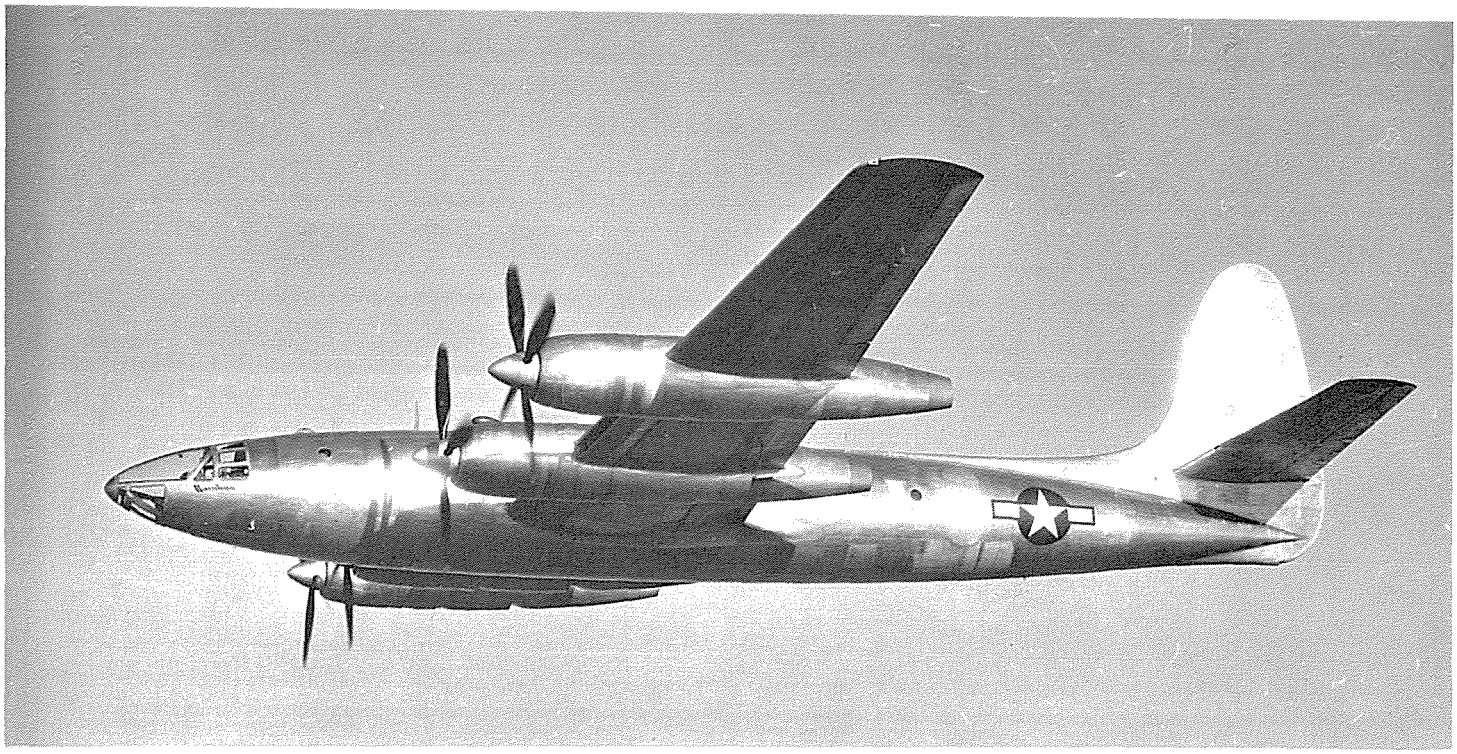


THE REPUBLIC XR-12 RAINBOW

By LIN HENDRIX

No history of Republic Aviation Corporation (famous for the P-47 Thunderbolt), would be complete without more than a casual mention of the four-engine type built by that firm. In the mid-1940s, Republic turned out a four-engine aircraft designed solely for the Air Force Reconnaissance mission.

In 1943, a requirements meeting was held at Wright Field, and in the course of this meeting the specifications were laid out for a reconnaissance type aircraft which must fly over 40,000 feet and in excess of 400 miles per hour.

