= Lockheed D @-@ 21 =

The Lockheed D @-@ 21 was an American reconnaissance drone with maximum speed in excess of Mach 3 @.@ 3 (2 @,@ 215 mph ; 3 @,@ 564 km / h) . The D @-@ 21 was initially designed to be launched from the back of a M @-@ 21 carrier aircraft , a variant of the Lockheed A @-@ 12 aircraft . Development began in October 1962 . Originally known by the Lockheed designation Q @-@ 12 , the drone was intended for reconnaissance deep in enemy airspace .

The D @-@ 21 was designed to carry a single high @-@ resolution photographic camera over a preprogrammed path , then release the camera module into the air for retrieval , after which the drone would self @-@ destruct . Following a fatal accident when launched from an M @-@ 21 , the D @-@ 21 was modified to be launched from a Boeing B @-@ 52 Stratofortress . Several test flights were made , followed by four unsuccessful operational D @-@ 21 flights over the People 's Republic of China , and the program was canceled in 1971 .

= = Design and development = =

In the 1960s Lockheed 's secret Skunk Works developed the Mach 3 A @-@ 12 reconnaissance aircraft for the Central Intelligence Agency (CIA) . After the shooting down of the U @-@ 2 piloted by Gary Powers in 1960 , a number of different concepts were proposed as alternatives . Kelly Johnson , the leader of Skunk Works , developed the concept of a long @-@ range drone that used much of the A @-@ 12 's technology . In October 1962 the CIA and the US Air Force instructed Lockheed to study a high @-@ speed , high @-@ altitude drone concept . Johnson specified speeds of Mach 3 @.@ 3 ? 3 @.@ 5 , an operational altitude of 87 @,@ 000 ? 95 @,@ 000 feet (27 @,@ 000 ? 29 @,@ 000 m) , and a range of 3 @,@ 000 nautical miles (3 @,@ 500 mi ; 5 @,@ 600 km) . It was intended to make a one @-@ way trip , eject its camera payload at the end of the mission for recovery , then self @-@ destruct . It had a double @-@ delta wing similar to the A @-@ 12 's wing design . The Q @-@ 12 was to be air @-@ launched from the back of an A @-@ 12 , and used key technology from the A @-@ 12 project , including titanium construction and radar cross @-@ section reduction design features .

Johnson wanted to power the Q @-@ 12 with a ramjet engine built by Marquardt for the Boeing CIM @-@ 10 Bomarc long @-@ range surface @-@ to @-@ air missile . Marquardt and Lockheed had already collaborated on several programs and had a close working relationship . The engine , the RJ43 @-@ MA @-@ 11 , required modification , since it was only designed to burn as long as the missile needed to hit a target , while the Q @-@ 12 's engine needed to operate at high temperatures for at least an hour and a half at high altitudes . The modified engine was designated as the RJ43 @-@ MA20S @-@ 4 .

A full @-@ scale mockup of the Q @-@ 12 was ready by 7 December 1962 , and had already undergone preliminary tests to measure its radar cross @-@ section . Marquardt had also successfully tested the modified RJ @-@ 43 in its wind tunnel in the meantime . However , the CIA was not enthusiastic about the Q @-@ 12 , mostly because the agency was overextended at the time with U @-@ 2 missions , getting the A @-@ 12 up to speed , and covert operations in Southeast Asia . The Air Force , however , was interested in the Q @-@ 12 as both a reconnaissance platform and a cruise missile , and the CIA finally decided to work with the USAF to develop the new drone . Lockheed was awarded a contract in March 1963 for full @-@ scale development of the Q @-@ 12 .

The camera and its film magazines with an inertial navigation system were carried in a cramped " Q @-@ bay " below the drone 's air intake . These components were built into a module that fit into the bay and was known as a " hatch " . The hatch would be ejected at the end of the mission and then snagged out of the air by a JC @-@ 130 Hercules , a technique that had been developed by the Air Force to recover film canisters from satellites . If the C @-@ 130 missed , the hatch was equipped with flotation devices so it could be recovered by ship if released over water . Honeywell built the avionics systems ; new construction techniques and materials had to be developed for the systems to withstand the high temperatures , extreme vibrations , and lack of space in the D @-@ 21 .

In late 1963 the project was named Tagboard ; the Q @-@ 12 was re @-@ designated D @-@ 21 while the A @-@ 12 version launcher became M @-@ 21 (D- for " daughter " and M- for " mother ") . Two of the original 18 A @-@ 12 aircraft were designated as M @-@ 21s with serial numbers 60 @-@ 6940 and 60 @-@ 6941 . The M @-@ 21 was a two @-@ seat version of the A @-@ 12 , with a pylon on the fuselage centerline between the vertical stabilizers to carry the drone in a nose @-@ up attitude .

