~~TOP SECRET~~ TAGBOARD

HANDLE VIA BYEMAN CONTROL SYSTEM

NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

THE NRO STAFF

23 January 1970

MEMORANDUM FOR THE DIRECTOR, NATIONAL RECONNAISSANCE OFFICE

SUBJECT: TAGBOARD

Attached is the memorandum you requested for Mr. Packard summarizing the TAGBOARD flight on 10 November 1969.

1 Attachment

FRANK W. HARTLEY, Jr.
Colonel, USAF
Director, Program D

HANDLE VIA BYEMAN CONTROL SYSTEM

~~TOP SECRET~~ TAGBOARD

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NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

OFFICE OF THE DIRECTOR

MEMORANDUM FOR THE DEPUTY SECRETARY OF DEFENSE

SUBJECT: TAGBOARD Flight - Nov 10, 1969

The technical investigation and analysis of the unsuccessful TAGBOARD mission over South China on Nov 10, 1969 has been completed. A brief summary of the flight and the technical analysis is presented below.

The B-52 carry out phase, drone launch and initial cruise were all successful. The drone obtained both the programmed altitude of 84,000 feet and a mach hold of 3.27. Telemetry received showed the drone was performing normally at 350 miles, 12 minutes, from the launch point. At 12 minutes and 14 seconds after launch time the telemetry was turned off to preclude signals from being transmitted over denied territory. During the terminal phase of the flight, the drone was not acquired visually or electronically and the hatch (payload) was not recovered. There was no reported SIGINT that could be correlated with any portion of the mission.

Earlier it was reported that preliminary analysis indicated TAGBOARD flew the programmed flight path, but a probable beacon failure as it approached the recovery area precluded recovery. As a result of a comprehensive investigation and analysis, it now appears that approximations in the drone's inertial navigation system (INS) computer program caused the drone to not fly the programmed route and, therefore, not complete the mission.

For the drone to successfully fly the prescribed route, the INS is programmed "to satisfy" a series of destination points. "To satisfy" means that the drone has reached a point along the route where a function such as change in heading, beacons on, etc. is programmed to be performed. These destination points must be satisfied in order, and if one point is not satisfied, the INS will not satisfy the following destination points.

The various destination points are satisfied based on the computation of the drone's "Distance to Go" (DTG). DTG is computed as the angle between the drone's present position and the next destination point in the route. A destination is satisfied either when the DTG is equal to or less than the look ahead angle (the satisfy criterion for programmed turns greater than 14 degrees), or when the DTG is less than 10 miles from the destination point (the satisfy criterion for programmed turns of 14 degrees or less). This second criterion, the ten mile distance value, is critical to the analysis of the TAGBOARD flight because at destination point 3 (363 miles from the launch point), the actual functions to be performed were for the drone's Command Receiver and telemetry to be turned off - no turn was scheduled.

The drone's INS computer uses sines and cosines to solve the "destination satisfy" equations. Errors in the computed sines and cosines are introduced as a function of latitude and longitude. In the specific case of the November 10 TAGBOARD mission route, the post flight analysis gives an actual computed error at destination point 3 of 11.6 miles, which means it is possible that the drone's computed DTG value never reached the 10 mile satisfy criterion. This is supported by the fact that telemetry placed the actual position of the drone 9 miles past destination point 3 with no print-out verification that the destination had been satisfied. The Command Receiver and telemetry were therefore turned off by the back-up command sent from the B-52 rather than by the INS program. By not satisfying destination point 3, the drone should have continued on basically a straight course until fuel exhaustion. It is also possible that the drone could have experienced structural or mechanical failure at any position along its course after destination point 3. In either case the drone would have destructed itself upon descent at the pre-set altitude of 52,000 feet.

Extensive flight data analysis, tests and simulations have been conducted by both Lockheed, the prime contractor and Minneapolis-Honeywell, the sub-contractor who builds the INS and writes the software program. The 10 mile destination satisfy limit had been adequate in all previous test flights to overcome computational errors and allow "destination satisfy." However, the recent tests and analysis have proven that the 10 mile limit is marginal for certain

latitudes and longitudes, including destination point 3 in the actual flight path. The worst case possible computed error (latitude, longitude position) in the Northern Hemisphere is 13.3 miles. It is important to note that the small computer in the drone's INS is limited in its memory available and in the accuracy of its sine and cosine computations. The larger SAC computer, which cut the mission tape, has greater memory available and is more accurate in the sine and cosine computations. Therefore, pre-mission analysis of the tape did not exhibit errors of sufficient magnitude to identify the destination satisfy problem.

Fortunately the fix for the computer program to assure destinations are satisfied is relatively simple and has been accomplished. Essentially the fix is a software change that increases the distance satisfy criterion from 10 to 17 miles. This 17 miles compensates for sine/cosine computation errors. It does not mean that the drone has an actual position error of 17 miles. Numerous laboratory simulations (worst case latitudes and longitudes) have been run with the new 17 mile limit set in the computer program, and in all cases the destinations have been satisfied. The destination satisfy capability of all future flights will be verified by a pre-mission run of SAC's tape through the actual airborne computer.

Additionally, two "fail safe" features will be incorporated in the drone's INS computer program. First, if an overshoot occurs at the destination and the DTG is increasing but less than 40 miles from the destination point, destination satisfy will occur. Second, if for any reason the drone veers off programmed flight path in a direction such that there is no component of velocity toward the destination point to be satisfied and the drone is greater than 40 miles from the destination point, fuel will be shut off and self destruct will occur upon descent to 52,000 feet.

The TAGBOARD Program Director has briefed me on the details of the flight and on the comprehensive flight investigation and analysis accomplished. He has expressed his confidence and the contractors' confidence in both the definition of the problem and in the fix.