Republic Aviation and Hughes Aircraft accepted the challenge.

In March 1944, Wright Field awarded Republic contract W3308 AC 2135 for two XF-12 aircraft plus spares for $6,545,699. It would be called the Rainbow. Hughes Aircraft also received a contract for two prototypes.

Late in October 1948, a Rainbow appeared at the end of the north-south runway at Eglin Air Force Base, Florida. This Rainbow was no wispy arc of delicate colors seen so often in the skies of northern Florida. Instead, it was a gleaming ultra-streamlined aluminum four-engine aircraft that represented more than the proverbial "pot of gold" to the members of the photo squadron who were gathered in front of the Climatic Hangar to await the arrival of the first aircraft designed specifically to accomplish the photo reconnaissance mission.

This writer, who was present in that assemblage, watched eagerly as the aircraft touched down, and my first thought was, *It looks small.* I knew its wings spanned 129 feet, but due to the remarkably clean design, it appeared to be much smaller.

The four big propellers went into reverse, and in a very short time the Rainbow, or XR-12, turned off the runway.[1] We stood somewhat in awe as the big plane taxiied to the ramp in front of us. The pilot reversed the propellers, and with some theatrics, backed the airplane into its assigned parking slot.

As the four big "corn cobs"[2] whined to a stop, I remembered all the planning, the conferences attended, the writing of a test program. I remembered too all the other detail work that had led to this exciting moment.

Several months before, as operations officer in the Photo Test Squadron of the 3200th Proof Test Group at Eglin, I had been selected to become the project officer on the Rainbow XR-12. During those months between test flights in the F-13, F-14, F6, and XRF-82, I had lived, breathed, and slept with the Rainbow. Unlike the other aircraft I had been flying on photo missions, the XR-12 had been designed specifically for that mission. Other aircraft assigned to photo reconnaissance squadrons were modifications of already existing aircraft. The F-13 was a modified B-29; the F-14 was a modified P-80; the F-6 was a P-51, and the XRF-82 was an Eglin modified twin Mustang.

But the XR-12 was the result of a requirements conference held at Wright Field following Col. Elliot Roosevelt's recommendations for a purely reconnaissance design. The design was formulated by the Photographic Section of the Air Technical Service Command. This meeting was held in late 1943.

Alexander Kartveli, the ex-Russian aerodynamics genius who had designed the rugged Thunderbolt, felt that the requirements called for a four-engined aircraft in order to achieve the range and speeds at high altitudes that were spelled out in the design specs. Although Hughes chose a two-engine configuration[3] it is noteworthy that both firms turned to Pratt & Whitney for the mighty four row R-4360, 3500 hp engine.

Republic's fighter experience and Kartveli's nearly fanatical low drag philosophy were put to good use in the design of the Rainbow. The perfectly streamlined fuselage, unmarred by broken lines for cockpit windshield, and unique approach to engine nacelle-wing joining produced a four-engine aircraft with a design dive speed of .8 mach! To understand the significance of this, one must remember that the F-84 Thunderjet had a critical mach of .82.

Once the four-engine configuration and the aircraft design was finalized, production of the two aircraft was begun, and the first aircraft, serial number 44-91002, was rolled out in December 1945. After a month of the usual ground testing, the Rainbow made its first flight on February 4, 1946, with the same Lowry

Brabham, who had flown the first P-47, at the controls. Copilot was Oscar "Bud" Hass, and the flight engineer was James Creamer.

With the war over, some of the urgency for the Rainbow was lost. So Phase I flight testing was spread over more than a year at Republic's Farmingdale plant. It wasn't until June 1947 that the aircraft was flown to Wright Field for Air Force Phase II testing. This first airplane was a highly instrumented test vehicle with none of the sophisticated photo equipment that would be installed in the number two aircraft, serial 44-19003. The latter aircraft didn't fly until August 12, 1947. The crew on that flight was Bud Hass, Pete Collins, and James Creamer.

