COMBAT AIRCRAFT 152

Peter E Davies

U-2 'DRAGON LADY' UNITS 1955–90

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CHAPTER ONE

BALD EAGLE AND *AQUATONE*

The U-2 proposal originated in November 1953 as Project *Bald Eagle,* a CIA initiative for a new reconnaissance type which the initially sceptical USAF would eventually buy into. It was needed to fly over the Soviet Union and provide information that was severely lacking on its military and industrial resources. The intended payload was a 500-lb camera package and radar, infrared (IR) or other intelligence gathering systems which were being developed. Eventually, the aircraft would carry five types of cameras and more than 20 electronic intelligence (ELINT) gathering and self-protection devices. It had to fly at Mach 0.8 for around 2400 miles, maintaining altitudes of 65,000–70,000 ft over 'denied territory', where the aircraft would be relatively safe from interception until around 1960, when it was estimated that adequate Soviet defences would have evolved.

The project was lent urgency by 1952 reports of Soviet long-range missile development. Concerns about the vulnerability of US bomber bases had been increased in 1953–54 by a supposedly large force of new long-range jet bombers such as the Myasishchev M-4 'Bison'. These threats were beyond the reach of US Air Force (USAF) aerial reconnaissance assets. Meanwhile, various piston-engined bomber conversions and a reconnaissance version of America's first jet bomber, the RB-45C (flown by American and British pilots) had patrolled around, and sometimes over, Soviet territory since the 1940s, but at increasingly vulnerable altitudes below 40,000 ft.

This U-2A has a fictitious NACA serial for CIA pilot training at 'The Ranch'. Early aircraft were all hand-made, so obtaining standard 'spares' was difficult. All were slightly different, which meant panels were not interchangeable. Experienced pilots claimed that the aircraft also had individual handling idiosyncrasies (*Lockheed*)

Several smaller companies including the Bell Aircraft Corporation, Fairchild Engine and Airplane Corporation and the Glenn L Martin Company were asked by the USAF to submit proposals for a better high-altitude design for *Bald Eagle*. Martin's Model 294 (a big-winged B-57 bomber) was adopted as an interim measure, while Bell's twin-engined X-16 was given a development contract. However, when John H Carter at Lockheed became aware of the project in the autumn of 1953, he suggested to company Vice-President L Eugene Root that it should submit an unsolicited *Bald Eagle* proposal. Carter felt that the high performance goals (set against the relatively low power of the available engines) would mean that weight saving – eliminating items such as a conventional undercarriage and an ejection seat – would be a major priority.

Carter also pointed out that if the aircraft's survivability extended only to 1960, unusually rapid development was essential. Following management approval, Lockheed's chief designer, Clarence 'Kelly' Johnson, started work on the CL-282 (U-2) early in 1954. His legacy of radical, innovative designs included the P-38 Lightning, P-80 Shooting Star and Constellation. He also had a reputation for completing design projects in unusually short timescales. Johnson suggested using the fuselage of his current supersonic, lightweight F-104 Starfighter design and adding 'wings like a tent' in place of the F-104's stubby, supersonic wings. The Starfighter's elongated, cylindrical fuselage and small cockpit was adapted, and a General Electric (GE) J73-GE-3 turbojet fitted in place of the fighter's GE J79. Its sideways-hinging cockpit canopy remained in all early U-2s, using the same part number as the F-104's.

The long, high aspect ratio wings were attached with three large bolts per side, like a glider's, to enable easy disassembly for air transportation. They were also early examples of the 'wet wing', with each one containing two fuel compartments holding 1335 gallons in place of conventional tanks, feeding a single sump tank.

Spanning 70 ft compared with the Bell X-16's 115 ft, the wing included glider-style 'gust control', with deployment of the flaps and ailerons to set a nose-high angle of attack that reduced stress on the wings. The Starfighter's distinctive 'high-T' tail was replaced by a lower-mounted version on a detachable tail unit. The structure was stressed to 2.5g – less than half the normal military standard. While this saved considerable weight, it made the airframe more vulnerable to aerodynamic stress than a normal design. Johnson eliminated an undercarriage, relying on two skids for landing and a wheeled dolly for take-off.

He calculated that the 13,768-lb CL-282 would exceed the specified 70,000 ft altitude limit by 3000 ft. Its tactical radius of 1200 miles gave seven hours of endurance. Johnson implied that the aircraft could be available within a year, and he expected a short production run with a limited lifespan, pending the arrival of a faster, higher-flying reconnaissance vehicle.

At first, the USAF's Wright Air Development Center (WADC) favoured the safety element of the Bell and Martin designs. Gen Curtis LeMay, who led Strategic Air Command (SAC), rejected the CL-282, seeing it as a Central Intelligence Agency (CIA) threat to his command's reconnaissance hegemony. WADC also rejected the CL-282 in June 1954, citing the lack

of an undercarriage and the choice of the rare J73 over the proven Pratt & Whitney J57 engine. Fortunately, Trevor Gardner, Special Assistant for Research and Development to the Secretary to the Air Force, supported Johnson's project.

