

Our information on DarkStar is less complete than that for Global Hawk. This section presents available information regarding the DarkStar flight test program.

#### **INITIAL PLAN AND UNDERLYING PHILOSOPHY**

Although DarkStar's origins are very different from that of Global Hawk, and although the two HAE UAV programs were originally separate, the DarkStar ACTD flight test program was intended to be similar to that of Global Hawk. Initial plans called for two engineering prototype UAVs to be fabricated for flight test beginning in the fall of 1995. Accompanying the UAVs would be one SAR, one EO sensor, one launch control and recovery station (LCRS), and one interim processing and display system. The last two systems were to be replaced by a CGS in subsequent phases. Phase II was to be a 12-month, contractor-run flight test program.

The December 1997 ACTD management plan states that the objective of Phase II was to partially characterize the system and to improve confidence that the \$10 million UFP could be attained.<sup>1</sup> Taking radar cross section measurements was included as an objective during Phase II, reflecting DarkStar's LO design and mission profile.

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<sup>1</sup>For a complete discussion of the UFP, see Robert S. Leonard and Jeffrey A. Drezner, *Innovative Development: Global Hawk and DarkStar in the HAE UAV ACTD—Program Description and Comparative Analysis*, MR-1474-AF, Santa Monica: RAND, 2001.

The initial (1994) HAE UAV ACTD management plan showed a limited user demonstration for DarkStar lasting approximately 18 months after the Phase II engineering tests. At the time, DarkStar and Global Hawk were on different development schedules, with DarkStar somewhat further ahead in design.

Following the destruction of its first aircraft, DarkStar flight testing was put on hold for more than two years. That delay, combined with Global Hawk flight test program delays, put the systems on roughly consistent schedules for the D&E. The plan for Phase III D&E became a combined 24-month flight test phase using both HAE UAVs. Up to eight additional DarkStar air vehicles and sensor payloads were to be fabricated during Phase III in support of the D&E program, funding permitting.

### **FLIGHT TEST PROGRAM EXECUTION**

DarkStar taxi testing began in January 1996. The first flight of DarkStar air vehicle 1 took place on March 29, 1996, 21 months after the Phase II Agreement was signed. The air vehicle showed significant anomalies, particularly in its “wheelbarrowing” for about 100 yards just prior to liftoff. As discussed previously,<sup>2</sup> LMSW and JPO engineers knew that there were unexplained phenomena and therefore recommended that the second flight be delayed. LMSW and JPO program management backed this decision but were overruled by more senior LMSW and DARPA decisionmakers. DarkStar air vehicle 1 was destroyed just after takeoff on its second flight attempt. Although the primary cause of the crash was related to air vehicle design, several additional factors contributed:

- The accelerated development schedule contributed to insufficient aerodynamic simulation data and modeling, which are usually considered essential when a new aerodynamic configuration is involved.
- Technical risk was significantly underestimated, partially as a result of an overestimation of the value of work on prior LO UAVs.

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<sup>2</sup>See Drezner, Sommer, and Leonard, *Innovative Management in the DARPA High Altitude Endurance Unmanned Aerial Vehicle Program*, 1999, pp. 76–80.

- The effort was hampered by poor communication and an overall poor relationship between the equal partners in the program: LMSW and Boeing.
- LMSW management pursued an aggressive schedule in an attempt to demonstrate that the Skunk Works remained the world's premier advanced technology development aerospace organization.

The crash of air vehicle 1 resulted in a 26-month flight test hiatus for DarkStar and contributed to increasingly risk-averse behavior in all other segments of the HAE UAV program.

The flight test experience of air vehicle 2 (Figure 4.1) is reproduced here for convenience. The first flight of air vehicle 2, which marked the resumption of Phase II flight testing, occurred on June 29, 1998. Five additional sorties were flown prior to program cancellation in January 1999. While the DarkStar air vehicle 2 flight test program showed the same caution as the initial part of the Global Hawk flight test program, the tone of the after-action reports was somewhat different. DarkStar continued to have major unresolved flight anomalies up to the time of program cancellation. The after-action reports reflected some concern on the part of program engineers; the aerodynamic behavior of the air vehicle continued to show significant differences from what was expected. These differences were not sufficiently explained, although there are some indications that the problems were being brought under control through changes in control software and flight test operations and procedures.

In contrast to Global Hawk, the 31st TES did not participate in the DarkStar flight test program, in compliance with LMSW's wishes. The 31st TES did monitor DarkStar's progress. Just prior to cancellation, LMSW reversed its stance and asked the 31st TES for active support; however, the program was terminated before the 31st TES became involved.

DarkStar's minimal flight hours allowed only limited information to be collected on the flight characteristics of the air vehicle configuration. Although initial sortie rates were the same as those of the Global Hawk program, cumulative flight hours in the first five sorties were less than those of Global Hawk's first five flights. DarkStar completed five sorties in six and one-half months for six total flight

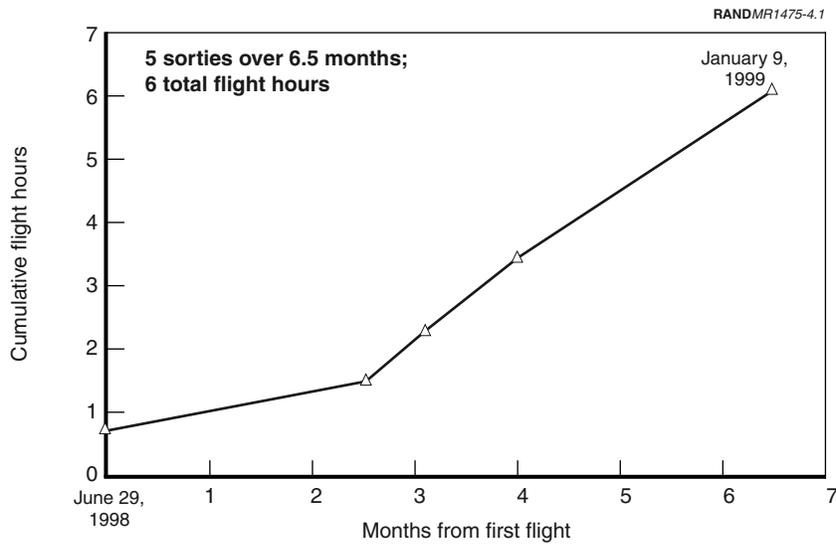


Figure 4.1—DarkStar Air Vehicle 2 Flight Test Program

hours; Global Hawk completed five sorties over seven months, accumulating 20.5 flight hours.

The key question regarding the DarkStar flight test program concerns what program officials learned from it. The program was terminated well before engineering tests had been completed and the flight characteristics of the air vehicle had been confidently understood. DarkStar did not participate in any D&E activities, and no imagery was taken to characterize sensor performance onboard the air vehicle.<sup>3</sup> While the termination decision was explained by future-year funding constraints, flight testing could have continued for the duration of the ACTD at very little cost to the Air Force.

Our reading of DarkStar test results suggests that air vehicle performance would have been considerably less than the stated goals; the aerodynamics of the configuration were clearly not well understood,

<sup>3</sup>DarkStar itself never carried the SAR or EO payload in flight.

implying that any early predictions of ultimate mission performance were highly uncertain. DarkStar payloads apparently performed well in tests but were never tested onboard the UAV.