= = = Testing and carrier change = = =

A D @-@ 21 mounted on an M @-@ 21 began captive flight @-@ testing on 22 December 1964 . Aerodynamic covers were initially placed over the D @-@ 21 's intake and exhaust to reduce drag , but had to be removed after the first few tests , as no way of discarding them at Mach 3 without damaging the drone or carrier plane could be devised .

The D @-@ 21 was first launched from an M @-@ 21 on 5 March 1966 . The drone was released but stayed close to the M @-@ 21 's back for a few seconds , which seemed like " two hours " to the M @-@ 21 crew . A second launch took place on 27 April 1966 ; the D @-@ 21 reached its operational altitude of 90 @,@ 000 ft (27 @,@ 432 m) and speed of over Mach 3 @.@ 3 (2 @,@ 215 mph ; 3 @,@ 564 km / h) , though it was lost due to a hydraulic pump failure after a flight of over 1 @,@ 200 nmi (1 @,@ 400 mi ; 2 @,@ 200 km) . The Air Force 's interest in the program continued and more D @-@ 21s were ordered after the second launch . A third flight took place on 16 June with the D @-@ 21 flying 1 @,@ 550 nmi (1 @,@ 780 mi ; 2 @,@ 870 km) through its complete flight profile , though its camera hatch was not released due to an electronics failure .

The fourth and final launch from an M @-@ 21 on 30 July ended in disaster . Unlike the three previous launches this one was performed straight and level , not in an outside loop to assist in the separation of the drone from the aircraft . The D @-@ 21 suffered engine problems and struck the M @-@ 21 's tail after separation , leading to the destruction of both aircraft . The two crew ejected and landed at sea . The pilot , Bill Park , survived , but the Launch Control Officer , Ray Torick , drowned .

Following the accident , Johnson suggested launching the D @-@ 21 from the very large Boeing B @-@ 52 Stratofortress bomber , and adding a solid rocket booster to get it up to speed . The drone was modified by adding attachment points on its spine to mate with the carrying pylon on the B @-@ 52 and its belly attachment points were adapted to accommodate the rocket booster necessary to increase its speed and allow its ramjet to operate . Its vertical stabilizer was increased in size by approximately 20 % . The modified drone version was designated D @-@ 21B (there was no -21A) . Two B @-@ 52Hs were modified to carry a pair of drones each by means of two large underwing pylons that replaced the smaller pylons used for the AGM @-@ 28 Hound Dog cruise missiles . The tail gunner 's and electronic warfare officer 's stations were replaced with two launch control stations . Command and telemetry systems were added , and high @-@ speed cameras were installed to track the drones as they separated from the pylons . The launch control officer on the B @-@ 52H could communicate with the D @-@ 21Bs , and could make it self @-@ destruct .

The solid @-@ fuel booster was both larger and heavier than the drone ; it was 44 feet 4 inches (13 @.@ 5 m) long and weighed 13 @,@ 286 pounds (6 @,@ 030 kg) . It had a folding tail fin on the bottom to stabilize it while the rocket was firing . The booster had a burn time of 87 seconds and a thrust of 27 @,@ 300 pounds @-@ force (121 kN) . During ground handling everyone within 25 feet (7 @.@ 6 m) was required to wear anti @-@ static straps to prevent any discharge of static electricity that might ignite the booster .

The first attempted launch of a D @-@ 21B was on 28 September 1967 , but the drone fell off the B @-@ 52 's launch pylon due to a stripped nut on the pylon before the aircraft reached its intended launch point . Johnson admitted that the incident was " very embarrassing " . Three more launches were performed from November 1967 through January 1968 . None were completely successful , so Johnson ordered his team to conduct a thorough review before renewing launch attempts . The next launch was on 10 April 1968 . It also failed as the engine did not ignite . On 16 June the D @-@ 21B finally made a completely successful flight ; it flew at the specified altitude and course for its full

range , and the hatch was recovered . The next two launches were failures , followed by another successful flight in December . A test in February 1969 to check the inertial navigation system with an actual mission profile was a failure . The next two flights in May and July succeeded .

= = Operational history = =

Four operational missions with the D @-@ 21B took place under the codename of Senior Bowl . These were conducted over the People 's Republic of China from 9 November 1969 to 20 March 1971 to spy on the Lop Nor nuclear test site . The USAF 's 4200th Support Squadron , based at Beale Air Force Base , California , flew the missions , usually from Andersen Air Force Base in Guam .