With encouragement from colleagues Frederick Ayer and Garrison Norton, Gardner took the CL-282 to Philip Strong, the CIA's Chief of Operations Staff in the Office of Scientific Intelligence. Strong in turn approached Richard M Bissell, the CIA's new Director of Planning and Coordination, who displayed interest, and Allen Dulles, CIA director, who was resistant to technological rather than traditional methods of intelligence gathering. He regarded overflights of the USSR as 'Air Force business', but President Dwight D Eisenhower insisted that it had to be a 'civilian operation'.

Also championing the high-altitude reconnaissance cause was a group of Boston scientists. Edwin H Land, founder of the Polaroid company, astronomer and optics expert Jim Baker and aeronautical engineer Allen Donovan offered their expertise in camera design and expressed their concerns about the lack of reconnaissance capability through the 'Land Panel'. Commissioned by President Eisenhower (prompted by Gardner), the panel included other distinguished academics, and it increasingly favoured Kelly Johnson's project. Johnson met the Land Panel and senior USAF figures in November 1954 and agreed to use the J57 engine and reconsider the 'skid' undercarriage.

On 24 November Eisenhower approved the CL-282 design and the Land Panel's suggestion that the aircraft should be flown by the CIA, not the USAF. Project supervision was given to Bissell by Dulles, with the comment that it was 'too secret for him to explain'. Bissell was loaned a packet of classified CL-282 documents, while Johnson began a redesign that would result in a larger airframe stressed to 2.5g (like a transport aircraft) and inevitable delays for his original eight-month period up to first flight.

Johnson learned that Pratt & Whitney could make a shorter, lighter, high-altitude J57-P-31A with its thrust increased to 11,200 lbs. Landing skids were replaced by a glider-style single main landing gear and a small metal and Teflon tail wheel. Two sprung steel 'pogo' legs with small wheels dropped away from the wings after take-off. Wingtips were protected from runway contact by abradable titanium skid buttons, lasting for around 100 landings. The large flying control surfaces were not boosted, causing work for the pilot but saving weight by omitting hydraulic systems. The wing structure used three spars and aluminium tubing lattice webs.

Normal aviation fuel tended to evaporate through the fuel tank vents at high altitude due to low air pressure. Shell Oil produced a special low vapour pressure type of kerosene, based on products used for Flit fly-spray, known as LF-1A ('lighter fuel' to the pilots). It was replaced in USAF service by the 'thermodynamically stable' JP-TS.

High-altitude flight also required a pressure suit to protect the pilot, whose blood would start to boil at 65,000 ft without cockpit pressurisation. Rather than inflict an inflated pressure suit on the pilot for an entire flight in an unpressurised cockpit, Lockheed pressurised the latter to an equivalent of 25,000–30,000 ft. The David Clark Company was asked to produce a suit that could be used uninflated for a 12-hour flight. If cockpit pressurisation

was lost, the MC-3 partial pressure suit would inflate and protect the pilot for up to four hours. Each pilot had to visit the manufacturer at Worcester, Massachusetts, to be personally fitted. An ejection seat was eventually installed, but several failures occurred. The first successful ejection was not made until Col Jack Nole narrowly escaped from U-2 56-6694 when it suffered control failure at 53,000 ft on 26 September 1957.

The prototype U-2A was completed on 15 July 1955. Lockheed test pilot Tony LeVier was scheduled to make the first flight, but a suitably remote test ground had to be found as the aircraft had been designed and built at Lockheed's 'Skunk Works' in absolute secrecy. Eventually, a disused World War 2 airfield was found in a nuclear weapons test range near Groom Dry Lake, 100 miles from Las Vegas, Nevada. Officially known as Watertown Strip, but christened 'The Ranch' or 'Paradise Ranch' (according to Kelly Johnson, in deference to the primitive nature of the base), the 6000-ft runway was served by a few new buildings but initially lacked water or power.

The completed aircraft, CIA Article 341, was disassembled and flown to 'The Ranch' in a C-124 Globemaster II. Reassembled and ground tested, the 'Angel' (Johnson's preferred name for it) began taxi trials on 1 August 1955, when LeVier found that its considerable wing lift made the aircraft take off unexpectedly at 70 knots, even though he had cut the power. It flew for around 1500 ft and then LeVier had to manage the first landing, which involved a heavy bounce and a long skid that blew the main-gear tyres and burned the brakes.

The first scheduled flight, with an interim J57-P-37 engine, on 4 August was a successful 20-minute workout of the basic handling until the landing. Following Johnson's advice to touch down on the main gear, LeVier, under the CIA pseudonym 'Anthony Evans', found that the 'Angel', reluctant to stop flying, started a porpoising motion, forcing him to abort the landing. After several similar experiences he noticed an incoming thunderstorm and touched down in a stall, tail-first. With slight modification, this technique enabled U-2 pilots to return safely for decades to come.

