



CLIPPER

A publication of the Pan Am Historical Foundation
Volume 6, Numbers 1-2 - Winter-Spring 2000



747: Pan Am sets the pace again

Thirty years ago this past January, Pan Am once again inaugurated a new generation of airliner—the wide-bodied Boeing-747, which was nearly twice as large as any plane flying at the time (see comparison with 707 above). But years of planning went into that first scheduled passenger flight—once again a tribute to Juan T. Trippe and all the Pan Am staff that made it happen. Bob Blake and John Borger (see stories below) recall events leading up to the milestone event in aviation history.

The durable giant

By Robert W. Blake
Resident Representative, Boeing

One rainy evening 30 years ago, George Nible of Boeing and I walked out on the ramp at Boeing Field to have our pictures taken in front of a very big airplane. We shook hands and he handed me the symbolic sterling silver keys, completing formal acceptance of N733PA "Clipper Young America," the first 747 to be delivered to any customer. It was 7 P.M. on Friday, December 12, my wife's birthday, and I was going to be late for dinner.

One week later, we repeated the same process for N734PA. Both of these airplanes were provisionally licensed by the FAA and both were flown immediately to Roswell, New Mexico so that Pan Am flight crews could start their flight training.

On December 31, 1969, the FAA issued the formal Approved Type Certificate for the airplane model and thereafter all newly delivered 747s would be fully licensed for passenger service. We then had three weeks to get three more airplanes ready to

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Evolution of an airplane

By John G. Borger
Chief Engineer

In the spring of 1965, we were looking around for a larger version of the B-707-321B. Douglas had already undertaken stretch versions of the DC-8, but the only one with sufficient range for Pan Am routes was not much larger than the basic airplane, slower than the B-707, and may have been underpowered. The stretched B-707 was going to need a bigger engine, so a Pan Am group including Frank Gledhill, Gen. Kuter, San Kauffman, Gen. Lindbergh, and I visited Pratt and Whitney for a review of what could be done to increase the JT3D's power.

They had some proposals, which would mean a derivative engine, but the crux of the meeting came at the very end. Art Smith gave us a brief rundown of the engine they were proposing for the Air Force C-5—an enlargement of the JT3D with 41,000 pounds of takeoff thrust.

This effectively ended all discussion of stretched B-707s or DC-8s. Transport airplanes are invari-

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Paul Roitsch selected first airline pilot to fly Concorde

Editor's note: Understandably Pan Am was involved with the Concorde from its beginning in 1963. And, in that year, the company began a competition for a pilot to be chosen for that project. This was unknown to most employees due to the extreme secrecy with which the program was to be conducted.

Captain Scott Flower, Chief-Pilot Technical, who had done most of the original evaluation work and design discussions with the Concorde manufacturers, was due to retire before the airplane was likely to be presented for company evaluation. He, there-

fore, determined to select a pilot who would fly the airplane and who would be trained in advance by the company.

Although Paul Roitsch was selected for this competition, it would be some six years before he would become the first commercial airline pilot to fly the Concorde. Before that November 1969 flight, he would be tested in a number of crucibles-some-what mysteriously. Following are the reflections of Captain Paul Roitsch of his circuitous professional life leading to his involvement in the ultimate evaluation of the Concorde.

A circuitous route to Supersonic flight

By Capt. Paul Roitsch

My initial introduction to this process was a request from the Chief Pilot-Pacific, Don Kinkel, to meet with him in San Francisco. At the interview, Captain Kinkel told me that there were management jobs to be filled in New York and asked if I would be interested. My answer was yes. At the time I was a 707 Second Officer (Navigator) and welcomed any opportunities for advancement. I was told to go home (Stockton, Calif.) and await further word. It seems that each Chief Pilot around the system had nominated several people for consideration.

After several months, Captain Kinkel called again to tell me I had been taken off schedule and was to appear at the Hyatt Hotel in Burlingame and ask for Captain Flower. I was interviewed by Captain Flower for 15 minutes.

