Project Tagboard/Senior Bowl
Overview

Project Tagboard/Senior Bowl is a relatively unknown project in the history of Area 51 reconnaissance aircraft (U-2 and A-12). This project was Top Secret from its inception and during the Senior Bowl part of the project, there were less than 100 personnel cleared to work on it.

This article is written by someone who worked at Area 51 during 1964 thru 1968 on the A-12's Honeywell Inertial Navigation System (INS). The author has written an article on the role the Honeywell INS played in the A-12 Oxcart project titled "Honeywell INS: The untold Story".

Project Tagboard/Senior Bowl also used a Honeywell INS in both the drone and the mother ship. It is the author's intent to make a brief description of the project and its mission, while at the same time focusing on the role the INS played in this project.

I have asked Russ Buyse to help me in this endeavor, since he worked for Honeywell on this project during the last three years, at both Area 51 and Beale AFB. Russ solicited the help of Stan Moeschl who was the technical director during the early phases of Tagboard in the MD-21 configuration and subsequently as engineering section head in the B-52H phase.

History

Project Tagboard/Senior Bowl was the brain child of Lockheed's Skunk Works' Kelly Johnson. It consisted of a drone (D-21) mated to a modified A-12 aircraft (M-21), the combination known as MD-21 (mother/daughter).

The project was first conceived in 1962 when Lockheed's Kelly Johnson got approval from the CIA to add two aircraft to the existing A-12 assembly line. Known as M-21's, these aircraft were built with a second crew station for the Launch Control Officer (LCO) and structurally enhanced aft fuselage with a large dorsal pylon to carry the new drone atop the rear fuselage. When attached, the wingtips of the D-21 would have only six inches of clearance with the tops of the vertical stabilizers of the mother ship. This combination was known as the MD-21 (mother/daughter).

The new drone was relatively lightweight, had a low radar cross section (RCS) and used a Marquardt ramjet. Since ramjets are unable to function at sub-sonic speeds, it would have to be launched from the mother ship at supersonic speeds.

The mission plan for the MD-21 combination was for the D-21 to be launched from the mother ship over the Pacific Missile Test Range at a point west of Hawaii. The drone would then fly its pre-programmed 3,000 nautical mile mission over China and return to a friendly area over the Pacific Ocean.

At the end of the mission, the D-21 was commanded to perform a controlled descent to a lower altitude, where it would jettison the payload hatch containing a special Hycon camera, its film, flight control computers and the Honeywell Inertial Navigation System (INS). The hatch would be lowered by parachute and retrieved in midair by a specially modified JC-130B Hercules aircraft. In the event it wasn't caught in mid-air, it would be recovered from the water by awaiting ships. Once the hatch was ejected, the drone would self-destruct.

The first MD-21 flight took place in December 1964. The purpose of this flight was to check the aerodynamic stability of the mated combination, the first operational flights did not occur until 1966.

During 1966 there were four operational launches, but on the fourth launch on 30 July 1966, the drone experienced an "unstart", causing the drone to strike the back of the mother ship, causing it to pitch up and break apart in mid-flight. Both the pilot, Bill Park and the LCO, Ray Torick ejected successfully over the Pacific Ocean, however Ray Torick drowned before he could be rescued.

Following that catastrophe, the drone was modified to be launched from a specially modified B-52H and re-labeled D-21B. A solid rocket booster under the drone, allowed it to reach supersonic speed to start the Marquardt ramjet.

A significant change had to be made to the INS for the new mother ship, a B-52H. As the time between take-off of the MD-21 mother ship to the launch site was only one to two hours, there was no need to update the INS in the drone. Being launched from a B-52H created a whole different situation. The MD-21 could fly 2000 miles in an hour. It took the B-52 three to four hours to cover that distance. As a result, it was necessary to improve the accuracy of the drone's INS prior to launch. There was no GPS at that time, so the device to provide the needed accuracy had to reside in the B-52H. Honeywell modified the INS (H-330) system used in the A-12 to accomplish this task. The A-12 and B-52H systems were identical except the INS in the B-52H had a new computer and the platform was modified to install a star tracker that capped the position error to 1 NM at drone launch. A sensor was needed to interface the H-330M's platform to the star tracker. That sensor was developed and manufactured by Kollsman.