Pilots had to master the trick of stalling the aircraft just before making contact, with guidance from another 'mobile' pilot sat in a chase car (in 1957, a supercharged Ford station wagon) travelling close behind at speeds in excess of 100 mph. He called out the last few feet of altitude to a pilot, who had only peripheral vision of the runway, communicating via an ARC-34 UHF receiver/transmitter.

Despite oil leaks, fuel-feed and flameout problems with the interim engine, the test programme showed that the prototype could meet all the specifications. Bell's X-16 was cancelled and 19 'Articles' were ordered for the CIA, together with 30 for SAC after LeMay had accepted the value of 'spy flights' in planning routes and identifying targets for his bombers. To reinforce secrecy, the aircraft became the 'Utility-2' or U-2, suggesting something as harmless as the Cessna U-3 light training aeroplane. The CIA procurement process used the cryptogram Project *Aquatone*, whereas the USAF's U-2 project was coded *Oilstone* from 3 August 1955, although many senior personnel, including Maj Gen Albert G Boyd, director of the WADC (the USAF's main research and procurement advisors) were still unaware of the U-2 programme's existence.

EYES IN THE SKIES

The U-2 project relied very much upon its cameras' ability to provide pin-sharp images from an altitude of 70,000 ft. The standard early 1950s aerial camera system could resolve images of around 25 ft in size from 33,000 ft – less than half the U-2's planned surveillance altitude. Resolution four times better would be needed, so cameras were developed in a secret project code-named NEPHO, which officially covered 'the study of clouds'.

A U-2's pressurised 'service bay' (or Q-bay) could accommodate several camera configurations and types. It was accessed from above and below. Different lower hatch covers allowed appropriate windows for each camera configuration. The A-3 configuration, common in U-2As, used three vertically mounted 24-inch focal length HR-732 cameras in a standard trimetrogon mapping arrangement. A single HR-732 and an RC-10 mapping camera comprised the A-4 fit, used for combined narrow and wider area coverage.

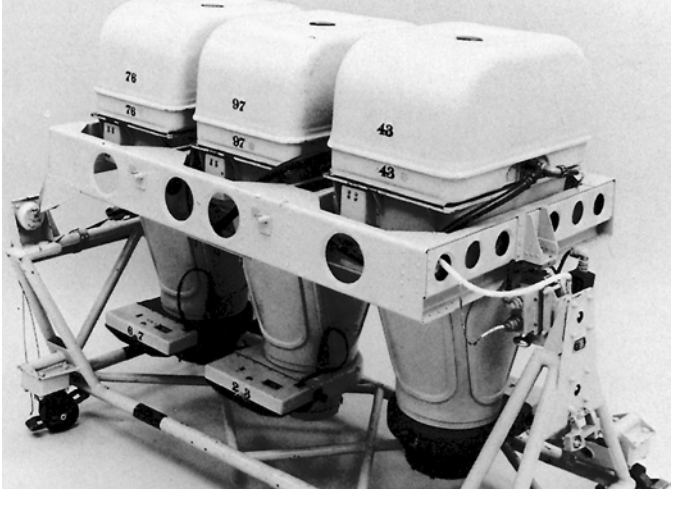
A massive 36-inch twin-frame, nine-position camera comprised the prototype-only C configuration. The little-used D configuration had a very long focus six-inch format camera that was vulnerable to vibration. A 70 mm Perkin Elmer tracking camera (later fitted with Mk II hand controls) recorded the U-2's progress, taking vertical views every 32 seconds throughout the flight so that the photo interpreters (PIs) could relate the main cameras' images to the aircraft's flightpath.

The widely-used, CIA-sponsored HR-73B Type B configuration camera installation photographed from vertical, near vertical and low and high oblique (showing part of the horizon) angles on either side. Projecting downwards and to the rear, the camera focused through a downward-looking prism that rapidly rotated left and right to acquire images through the row of seven rounded windows in the Q-bay belly door. These 'portholes' were protected from water splashes on wet runways by an aluminium cover, jettisoned with the pogos on take-off and re-attached after landing.

The prism's sequence gave a vertical view, with every fifth and tenth shots showing the horizon. Priority was given to vertical or near-vertical photographs. The cameras had a dual drive, and the whole module was mounted on its Image Motion Compensation platform in the laboratory before being trucked out to the U-2 and winched into the Q-bay. Air conditioning and pressurisation were provided, and the cameras were temperature-controlled to avoid distortion.

The Type B's two 300-lb canisters held two miles of Kodak thin-base Mylar film that was fed in opposite directions, one feeding forwards and the other one aft to preserve the U-2's centre of gravity at altitude. Eastman Kodak developed Mylar film base as a much lighter and stronger replacement for previous versions, using improved emulsions.

OPPOSITE
USAF camera technicians load a Type B camera into the Q-bay of a U-2A. The camera was uploaded from the bottom of the open Q-bay via a lift fixture that hooked into the upper hatch attachment points (*USAF*)



The A-3 high-resolution camera system, common in U-2As, on its transport trolley. Three vertically mounted HR-732 cameras, each with 24-inch focal length, could be operated singly or together. Each camera held enough film for 1200 9 x 18-inch exposures (*NASA/Terry Panopalis Collection*)