Again, some months went by. Captain Kinkel called in December of 1963, to inform me that I was to fly to Kennedy and report the next morning to meet with Captain Sam Miller. On this trip, I also met Pan Am's Chief Engineer, John Borger, Engineering Vice President Sanford Kaufmann and others on the Operations and Engineering staff.

"After returning back to Stockton in February 1964, I received a call from Sam Folsom, Captain Miller's assistant, and was told to



Boarding the Concorde were (from top down) Paul Roitsch, Captain; Scott Flower, Director, Special Projects; Bill Hibbs, Performance Engineer, and John Anderson, Flight Engineer.

take an airline transport pilot rating on the 707, take an advanced course in differential and integral calculus at a local university, sell our home and be ready to report in June of that year (1964) to the Navy test pilot school at Patuxent River, Maryland. This took some doing but I made it to the test pilot school on time, driving cross country with my wife, two small children, and the family pets.

All of these calls and notification mystified me and were not then explained. In retrospect, I tied the secrecy to Pan Am's involvement with a classified relationship with the Concorde program.

No matter, I continued my studies, graduated in February 1965 and was flattered when Captains Miller and Flower attended the graduation ceremony and the dinner.

After some post-graduation leave, I reported back to Kennedy as Assistant Chief Pilot-Technical to begin and complete the 727 aircraft operating manual.

Thereafter, I was assigned to the Fan Jet Falcon project in Bordeaux in May 1965. There, I flew the initial specification conformity flights, several performance flights-and then started flying acceptance flights. In December 1965, after turning further ac-

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ceptance flying over to an assistant, I returned to Boeing Field to begin the 727 project work, acceptance flying at Boeing with delivery of the new airplane to Miami, with the last delivery in November of 1967.

I was still responsible for the 727 operation but flew the 707 regularly until 1969. Then I re-

turned to Seattle, to begin training on the 747. But before that was finished, I was taken out to report to Toulouse in connection with the evaluation of the Concorde. When that was completed, I returned to Roswell, N.M., to conclude 747 training.

A year before the first Concorde was offered for flight evaluation,

Chief Pilot-Technical Scott Flower and Project Engineer Bill Hibbs reported the findings of the Airline Supersonic Committee of March 4, 1968 to the Chief Engineer, reducing the minutes of that committee to verse. Only parts of this extended tongue-in-cheek exercise of poetic license follow:

'Mais pas aujourd' hui'

The above mentioned meeting was held in Toulouse
Where we dined on green oysters and liver of goose.
Our friends in BAC/Sup may find hard to swallow
Our view of the Concorde, which is to follow:

As Concorde develops-one thing seems funny
There's less and less range for more and more money.
But BAC/SUD replies, in words meant for fools,
"You analyze Concorde under incorrect rules."

For the payload is better if you leave out the food
And omit other things, such as - to be crude -
The toilets which now, of course, won't be used
And no passenger entertainment to keep them amused.

And passenger seats made of plastic and string
(So they literally have their behind in a sling)
Will reduce the weight, if the thing doesn't bend
To which we replied "God help our rear end."

We listened for days and attempted to write
A report on the meeting but we're not that bright.
So we summarize here with a tear and a sigh
The words that they offered as standard reply;

"The problem you raise just cannot be
For Concorde is practically maintenance free.
We'll do a short paper on this and you'll see
You'll get it next year, mais pas aujourd' hui."



"Well done!" were the sentiments of Captain Paul Roitsch (left cockpit), Sud Aviation Test Pilot Jean Franchi (right cockpit), and Flight Engineer John Anderson (foreground.)

The ultimate high, and low

Between March 1968 and November of 1969, reservations about the Concorde were resolved, before Captain Roitsch and Flight Engineer John Anderson arrived in Toulouse for Flight Evaluation of the Concorde. Both had been at ground school in England in early 1969.