Both Republic and the commercial carriers early recognized the commercial possibilities of the Rainbow, and Republic's sales engineering staff headed by Murray Berkow made presentations to many of the airlines.

Juan Trippe, of Pan American, looked at the sleek Rainbow and quickly foresaw its capability as a transatlantic passenger aircraft. Its speed of over 400 miles an hour above 40,000 feet and its range of 4500 miles would provide a scheduled passenger service from New York to London of nine hours—three hours less than the scheduled time of the Boeing Stratocruiser, which was still in service until the mid-50s.

The veteran president of Pan American ordered 25 Rainbows —an order which was never to be filled; for when the Air Force canceled its initial order for 20 XR-12s, Republic found it couldn't meet Pan Am's price with a purely commercial production run. Therefore the Rainbow was to suffer the fate of many other advanced designs flown in the postwar years. Actually, lack of military funds prevented many a promising aircraft of the late 40s from reaching the production lines. The two prototype XR-12s were to suffer ignominious ends as well.

Despite the fact that the Rainbow never went into production its design features are worth examining. Republic's experience with high altitude flight and early discovery of the effects of compressibility in high speed dives with the P-47 gave the firm unique qualifications to build the Rainbow.

The first thing that impressed the viewer on seeing the Rainbow was its streamlining. Virtually no protuberances marred the lines of the smooth-nosed fuselage, and the clean joining of the long engine nacelles to the wings gave clear evidence of fighter design.

The high-speed requirement for a four-engined, propeller-driven airplane tested even Kartveli's acknowledged mastery of low-drag design, but he rose to the demand and produced what was one of the most beautiful designs of its time and certainly an advanced product of the state of the art in the mid-40s.

He recognized that good visibility through the forward windshield was a necessity for landings and takeoffs, but he felt that the usual flat or tapered windshield produced too much drag—an archenemy in normal aircraft design. So he came up with an ingenious idea for that offending area. He insisted that the nose of the Rainbow be streamline in shape when the aircraft was in high-speed flight, but he also recognized that a nose of such shape would present serious reflection problems on night and low visibility landings and takeoffs. So he kept his streamlined nose, but he made the forward long-tapered conical halves of the windshield retractable. These halves slid down into the lower forward fuselage section for landing and takeoff, thus revealing a conventional flat plate windshield.[4]

Speed dictated the power plant selection and the design of the nacelles in which they were housed. Republic's power plant engineers felt that the only engine which could fulfill the requirement for the power required at the high altitudes at which the XR-12 was to fly was the Pratt and Whitney R-4360 four-row radial engine. And their long experience with the proven reliable Pratt and Whitney R-2800 in the P-47 did nothing to dispel that notion. But Kartveli went a step further. The mighty R-4360 could deliver full military power through turbo supercharging at 40,000 feet, but the designer felt that the exhaust gases from these powerful engines might also be put to good use. It was decided to take advantage as much as possible of the energy contained in the exhaust gas after it had left the turbine.

Quoting Kartveli: "To this end the turbo-supercharger is mounted horizontally and the exhaust gas, after leaving the turbine, is discharged directly aft through a jet pipe in the tail of the nacelle. At most altitudes and power settings, however, the turbo-supercharger does not require all the available engine exhaust gas. In a normal installation a waste gate is provided through which this excess gas can bypass the turbine. However, to merely exhaust this gas overboard without obtaining any benefit from its energy is wasteful. Therefore after bypassing the turbine this waste gate gas is piped back into the jet pipe, and its momentum is used for additional thrust." This approach produced approximately 10 percent of the engine brake horsepower as additional jet thrust.

An additional feature of the powerplant package was a variable speed cooling fan installed at the front of the engine to provide adequate cooling for the tightly cowled R-4360s. The cooling fan provided Kartveli's low-drag program with another plus, for the fan provided engine cooling at all altitudes without the necessity of deflecting cowl flaps. Hence the Rainbow's cowl flaps were of the flush, sliding type.