The Chinese never spotted the D @-@ 21B . The first one failed to turn around and continued straight on , crashing somewhere in the Soviet Union . Another test flight was conducted on 20 February 1970 in a successful attempt to correct any problems . The second operational mission , however , was not until 16 December 1970 . The D @-@ 21B reached Lop Nor and back to the recovery point , but the hatch had a partial parachute failure and was lost at sea with its photographs .

During the third operational mission , on 4 March 1971 , the D @-@ 21B flew to Lop Nor and returned , and released the hatch , which deployed its parachute , but the midair recovery failed and the hatch fell into the water . The destroyer that tried to retrieve the hatch ran it down and it sank . The fourth , and last , operational flight of the D @-@ 21B was on 20 March 1971 . It was lost over China on the final segment of the route over China 's Yunnan province ; wreckage was found by local authorities . In 2010 , after being in the junkyard of China Aviation Museum for years , the wreckage was moved to the exhibition area .

On 23 July 1971 , the D @-@ 21B program was canceled due to its poor success rate , the introduction of a new generation of photo reconnaissance satellites , and President Richard Nixon 's rapprochement with China . A total of 38 D @-@ 21 and D @-@ 21B drones had been built , 21 of which were expended in launches . The remaining 17 were initially stored at Norton Air Force Base , California , then moved to Davis @-@ Monthan Air Force Base " boneyard " near Tucson , Arizona , in 1976 and 1977 . With the base open to the public , the D @-@ 21 drones were quickly spotted and photographed . The Air Force called them GTD @-@ 21Bs with the GT standing for Ground Training .

The fate of the D @-@ 21 that had disappeared on the first operational flight was finally revealed in February 1986 when an official from the CIA returned a panel to Ben Rich that he had been given by a Soviet KGB agent . The drone had self @-@ destructed over Siberia and the Soviets had recovered the wreckage . The Tupolev design bureau reverse @-@ engineered the wreck and produced plans for a Soviet copy , named the Voron (Raven) , but it was never built .

In the late 1990s NASA considered using a D @-@ 21 to test a hybrid " rocket @-@ based combined cycle " engine , which operates as a ramjet or rocket , depending on its flight regime . Ultimately NASA used a derivative of the agency 's X @-@ 43A hypersonic test vehicle for the experiments .

= = Aircraft on display = =

Aerospace Maintenance and Regeneration Group (AMARG) located on Davis @-@ Monthan AFB , Tucson , Arizona (D @-@ 21 # 530 and two more)
Blackbird Airpark , Palmdale , California (D @-@ 21B # 525)
Chinese Aviation Museum , Beijing , China (D @-@ 21 # 527)
Evergreen Aviation Museum , McMinnville , Oregon (GTD @-@ 21B # 534)
Grissom Air Museum , Grissom Air Reserve Base , Peru , Indiana (GTD @-@ 21B # 528)
March Field Air Museum , March Air Reserve Base , Riverside , California (D @-@ 21B # 537)
Museum of Aviation , Robins Air Force Base , Georgia (GTD @-@ 21B # 538)
Museum of Flight , Seattle , Washington (D @-@ 21 No. 510 mounted on remaining M @-@ 21 #

60 @-@ 6940)
National Museum of the United States Air Force , Wright @-@ Patterson Air Force Base , Ohio (D @-@ 21B # 524)
Pacific Coast Air Museum , Sonoma County , California (D @-@ 21B # 522)
Pima Air & Space Museum (adjacent to Davis @-@ Monthan AFB) , Tucson , Arizona (D @-@ 21B # 533)

= = Specifications (D @-@ 21) = =

D @-@ 21A and D @-@ 21B without booster
Wingspan : 19 ft 1 / 4 in (5 @.@ 79 m)
Length : 42 ft 10 in (12 @.@ 8 m)
Height : 7 ft 1 / 4 in (2 @.@ 14 m)
Launch weight : 11 @,@ 000 lb (5 @,@ 000 kg)
Maximum speed : Mach 3 @.@ 35 (2 @,@ 210 mph , 1 @,@ 920 knots , 3 @,@ 560 km / h)
Service ceiling : 95 @,@ 000 ft (29 @,@ 000 m)
Range : 3 @,@ 000 nmi , 3 @,@ 450 mi , 5 @,@ 550 km
Engine : 1 x Marquardt RJ43 @-@ MA @-@ 20S4 ramjet , 1 @,@ 500 lbf (6 @.@ 67 kN)
Sources : Pace , Landis & Jenkins , Donald