Paul Roitsch reports: "John Anderson and I were given approximately two more days of ground school and at least two simulator rides on the Concorde. On November 8, 1969, accompanied by Sud Aviation test pilot Jean Franchi, John and I flew the first airline evaluation flight during the one-hundredth hour of operation of the first prototype (Concorde 001). For two hours and five minutes, we took the 1,400-mph Concorde to an altitude of 43,000 feet and to a speed of Mach 1.219 (802 mph). I didn't want to bring it back.

"Thereafter, John and I flew the airplane in 1971, three more times evaluating performance, flying qualities and failure modes and reached a top speed of Mach 2.6.

"Ultimately, all of the U.S. airlines canceled their orders for the Concorde for economic as well as environmental reasons. John Anderson and I were tremendously disappointed."

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ferry to New York in time for one of them to take the first scheduled commercial flight on January 21, 1970.

On January 5, I watched the FAA ultimate load demonstration in the structural test facility at Everett. The fuselage buckled at the #5 door with a shock that rumbled buildings all over Paine Field. Failure was at 107 percent of design load, assuring plenty of margin at the weights we would be flying, and potential for growth in the future.

Heat on for a back-up

At 11 A.M. on January 9, we took delivery of the first fully certificated 747, N735PA "Clipper Constitution." (Name was later switched with N733PA). It flew off to New York at 2:45 P.M. That gave us one airplane for the schedule, but the heat was on for a back-up.

On Saturday, January 17, my telephone started ringing at 7 A.M. and did not stop until after midnight New York time. On Sunday, it was 9 A.M. to 7 P.M. By working our inspectors and Boeing line crew all night on the

19th, we were able to get N736PA "Clipper Victor" on its way by noon on the 20th. The back-up airplane was indeed needed, and it was "Clipper Victor" that made the first scheduled passenger flight, Captain Robert M. Weeks in command. Tragically, it was this same airplane that would be destroyed at Tenerife seven years later.

We did get our second back-up of: Early the morning of the 21st, but it was not needed until later.

From February through May, we took delivery of four airplanes per month, with other airlines taking as many as three, a remarkable production achievement for Boeing, even though we groused about airplanes being late. My job was to see that the airplanes delivered were right, as well as on time. This work included the refurbishment and re-delivery of the two NP airplanes as well as the three Pan Am airplanes in the flight test program. Last to be delivered of the original 25 ordered was N747PA, the second production aircraft and one of the hardest-flown in flight test.

Those 25 aircraft would form the core of the Pan Am fleet for more than 20 years. Many of them are still flying today, though in other airline colors. Pan Am may be gone, but the wide-body machine Tripp conceived still goes on and it is still unequaled in its class. More than 1,200 have been delivered and they are still rolling out the door at Everett. Unmatched in size, it is also unmatched in speed except by the tiny Concorde fleet (see story pages 2-3). Just recently have come reports that Boeing is planning to once again increase the production rate.

How this all began is a story best told by John Borger (see accompanying story, beginning page 1). My role was to watch over the development of Pan Am's aircraft at the Boeing factory.

World's largest building

When I first learned of the 747 program, I was watching over the Falcon program at Dassault in France. In July 1967, I was transferred to Seattle to monitor the 747 program at Boeing. When I arrived, there was as yet no production in evidence. The main design offices were in Plant #2 at Boeing Field. Forty miles to the north, the shell of the Everett factory (already the world's largest building) was complete, but there was nothing inside except in one walled-off corner building.

Shortly after I arrived, Pete Gregor took me up there to have a look. First we entered the lobby, walls lined with production charts. Pete opened a door in one wall and said, "Look". I did. What I saw was a huge room with the mock-up of a monstrous airplane inside. "Jesus Christ," I said. "That is everyone's first reaction," Pete said. "I think it should be called the 'Jesus Christ' airplane."

Equally impressive was the interior mock-up at the Renton plant at the south end of Lake Washington. These three facili-

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Resident Representative Bob Blake (in dark suit) checks out 747 fuselage job assembly at Everett, Washington in 1968.



Some of the Pan Am crew at 747 inaugural flight, Heathrow Airport, January 22, 1970. (Photo, courtesy R.E.G. Davies)

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ties-Renton, Boeing Field, and Paine Field-became my regular circuit for the next three years.