Further reductions in drag were achieved through the use of wing leading edge inlets for all air required by the power plant with the exception of the engine cooling air. The pressure recovery of these intakes was in the order of 98% of the ram air or virtually perfect. These intakes freed the nacelles of scoops and external protuberances and contributed to the near-perfect streamline shape of the nacelles.

The same care that went into the design of the engine nacelles was given to the wing design, which was a Republic airfoil—R-4. The wing's maximum thickness was a 17½% section at the junction of the wing and fuselage. This thickness was determined by the space necessary to retract the main landing gear.

The tip section was 12%, and in order to provide good stall characteristics a rather blunt wing tip was chosen. The low mid-wing arrangement was chosen so that the interference between the wing and fuselage would be minimal, since this arrangement gave the least amount of curvature in plan view. This permitted minimal sized fillets as well.

The flaps were of the double slotted type and were composed of three separate units on each side of the fuselage. Despite the poor flap efficiency which might have been expected from so many interruptions along the wing, the detrimental effect due to intermittent flaps was negligible because the rear portion of the nacelles formed end plates.

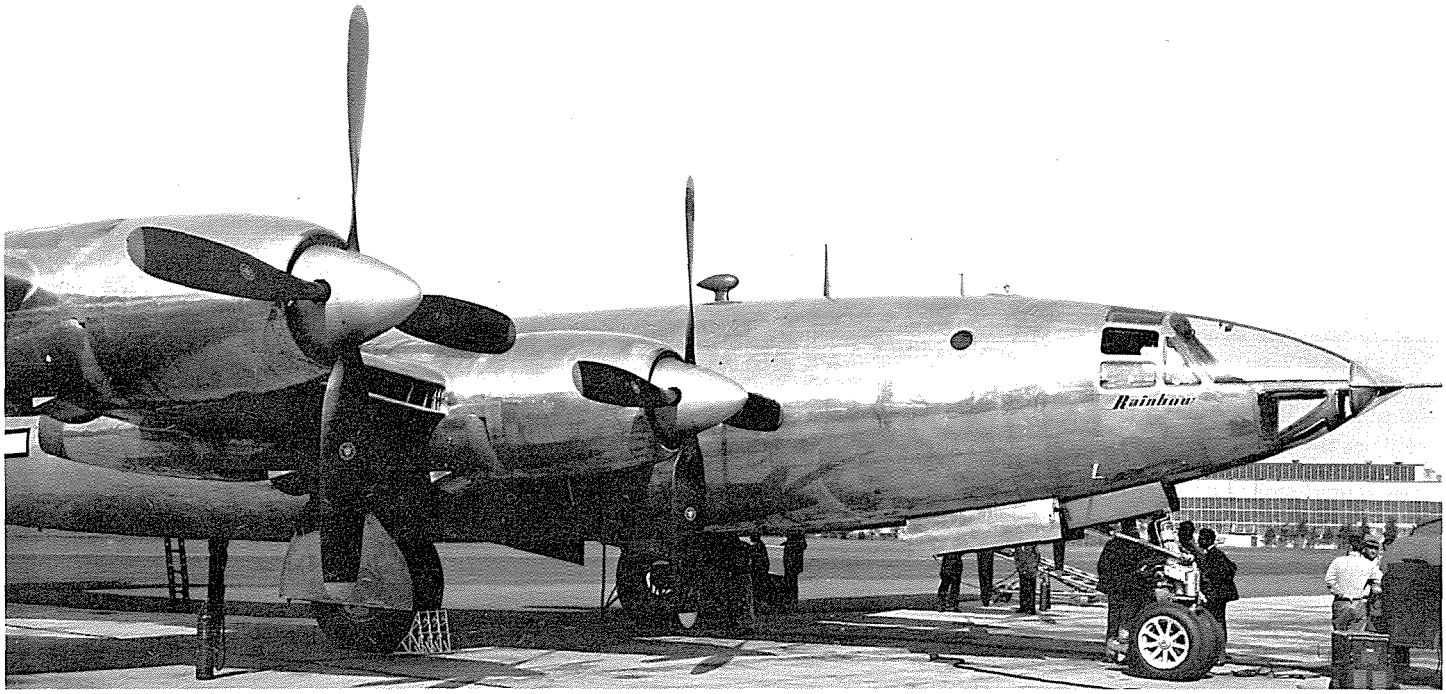
The empennage was of high aspect ratio, and the horizontal tail was mounted well above the fuselage with the same dihedral as the wing. The reader will spot the similarity between the Rainbow's tail and that of the P-84 jet fighter.

