

# Big Flying Boat Service Began 50 Years Ago

By A.T. Lloyd

A revolutionary new aircraft began scheduled Atlantic service 50 years ago on May 20, 1939. This was the Boeing Model 314 *Clipper*. A total of six Model 314 airplanes were delivered between January 27 and June 16, 1939, followed by the six Model 314As which left the factory between March 20 and July 28, 1941. With a maximum gross weight of 82,500 pounds, the *Clippers* were exceeded in size only by the then extinct German Dornier DO-X and the Russian Tupolev ANT-20 *Maksim Gorkii*. Neither of the latter two aircraft were ever placed in regular service.

Discussions between Boeing's Chief Engineer, R.J. Minshull, and Pan American World Airways Vice President, Franklin Gledhill, in 1935, resulted in the concept of a large flying boat which would combine long range, comfort and safety. On February 26, 1936, Pan American formally requested Boeing to submit a proposal for a long-range, four-engined marine aircraft, built around engines with a takeoff rating of 1000-1250 horsepower. Wellwood E. Beall conceived the basic design configuration at home. The airplane would contain two flight decks, afford spacious passenger accommodations. Engineering commenced in May 1936 and on July 21 of the same year, a contract was signed for the first six aircraft. A trust agreement in the amount of \$3,500,000 was executed on January 20, 1939 for the funding of six Model 314 *Clippers* and three Model 307 *Stratoliners*. The average cost of a *Clipper* was \$668,908 while an additional \$756,450 was required for spare engines and parts.

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End for the big flying boats came as the Allies "paved the world" ushering in the era of land planes (DC-4) transoceanic service at the end of WWII. Pan Am who operated ten of the twelve flying boats built unceremoniously decommissioned the aircraft that were later junked. Today not one of these legendary airplanes remains.



Design & development of 314

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The original design criteria for the Model 314 consisted of four primary requirements. The airplane was to:

- transport 10,000 pounds of payload over a distance of 2400 statute miles against a 30 mph head wind at a cruising speed of 150 mph and an altitude of 10,000 feet.
- develop an aircraft which could be efficiently operated with a minimum of crew fatigue and a minimum of maintenance.
- efficiently afford the passengers with unprecedented comfort, spaciousness and luxury.
- develop an aircraft which would be as inherently safe as could be possibly made with the existing state-of-the-art with regard to materials and equipment.

After the design concept was established, a program of model testing was developed. For the first time in the history of American aeronautics, it was possible to have the towing-tank and wind tunnel tests conducted simultaneously in the NACA full-scale wind tunnel.

Power would be provided by four newly-developed 14-cylinder double-row radial engines mustering 1500 horsepower at takeoff. These Wright GR-2600-A2 engines would be coupled with another innovation; the Hamilton Standard hydro-matic full-feathering propeller.

A fourteen-foot diameter, three-bladed propeller was selected. The maximum fuel capacity of the *Clipper* was 4300 gallons and 300 gallons of oil would be



provided. With the maximum gross weight of 82,500 pounds, the superb power package, and large fuel capacity, the payload, speed, and range requirements were easily met.

In order to reduce drag, it was decided that all surfaces would be cantilevered and the exterior would be as clean as possible.

The wingspan was 152 feet with an aspect ratio of 8.05, and was tapered in both span and thickness so as to reduce weight. A symmetrical airfoil was used because it offered both aerodynamic and manufacturing advantages.

The hull was designed to maximize volume and minimize weight and drag. Without much increase in weight, it gave additional volume for the passengers and crew. The hull bottom was designed with an antrawship main step and a pointed rear step which produced less aerodynamic drag and gave excellent water running characteristics. Depending on the aircraft loading and the sea state, the takeoff times ranged between 17-58 seconds.

The Model 314 was equipped with a pair of hydrostabilizers; sometimes referred to as sponsons or sea wings. Some advantages of the hydrostabilizers were: excellent taxiing characteristics and good seaworthiness in rough water. While they served as excellent loading platforms, and provided better fuel storage areas than the hull, they added weight and aerodynamic drag.

Frieze balanced-type ailerons were operated differentially through a semi-irreversible gear segment and worm which was connected directly to the aileron cable system. Trim tabs were employed on the in-board ailerons only.

The large elevators were assisted through use of control tabs and spring links. Trim tabs were also installed. No aerodynamic balance system was required. The elevators were both dynamically mass balanced and were statically balanced. A single counterweight in the center of the hull and a mass balance at the tip of each elevator was employed.

Initially the aircraft were equipped with a single vertical fin and rudder. When *Dutch roll* was encountered during flight testing, a pair of outboard vertical fins and rudders were determined to be required. Later testing showed that an additional center vertical fin would further enhance directional stability. This final design resulted in an aircraft which would maintain its course for great lengths of time and yet have the lightness of control of a pursuit plane.

Approximately 6000 engineering drawings, encompassing 390,000 square feet of blueprint paper, described the aircraft. Nearly 32,000 parts were held together by 500,000 rivets and 12,000 bolts. Much of the non-critical structure was assembled by spot welding.

Throughout construction, accurate

weight control was maintained. The completed aircraft was within 50 pounds, or about .01% of the estimated empty weight.

An on-duty flight crew of six operated the airplane. They included: a master or watch officer, first pilot, second pilot, navigator, radio operator, and flight engineer. The spacious flight deck was 9'6" wide and 21'4" long, and had an average head room of 6'1.5". The forward flight deck was occupied by the two flight pilots. An aisle between the pilots gave access to the bow compartment which housed the anchor. A spiral staircase behind the second pilot led to the passenger cabin. The aft flight deck housed the navigator with a large chart table, the watch officer, the flight engineer, and the radio operator. Behind the control cabin were a pair of mail compartments, two baggage compartments, and two cargo compartments.

Up to 74 passengers could be carried by day or sleeping provisions for 34-40 passengers at night were available.

The Model 314 *Clippers* were designed with maintenance in mind. The hydrostabilizers afforded easy access to the cabin. The nacelles featured fold-down panels which served as work stands. In-flight access to the engine accessories was a boon to the flight engineer who could perform certain maintenance tasks while airborne.

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