In the rest of 1967, the Everett factory filled up with tooling, including the monster Drivematic machines that fabricated the wings. As soon as there was fabrication at Everett, we installed Paul Henderson there as Pan Am 747 Chief Inspector. At full production we had nearly 20 Pan Am inspectors working shifts.

40 miles apart

Meanwhile, Boeing design work continued at Plant #2. Shep Cronier, our resident project engineer, had an office there. We were concerned at engineering and production being 40 miles apart and pushed Boeing to get its design group up to Everett. I was able, however, to get a Pan Am project office at Everett, in a trailer outside the mock-up building. We had to do with that for several months until the Everett administration building was ready to occupy.

I had lots of Pan Am visitors throughout my tenure at Boeing. In fact, before I even had a place to live, Larry Kuter, San Kauffman, Howard Blackwell, John Borger, and Scott Flower arrived for a top level meeting with Boeing. The airplane was overweight and there was con-

cern that performance guarantees might be affected. Two weeks later Lew Allen, Scott Flower, and Jon Olds were back again for cockpit design discussions. The following month Boeing held a landing gear general design review for all 747 customers. In the months to come, every major system on the airplane was reviewed by Boeing with all customers before the final drawings were put to bed. These were not just office discussions. Whenever we called in Pan Am specialists, we would sit right down with the Boeing engineer at his drawing board. We did not always get our way, but we had a pretty good batting average.

Weight watcher program

Boeing attacked the weight situation with a weight reduction program, which we monitored. Any specification change required a Change Order approved by Pan Am. Eventually, Change Order No.1 became as thick as the original specs. As I recall, it was not approved until the first airplane was ready for delivery. The airplane weight came down, then went up again as final designs were completed.

As a corollary to growth of the airplane was a need for growth in engine thrust. The JT9 was a totally new engine-the first ever

designed directly for a new commercial airplane. It was on the same tight development schedule as the airplane, but now a level of take-off thrust was being demanded that had not been expected until after several years of airline service. As a result, engine deliveries were late. We did not see any engines at Everett until shortly before roll-out of the first airplane at the end of September 1968.

Critical spot

In the fall of 1968, as Pan Am aircraft moved into final assembly, we watched very carefully. One critical spot was the wing/body join; we had seen a potential misalignment on the first airplane. Soon, we would be witnessing an actual aircraft weighing and have a fixed check on the weight situation; all figures to this point were based on estimates or calculations.

By early 1969, N7470 was getting ready for its first flight. On February 8, Boeing conducted its first full-scale evacuation test from a mock-up at Renton, using church volunteers for passengers. Cabin crew were Seattle-based Pan Am flight attendants. The next day Project pilot Jack Waddell took N7470 on its maiden flight, from Everett, with minor

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incident. Walter Frey from Borger's office in New York flew out for the occasion and we watched take-off and landing with great interest.

From here on Boeing issued a weekly summary of flight test operations, which were studied carefully by all customers. Soon all were to see many reports of serious engine surging. On March 3, 1969, N747PA was painted and weighed. Two days later, a Pan Am 707 was flown to Paine Field so the two could be photographed together. The once-huge 707 looked like a fighter beside the new giant.

Engines hung

On April 2, 1969 engines were hung on N731PA, the second Pan Am aircraft in the flight test program. Ron Marasco, chief of the Pan Am New York tech crew, came out to witness the exercise. He would remain with us through first delivery. The following week N747PA made its first and second flights. Within another week we would have visits from John Borger, Lew Allen, Walter Frey, Scott Flower, Stan Sabalis, and Larry Kuter.

On May 10, 1969, N731PA

made its first flight. By late May it had accumulated 10 hours' flight time. The Paris Air Show was coming up and Boeing wanted to have a 747 there. If any airplane was sent, N731PA was the logical one; it was the designated service-test airplane. Contrary to Clive Irving's book *Wide-Body*, Pan Am did not want the airplane to be exposed to this risk this soon. We certainly did not demand that the airplane be painted in Pan Am colors, as Irving states. It was, in fact, already in Pan Am colors, except for the blue ball and Pan Am logo. The decision to go was entirely Boeing's. I was not invited along.