Because of the clean design of the Rainbow it was able to achieve speeds in excess of its design dive speed quite rapidly, and dive recovery flaps were installed similar to those installed in the later model P-47s. The XR-12 was the first four-engine aircraft to have such devices, but it was also the first four-engine airplane to fly in the regime of mach .8, a speed approaching the critical for even the jet fighters of the time. These flaps with a chord of seven inches were located along the under surface of the forward portion of wing and operated automatically.

Since the Rainbow was designed for high altitude, the cylindrical fuselage was pressurized to sea level (14.7 psi) pressure at 10,000 feet. The pressure compartment extended from the windshield to aft bulkhead in the cabin and included the below deck compartments.

75ST Dural was used throughout in the construction of the Rainbow, so it carried on the Republic tradition of very high strength.

This strength was tested early in the Air Force Phase two flight testing when the Wright Field Project pilot, Capt. William Elliot was making a minimum length, max gross weight landing at Farmingdale. The landing was so hard that the right main landing gear was sheared off. Elliot quickly advanced all four throttles and amazingly pulled the Rainbow back into the air without grazing the props. He spent the next four hours burning off fuel and made an excellent two-wheel landing, which resulted in damage



The XR-12 at Farmingdale. Note virtually no protuberances mar the lines of the smooth-nosed fuselage, and the clean joining of the long engine nacelles to the wings that gives evidence of fighter design. All photos Republic Aviation Corp. via Lin Hendrix.

to the right wing and the number four propeller and engine.

The damage was repaired at Republic, and the airplane was returned to Wright Field, where a careless tug driver tore off the upper section of the vertical tail when he towed the airplane into a hangar missing the cutout section designed to provide tail clearance. Again the damage was repaired and flight testing continued. But this number one Rainbow finally was destroyed by artillery fire, when it was assigned to the Aberdeen Proving Ground as a target. A sad end for an aircraft that should today be housed in the Air Force Museum.

Meanwhile the number two aircraft was assigned to the photographic section at Wright-Patterson. This was the first true photographic XR-12 as it contained a large variety of photographic equipment, including a complete dark room for the processing and printing of films in flight. Three separate camera compartments housed virtually any combination of cameras available at the time, including tri-metrogen, Sonne strip, and various focal lengths of vertical cameras.

This aircraft, serial 44-19003, achieved fame when it flew from the west to the east coast in under six hours and made a continuous photo strip of the entire flight.

When the photo section at Wright-Patterson had completed its preliminary testing, the aircraft was assigned to Eglin for full service testing, and it arrived in late October 1948.

The engineers and pilots at Republic and Wright-Patterson had proved the aircraft would fly and meet its performance specifications. Now we at the 3200th Photo Squadron had to prove it would perform the mission for which it was designed under simulated combat conditions. We, and the top planners in the Reconnaissance Branch of the Air Force had waited for this moment for years, for the Rainbow—and its competitor the Hughes XR-11.

Until the Rainbow arrived we had made do with an F-6 (modified P-51), an F-13 (modified B-29), a B-26 (Douglas A-26), an F-14 (modified P-80), and an as yet uncompleted F-82B modification which we designed and built locally.[5]

So we looked with understandable pride at the sleek aircraft which represented the dreams of the entire Air Force Reconnaissance Section, and almost before the big four-bladed props stopped turning we swarmed all around the airplane.

After a quick look through the spacious cabin and cockpit, I returned to my desk to start planning the first mission. The first flight was to be my checkout in the Rainbow as well as a tri-metrogon run across the entire Eglin Reservation—the world's largest Air Force facility. We also planned to do a 40,000-foot vertical photo mission.

