later converted to a DC-8-43. Trans-Canada Air Lines became Air Canada. Air Canada leased Ship Nine to Air Jamaica, as 6Y-JME, from July 28, 1977, to March 15, 1980. Air Canada sold this DC-8 to Aeronaves del Peru S.A. on July 28, 1980. Aeronaves del Peru registered the aircraft as OB-R-1205 and only operated it for nine hours and two landings (probably the delivery flight). OB-R-1205 was officially retired on September 30, 1982, with 46,661 hours making 21,006 landings.

Some early features that were left behind

In order to produce sufficient thrust with the early JT3s, a water/alcohol injection system was installed on early aircraft. The water/alcohol mixture provided denser, cooler air for enhanced combustion. The cooling effect allowed greater amounts of fuel to be injected during takeoff. The system included a 190 gallon tank for each of the four engines. This system had several disadvantages. The approximately 5,000 pounds of water/alcohol mixture carried represented a significant payload penalty. The water/alcohol tanks only held enough for one takeoff. This must have been a severe problem in these pre-simulator days when crew training used real aircraft. Another problem was the great amount of smoke produced by water/alcohol injection. Crews referred to aircraft equipped with the water/alcohol systems as "water wagons" and/or "smokers." The photo of the first flight takeoff accompanying this article gives some idea of the smoke produced. Most of these JT3-equipped DC-8-10 series aircraft were upgraded to DC-8-21 standards with Pratt & Whitney JT4A eventually.

The first ship had speed brakes mounted on the lower rear fuselage. These were quickly removed as they proved ineffective. Their function was accomplished more effectively by the ejector rings/thrust reversers at the rear of each engine nacelle. These were capable of redirecting engine thrust to slow the aircraft. At the Ship One Roll-Out ceremony Douglas announced the development of a revised sound suppressor design. The new design would reduce noise by 10 decibels and incorporated a thrust reverser capability. The ejector rings contained clamshell doors which could be closed to redirect engine thrust to provide a braking effect. This system was tested on Ship Three, N8028D, and installed on all subsequent aircraft until the DC-8-50 thrust reverser system was introduced.

The DC-8-11 was certificated by the FAA on August 31, 1959, 14 months after the first flight. The DC-8-11 was certified without wing slots. The maximum gross takeoff weight was 265,000 pounds and the maximum landing weight was 190,500 pounds.

Certification dates for:

DC-8-12	July 1, 1960
DC-8-21	January 19, 1960
DC-8-31	March 30, 1960
DC-8-32	February 1, 1960
DC-8-33	November 28, 1960
DC-8-41	March 23, 1960
DC-8-42	April 26, 1960
DC-8-43	February 1, 1961

Conclusion

Douglas may not have pioneered the modern airliner, but they dominated commercial aircraft manufacture for over a quarter of a century. They failed to win the sales competition in the DC-8/707 class (556 DC-8s to Boeing's 1010 707s). Douglas placed third in the sales competition among DC-9s (2,439 built), Airbus A-320s (3,600 plus built to date) and Boeing 737s (5,800 plus built to date). Regardless, both the DC-8 and DC-9 programs were very successful.

The last of 556 DC-8s was delivered on May 13, 1972

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