I wanted to be there when the airplane arrived, however, so I flew on ahead on the May 29 Pan Am "polar" flight. When N731PA emerged from the mist at Le Bourget on the morning of June 3, I was on hand and waiting at the foot of the air-stairs when #2 door opened and Joe Sutter poked his head out. If Boeing thought they had escaped Pan Am surveillance, they were wrong. I stayed around and saw the airplane off again on June 7.

In those early days, the 747 in flight made an unusual sight. The

airplane was so big that it confused the observer's sense of distance and speed. It seemed to be closer than it really was. Because it was so far away it seemed to be going slower than other airplanes, when actually it was going faster. It made its approach to the airport with great dignity.

First flight

When I returned to Seattle, I had my first flight in the 747. On June 23, Hal Graham, John Borger, Lew Allen, John Petch, and John Forberg came out to review the interior of N731PA. We collected a bushel of comments on that from Graham, and he departed. The next day the rest of us went for a flight in the airplane with Ed Pfafman of Boeing. We detected a little ripple in the airplane's flight in mild turbulence, and Pfafman decided a little yaw damper tuning was in order.

The summer went on and the problems with the engines continued. We also were finding a lot of troubles with the passenger entertainment system. These were buyer-furnished, and so it was up to Pan Am to get the problems worked out with our supplier. By fall, engine deliveries had become a major problem; airplanes were moving out of the factory with concrete blocks hung in the nacelles instead of engines.

Ovalization problem

Also, another engine condition had developed in flight test called "ovalization," which affected thrust end fuel consumption. Pending stiffening of the engine case by Pratt, Boeing developed a special Y-frame in the nacelle that supported the engine differently. Indeed, the Y-frame stayed with us for years.

By early October, we were starting our final run towards an aircraft delivery. For the first unit of a totally new model, this process becomes an elaborate exercise to show that the aircraft does

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The nose-loading all-cargo 747F was capable of carrying nearly 100 tons of freight, including such large items as printing presses, drilling rigs and luxury limousines.

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or does not conform to the specification and contract guarantees in every way. We had established a team to verify every article of the specification. Some we could verify by observation or functional test. Others required a review of Boeing engineering test data. Many documents were needed, notably an FAA-approved operating manual for certified take-off and landing data and any other operating limitations. That would not be available until the Approved Type Certificate was issued. On October 26, we flew N731PA to demonstrate the cruise performance guarantee; Scott Flower flew the airplane, Bill Hibbs collected data points.

Najeeb Halaby wanted to fly the airplane himself. A flight on N731PA was arranged November 7 with Project Pilot Jack Waddell. I was on board, as were two Pan Am cabin attendants. The maneuvers performed were not unusual for a demonstration flight for an airline executive pilot, contrary to comments in Clive Irving's book. I have no recollection of any comments by Halaby on performance short-comings of the airplane.

On November 14, the FAA Blue Team arrived to start its work. On November 21, Boeing released N733PA for Pan Am acceptance.

We flew the airplane the next day. Pan Am acceptance crew members were Scott Flower and FEO Stan Sabalis. The flight lasted 26 minutes. We took off from Boeing Field and headed north. Just past Paine Field there was a loud bang and #1 engine fire warning light came on. Scott shut the engine down. Back in

of the agreement that permitted us to proceed. I received the go-ahead for the formal acceptance on the morning of December 12. This was a paper exercise with Boeing contract officials at Boeing Field. After all the documents had been counted and verified, I placed a three-way call to Pan Am attorneys in Oklahoma

City and to Boeing and Pan Am officials in New York. I received authorization to accept the airplane and signed the official receipt on behalf of Pan Am. Money changed hands; it was after banking hours in New York on Friday. So I sent a message confirming the time of acceptance. An electronic transfer of funds was made at the opening of business in New York



Pan Am Resident Representative Bob Blake (left) accepts the symbolic sterling silver keys from Boeing Vice President and General Manager George Nible, on a rainy night in Everett, Washington.

the cabin we saw that the #1 engine cowling was missing. That ended the flight and we landed at Everett.