Hatch components

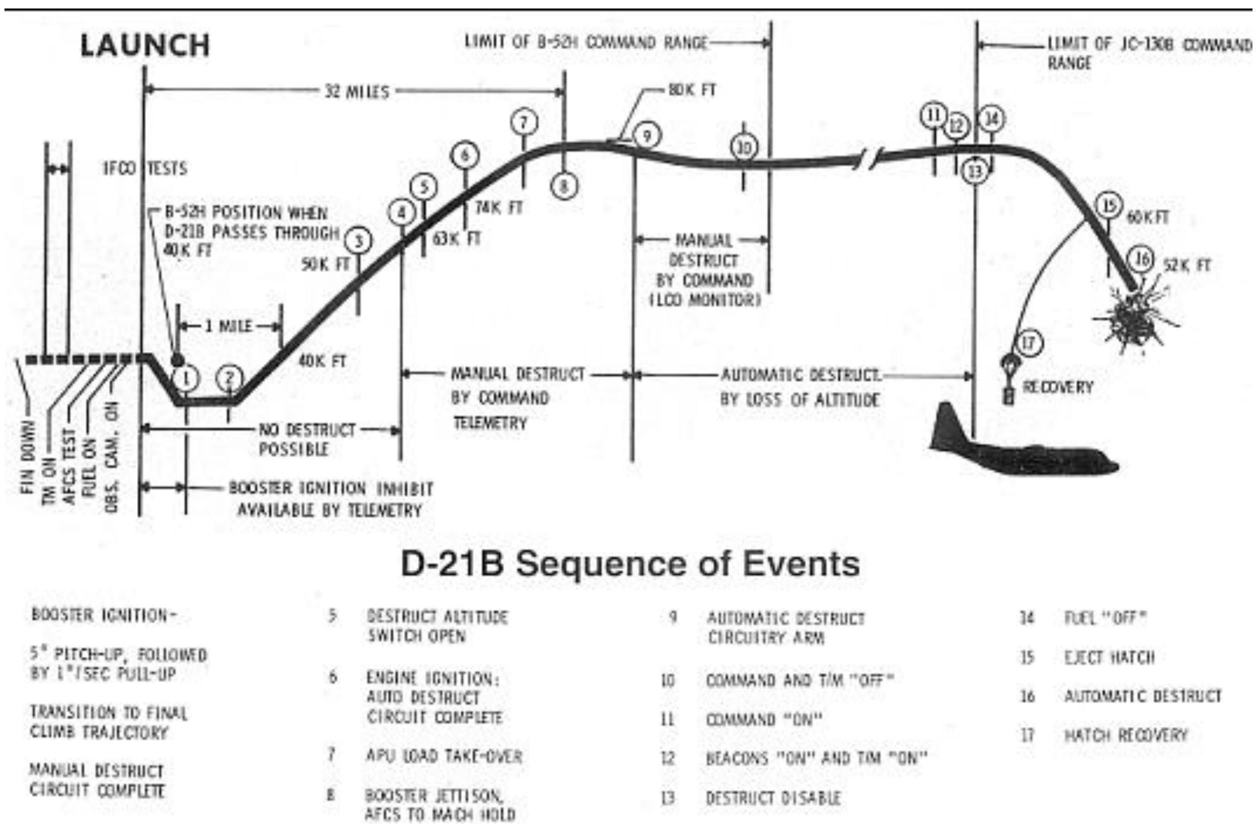
Inside the hatch were the avionics packages made by Honeywell. These included the Inertial Navigation System (INS), the Automatic Flight Control System (AFCS), and the Air Data Computer (ADC). These were installed within the hatch so they could take advantage of the same cooling system used for the payload, as well as be recovered with the hatch at the end of the mission. After the hatch was sealed, these systems were also tested via IFCO checks.

The autopilot was a combination of digital and analog technology, all housed in a one-cubic-foot box with three line-replaceable units (LRUs)). One LRU controlled the roll and yaw, one controlled the pitch axis, and the other was a power supply for the in-flight checkout equipment. Due to the extreme lack of space and high vibration environment on the aircraft, new construction techniques were developed. The autopilot utilized what was called "welded cordwood construction" because the resistors, capacitors and other pieces of equipment stood on end, resembling cordwood. The ends of these units were welded together and to the motherboard with a technique similar to a spot weld but without using solder. Maintenance proved to be exceptionally difficult because the units needing work had to be drilled out, the Mylar separators that held the devices in place had to be patched, and then the units being replaced had to be re-welded into position.