On November 4, 1948, I sat down in the left seat beside Capt. C.W. Morgan, who was my instructor pilot for the checkout, and with MSgt. H.C. Lee at the engineer's position and a hand-picked crew of photo personnel aboard, we taxied to the end of the runway. After a preflight engine check, I lined the big bird up on the runway, advanced the throttles and almost before I realized it we were airborne. My first feeling was that this airplane didn't feel like a four-engine aircraft. Control response was immediate and crisp, and this airplane climbed like no other four-engined aircraft I had flown.

Once the gear and flaps were up and I was in a steady climb, I felt almost superfluous—everything on this remarkable airplane was automatic! And the visibility was something else; I felt as if I were in a greenhouse.

Typical northern Florida towering cumulus clouds had built up and prevented us from making our 40,000-foot photo run, so Capt. Morgan and I decided to use the rest of the flight for pilot practice in emergency procedures and landings and takeoffs. This big bird handled like a fighter. In fact, on my first approach I used that well-known tactical fighter procedure of flying low over the active runway, pulling up into a chandelle, and landing out of the 360-degree turn just as I would have done had I been in an F-51 or an F-80. And with those marvelous reverse pitch props the landing roll was short.

We didn't fly the 12 again until three days later. On November 7, 1948, the number two Rainbow made its next—and last—flight. The mission scheduled was a 40,000-foot photo mission, but the number 3 turbo-supercharger malfunctioned, so the flight was continued at 20,000 feet.

When the photo mission was completed, we decided to practice simulated approaches and go-arounds. During the last of these, a strong burning odor became evident in the cockpit. The flight engineer, MSgt. Lee, was sent to investigate. It was then I caught the number two engine tachometer malfunctioning. More-

over, the carburetor air temperature indicator went above the maximum on the scale. However, neither Morgan nor I considered this dangerous as the engine was obviously developing full power. We had encountered previous instrument malfunctions without consequence.

At the moment Lee reported he could find nothing wrong, the aircraft was wracked with an explosion.

Number two engine burst into flames.

The aircraft immediately started buffeting violently in a descending turn to the left.

We were above the choppy waters of Choctawhatchee Bay just off Fort Walton Beach, Florida.

Morgan and I pulled back and right on the control wheels in our desperate attempt to level the Rainbow. The control wheels moved but the plane continued its same sickening left diving turn. The altimeter was unwinding at an alarming rate.

Morgan and I looked at each other. There was only one course of action and he said it, "Let's get the hell out of here."

I pressed the console emergency alarm bell that signals, *Bail out.*

MSgt. Lee, a veteran of B-29 emergencies, had already reached the same conclusion. He released the emergency escape hatch over the left wing, and found this exit sheathed in flames. He raced to the aft fuselage to jettison the main entrance door.

Morgan and I joined the crew in their dash toward the rear of the Rainbow. Lee was struggling with the door. It would not release. While we waited, Lee—superhuman strength—finally forced the door open.

We bailed out—that is, six of us. One crew member refused to jump.

As I left the burning airplane, my thoughts were, *Is my chute on fire?*

The nylon panels snapped into full bloom, and I saw with relief there was no fire. My attentions turned to the other chutes. There were five. This meant the seventh crew member was in the doomed plane.

I watched the burning XR-12 hit the bay with a tremendous splash and heard the distant slap of noise. Almost instantly the Rainbow disappeared beneath the water.

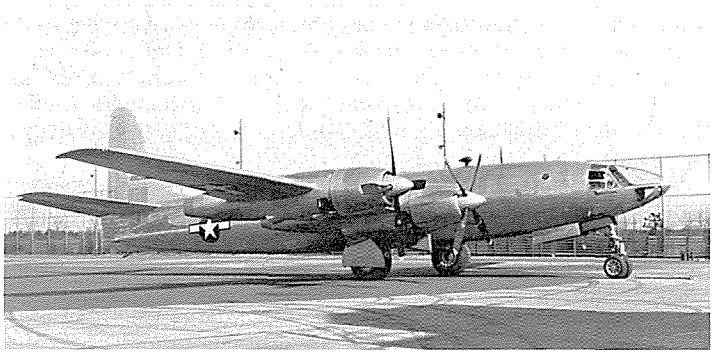
In the remaining seconds before my feet hit the water I unbuckled my harness as practiced in drills. I folded my hands across the loosened chute straps. When I saw my shoes submerge I opened my arms. The now dangerous chute floated harmlessly away. Immediately I inflated the Mae West. Bobbing in the water I considered my situation. I was about midway between the shores of the bay in a 20-knot wind. I couldn't see the shores due to the choppy water, nor could I see other survivors of the crash. (Later I learned one crew member drowned when he failed to get rid of his chute.)