Investigation revealed a broken high-pressure fuel line. A subsequent service bulletin would revise routing of this line. Meanwhile, a second flight was delayed to November 26. A final one-hour flight was made on Thanksgiving Day. Then we all sat while the Pan Am and Boeing differences were negotiated at a much higher salary level than any of us. I do not recall the terms

on Monday. Meanwhile, George Nible and I walked out on the ramp to have our pictures taken.

Months after Pan Am placed the 747 in service, both Douglas and Lockheed came out with their versions of a wide-body airplane—both smaller and slower than the 747. Today, both of these airplanes are out of production, but the 747 goes on—updated to 2000 technology. Last September, I flew to London in one of British Air's new 747-400s. Still a great airplane. I only wished it carried the Pan Am blue ball.

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ably designed around available engines and if there was to be a 41,000 pound engine, there surely would be an airplane built around it. Juan Trippe knew this, and had no interest in buying an airplane that soon would be obsolete.

General Electric won the competition for the C-5, also with a 41,000 pound engine, the TF-39. This was unquestionably superior to the Pratt and Whitney proposal at that time.

We continued to study the C-5, for which Boeing, Douglas, and Lockheed were competing, with hopes that a commercial version would be available. We were not too encouraged however, because the Air Force requirements were so different from the commercial requirements.

Double-deck proposal

After a briefing in New York from Boeing's Finlay and Munson about a "New Technology" airplane in July, we met with a bigger group in the Pan Am Building on Sept. 30, 1965. Boeing was then losing hope for a C-5 award (as a matter of fact, the award to Lockheed was announced during the meeting). While much of Boeing's proposal was a commercial transport based on the technology they had learned during their C-5 studies, this proposed airplane had a narrow double deck fuselage (a 707 fuselage placed on top of another 707 fuselage) powered by four CTF-39 engines similar to those for the C-5.

Discussions continued during the fall, particularly between Messrs. Trippe of Pan Am and Allen of Boeing. These resulted in a

Letter of Intent to buy 25 passenger airplanes, signed on Dec. 22, 1965. This airplane was to have about 550,000 pounds maximum takeoff weight, four General Electric CTF-39 engines, and capable of carrying 350-400 passengers.

First five for Pan Am

Quoted cruise speed was .90 Mach Number at 35,000 feet altitude, plus a range of 5,100 nautical miles. Delivery of the first airplane was to be in the fall of 1969, and Pan Am was to receive the first five. (Mach Number-M is actual speed divided by speed of sound at altitude). Price was to be between \$15,000,000 and \$18,000,000, depending upon configuration.

The airplane continued to evolve from January through April. Pratt & Whitney decided to offer a competing engine, the JT9D-without a military order. This was unusual, for most engine development programs had been kicked off by a military order. This engine also was to have 41,000 pounds takeoff thrust, but a b_{yp} ass ratio of 5.5:1, instead of the TF-39's 8:1. (B_{yp} ass ratio: amount of air passing through the outer engine case, divided by

the air passing through the core). The reduced b_{yp} ass ratio had the effect of improving engine performance at high altitude. We studied the relative range/payload performance of the airplane with either engine, with the result that the JT9D showed that takeoff weight for the same payload was 20-30,000 pounds less, with cruise at 35,000 feet.

Pratt & Whitney

Then Rolls-Royce entered the game, proposing the RB211. After study by Boeing, it was decided that Rolls could not meet required deliveries. GE also advised that they could not build a second engine that appeared to be required to meet Boeing and Pan Am requests, and still meet their commitments to the Air Force. So Boeing committed to Pratt and Whitney. We agreed.