The INS consisted of five different boxes, the platform, which contained the gimbals with three gyros and three accelerometers, a Power Supply which converted the drone's power to power usable for the INS boxes, a new Computer which had a three inch magnetic drum with embedded integrated circuits, a Gimbal Drive box which moved the three gimbals to the correct orientation, and a Coupler which interfaced the INS with the other electronic boxes in the hatch, like the AFCS. The new INS computer used some of the same construction techniques used in the AFCS.

A 24-inch focal length, F5.6 lens camera provided the D-21 reconnaissance capability. The camera could be operated in one of two modes. The first (Mode 3) allowed the camera to expose a photographic swath of 16 NM wide and 3,900 NM in length. When operated in the second position (Mode 5), the camera will expose a swath 28 NM wide and 3,000 NM long. Design resolution was two feet at nadir. In-flight data was recorded on the film consisting of latitude, longitude, time, oblique position, and exposure number.

Mission description



Once the B-52H was took off on a mission, it was totally out of the ground crew's control. It was the Launch Control Officer (LCO's) job to get the D-21B to its drop point accurately and exactly on time. The LCOs were able to perform IFCO checks while airborne and also had some manual control of the D-21B if needed.

Any velocity or position errors would grow over time during the long flight and these had to be corrected prior to launch. For example, en route to an operational launch point in the northern part of the Sea of Japan or the South China Sea, a complex set of procedures had to be followed to update the D-21's inertial system in order for it to go its full mission distance. The velocity input was pulled off the B-52H. The BUFF would go through a series of U-type maneuvers, making three orthogonal (right-angle) turns in order to update the velocity and position parameters. The stellar systems were crude by today's standards. The computer in the navigation system of the B-52H was comprised of magnetic drums programmed in their own assembly language. It was a 24-bit machine, limited in memory, and yet it had to store the entire sequence of tests for in-flight checkout because it was the only computer on board.

After the final IFCO checks had been performed by the LCO and if everything was in order, *and* if the operation had not been recalled (which happened occasionally), the LCO would initiate the launch sequence and drop the D-21B/booster. Once the D-21B/booster had been released from the pylon, very little control of it (other than some telemetry signals from the LCO on board the B-52H) was possible.

Instantaneously, as the D-21B/booster dropped, automatic sequencing within the D-21B would kick in. Approximately one to three seconds following the drop, the booster would ignite and the AFCS, INS, ADC and other systems inside the D-21B would follow their sequencing to start up the ramjet and propel the D-21B into proper trajectory. The AFCS had a very simple pitch program, putting the D-21B into a steep climb and leveling off at the end of the booster's 90 second burn. Following that, the booster would be jettisoned, the programmed operations from the on-board computer would commence, and the D-21B would be on its way. Now all that could be done (other than a few actions remaining under control of the LCO) was to wait and hope. The most vital command the LCO could order was a signal for immediate destruction of the D-21B, available in the event anything went wrong or if conditions demanded abandoning the bird for safety and/or security reasons.

The mission track was programmed into the INS, which provided steering commands to the roll channel of the AFCS. The ADC was pre-set to keep the D-21B flying at a fixed Mach number.

Once en route and on target, the payload/camera equipment would begin operating and continue until the computer shut it down. The D-21B would then be vectored into its final return leg. At an exact spot determined by the INS, the Marquardt engine would shut down and the vehicle would decelerate and enter a controlled descent to a lower altitude of about 60,000 feet. At a pre-determined point, explosive bolts would fire and the hatch would be ejected. The hatch-less vehicle would then tumble on its way until an explosive charge would destroy the entire

D-21B drone, leaving behind only a meaningless residue of ashes, debris, and whatever else remained from the blast.

After egress, the hatch would drop to an altitude of about 15,000 feet or so when the drogue and main chute (attached to the inside of the hatch) would engage, trailing the hatch via cable a few hundred feet below the chute. There were calculated markings on the cable that the “Cat’s Whiskers” on the JC-130B would hopefully engage. The hatch would then be taken into the aircraft and delivered to the closest location for recovery operations by ”A” Flight/4200th Support Squadron personnel.

If the JC-130B missed its target, the ship (at location number three) would then attempt recovery operations, performed by ”A” Flight/4200th Support Squadron personnel already on board. In the case of a successful recovery, the ship would return to port and the camera pallet would be sent to the photo analysis center at Beale AFB, California. Unfortunately, the Navy was never successful in recovering a hatch. It was always either recovered by the JC-130B or lost completely.