I was trying to decide which way to head, when I heard a plane above. It was a Navy F4F from nearby Pensacola circling the area. Suddenly it came at me in a dive. A tiny pellet ejected from it. With great accuracy the Navy pilot fired a dye marker that nearly scored a bull's-eye on my head . . . so it seemed.

Shortly thereafter I heard the welcoming throb of twin Packards of the Air/Sea Rescue boat. The growing sound meant it was coming my way. Within minutes I was hauled aboard. In one, two, three order I was given a robe, fed hot chicken, and got a stiff shot of bourbon. None other than General Kepner, the base commander, did the honors of favoring the survivors with drinks.

As I sipped my bourbon and shivered under the robe, I looked at several bright green oxygen bottles floating aimlessly. They were the sole remaining signs of the sunken Rainbow.

With no little sadness I realized the hopes of the reconnaissance branch of the Air Force, and those of Republic Aviation Corporation, were buried deep in mud 25 feet beneath murky waters.



SPECIFICATIONS XR-12

Dimensions		
Wing span		129 ft 2 in
Length		93 ft 9½ in
	(Commercial version)	98 ft 9 in
Height		30 ft
Chord (max)		17.79 ft
Wing area		1640 sq ft
Power Plant		
Pratt & Whitney R4360		Rated at 3500 hp for T.O. with water injection Rated at 2300 hp at 40,000 ft
Performance		
Cruise speed at 40,000 feet		490 mph
Cruise speed at sea level		330 mph
Range cruise at 40,000 ft still air, no reserve		4100 miles
Weights		
Max gross		116,500 lbs
Payload (46 passengers, 7 crew members and cargo)		12,000 lbs
Fuel capacity		5900 gals

REFERENCES

1. The Rainbow appeared on the scene just as the Air Force became a separate military body, and, of course, all aircraft designations were changed to add to the historian's problems. The Rainbow was originally contracted for as the XF-12 but became the XR-12.
2. An obvious nickname for the huge four row radial 28-cylinder engine, the most powerful production reciprocating engine in the world at the time.
3. The first XF-11 was equipped with counter-rotating propellers, and it was in this airplane that Hughes nearly met his death when one set of props went into full reverse in flight. The second XR-11 (new designation) arrived at Eglin shortly after the second Rainbow crashed, and the author made one flight in it. Its high altitude performance was superb, but the control response was poor compared to that of the XR-12.
4. This feature was one looked on with envy by B-29 and B-50 pilots. Landing the Superforts at night was a literal nightmare due to reflections in the rounded nose glass.
5. The engineering section of the Photo Test Group designed and the sheet metal shop built an aluminum camera pod capable of housing six various cameras and mounted it on the center section of an F-82B. We unofficially designated the plane the XRF-82. North American engineers predicted a speed loss of at least 15 mph—actually it was 3 mph—and they warned it wouldn't stand any G load. I tested it to 4.5 g without incident.

ABOUT THE AUTHOR

Lin Hendrix was an experimental test pilot at Republic for many years. While there he tested all the F-84 series except the B and J. He also flew all series of the F-105 except the F. During World War II he flew a combat tour in the 8th Air Force in Libs. His logbooks list his having flown some 80 types of aircraft. Lin has a deep interest in aviation history, and in his home are voluminous files on most aircraft, with particular emphasis on Republic aircraft. He will answer letters on those aircraft within the capability of his time. He makes his home in Chula Vista, California.