In those early stages, Mr. Trippe asked that the airplane be convertible to a cargo carrier in the future, for indications were that the SST would take over future passenger business. This had the effect of increasing allowable landing weight, with stronger landing gear and stronger floor. Because we insisted on ability

to load 8 x 8-foot cross section containers 10-feet long through the fuselage nose. Swing tail loading and side loading were considered unsuitable. Thus the upper shape of the fuselage-with the cockpit above the load. When Trippe visited the mock-up, after the contract was signed, he noted the large space behind the cockpit under the fairing and asked if that space could be used for
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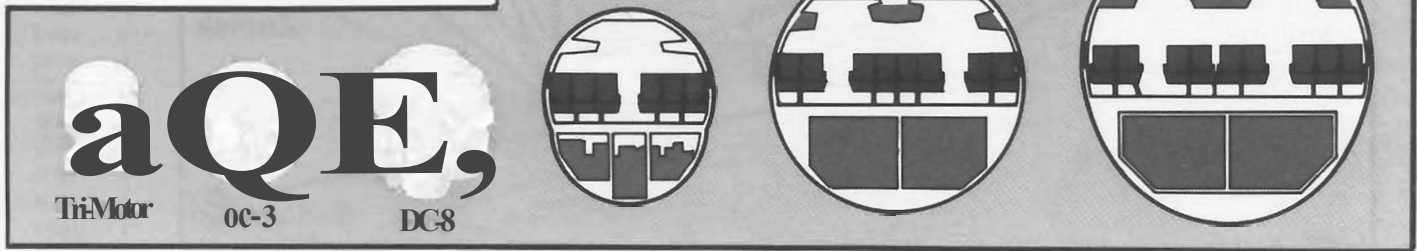


Extra space behind cockpit became 747 Upper deck lounge.

(Photo, courtesy R.E. G. Davies).

Fuselage Cross-Sections

Courtesy, R.E.G. Davies



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passengers. The result: the Upper Deck Lounge. In an earlier get-together, Messrs. Trippe and Wells had agreed to an 80-inch extension of the fuselage.

Boeing made innumerable studies of the fuselage cross section. First was the double deck. But this aroused concerns about evacuation of passengers in event of accident and would limit the cargo load. Another school at Boeing favored a single circular cross section. This was better for the 8' x 8' containers, which were placed side by side. The dimensions of such a cross section worked out just right for 9 or 10-abreast seating in Tourist Class. The result, the wide body.

Wide-body advantage

The large circular fuselage had another advantage. The belly cargo capacity was increased markedly, thus increasing the earning potential of the airplane. Large cargo/baggage containers were developed, helping to speed loading and unloading. Two large outward-opening cargo doors were to be installed on the right side, and five double-width passenger doors on each side. Evacuation from the upper deck was through a door on the upper right side. Ultimately, the airplane just barely passed the 90 second emergency evacuation requirement.

Wing area was increased from 5,200 square feet to 5,500, and wing sweep decreased from a planned 40 degrees to 37.5 (B-707 sweep: 35 degrees). This had the effect of reducing the cruise speed guarantee to .877M. The B-

747 is normally cruised at .84M and the B747SP at .85M. Either one is still faster than any other subsonic passenger jet transport.

Pan Am team

Others on the Pan Am team included Lew Allen, covering the whole airplane; Bill Hibbs, performance analysis and flight test; Capt. Scott Flower, cockpit, flying characteristics, flight test; Ben McLeod, communications; Johnny Petch, interiors, seats, and galley design; Jim Martin, cargo; Walt Frey specification monitoring; Vice President Harold Graham, Marketing, and several specialists from the operating divisions, including Capts. Vinal and Fleming, Bill King, Norm Smith, Johnny Olds and others.

The Boeing team was headed by Joe Sutter, Director of Engineering, who ultimately became Vice President for the entire B-747 project. He was assisted by Ron Brown, Chief of Preliminary Design; Everett Webb, Chief of Technical Staff; Milt Heinemann, Chief of Interior Design, assisted by consultant Frank del Guidice, and many, many others.

Saving weight

One request by Boeing was to change the engine mounting to the rear fittings on the engines, rather than the front—this to save weight. They negotiated this modification with P&W, and we agreed. There also was considerable discussion on whether there should be three or four hydraulic systems. We jointly settled on four, even though a weight in-

crease resulted. (A good decision: In one early incident, when the pilot was directed to the wrong takeoff runway, three hydraulic systems were knocked out. Fortunately the fourth survived, and the airplane was safely landed.)

A similar question arose regarding the number of Inertial Navigation Systems: two or three. We decided on three to give the crew backup in the event of failure, especially when far away from home. Changing a unit would have meant a schedule delay.

Big troubles

Big trouble #1, Weights: Early in 1967, I became aware that the weight empty of the airplane was creeping up. The first number given was 11,000 pounds overweight, not much later it was 20,000 pounds, and I'm not sure it wasn't really more. So I hid myself out to Seattle and requested an up to date review. I didn't get much, except an acknowledgment that the problem existed, that they were organizing a team to make a complete review with proposed weight reduction items, and that I should come back in about a month.

In June, the Boeing team heads Maynard Pennell, Vice President Engineering, and George Snyder gave their report. Many items were removed or altered, some redesign was to be undertaken, and a sizable weight reduction was achieved. But, the biggest single item was a change from triple slotted wing flaps to double slotted, saving 1,700 pounds. I

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asked what the effect would be on the guaranteed approach stall speed; they said plus 8 knots. I said this was unacceptable, and was later backed up by Messrs. Gray and Trippe. The triple slotted flaps were retained.

Fine safety record

I believe the relatively low approach and landing speed of the B-747 has contributed to the fine safety record. Later, Boeing proposed substituting a Multiplex system for the maze of wiring for passenger entertainment, and call wiring at a saving of some 600+ pounds. We opposed this, but lost the battle. We both paid later, for the Multiplex system was responsible for a number of weird occurrences. It took at least a year to overcome these. After much further argument, it was agreed that the maximum take-off weight would be raised from 655,000 pounds to 710,000. To compensate for this increase, the engine takeoff thrust was raised to 43,500 pounds. Boeing wanted Pan Am to pay for this, but we refused, saying it was Boeing's responsibility. Finally P&W bailed us all out by absorbing the additional cost. Even with the additional thrust, there was an



Spacious first-class 747 cabin. (Photo, courtesy R.E.G. Davies).

adverse effect on takeoff runway, now to be 11,750 feet. Initial cruise altitude was to be 31,600 feet.

Big Trouble #2: During their tests to determine wing flutter boundaries, Boeing encountered flutter. This is a no-no. It took Boeing most of a month of flight tests to work out of this problem.

Big Trouble #3, Ovalization: Early fuel consumption tests indicated a deterioration of engine fuel consumption as the engines acquired time. This was traced to the engine case getting out of round, with compressor and es-

pecially turbine blading rubbing against the case and losing efficiency. In turn, the out of round (ovalization) condition was traced to engine mounting at the aft mounts instead of the forward, which had become conventional. P&W came up with a yoke that transferred loads to forward engine mounts and solved the problem at a cost of about 150 pounds per engine.

This was no yoke

Unfortunately, it took time to make the yokes and install them in nacelles, so early airplanes were accepted without the yokes. Boeing supplied 12 nacelles to help Pan Am make the change. Thus Boeing's initial suggestion re changing the engine mounting was negated, although P&W accepted technical responsibility—they built the engines knowing how they were to be mounted.

After some further argument, the first airplane, with a Provisional Certificate, was accepted on Dec. 12, 1969. A portion of the purchase price was withheld until the yokes were received. Full airworthiness approval by the FAA came on Dec. 31; first scheduled service on Jan. 20-21, 1970. A substitute airplane was used because of engine trouble on the first.



Flight deck of the world's largest airliner. (Photo, courtesy R.E.G. Davies).



The Ford Tri-Motor and the Boeing 747—symbols of the beginning and the end of Pan Am—stand in awesome comparison. Pan Am used a fleet of Ford Tri-Motors in its early days of flight, mainly on its Latin American routes.