EXECUTIVE SUMMARY
ACCIDENT INVESTIGATION
E-4B, S/N 73-1676
Langley AFB, Virginia
3 February 2004

On 3 February 2004, at approximately 0900 hours local time, the number four engine Exhaust Gas Temperature (EGT) gauge caution light illuminated on an E-4B, S/N 73-1676, flying an Operational National Airborne Operations Center (NAOC) alert mission, during climb out from Langley AFB, VA. The caution light was accompanied by indications of high EGT, excessive fuel flow and vibration. The crew successfully shut down the mishap engine (ME), declared an in-flight emergency, and landed uneventfully at Langley AFB, VA. A post flight inspection revealed metal fragments in the tail cone of the ME. Subsequent analysis of the ME showed that a turbine blade in the High Pressure Turbine (HPT) Stage 2 broke, causing extensive damage. Additionally, in the HPT Stage 1, one turbine blade was found to have burned due to chaffing caused by a broken shroud. There were no injuries to any of the crew members or passengers. There was no damage to military or civilian property, other than damage completely contained within the ME. The damage to the ME is estimated at $3,795,471.50

The cause of the mishap, supported by clear and convincing evidence, was a combination of two mechanical failures in the number four engine, an High Pressure Turbine Rotor (HPTR) Stage 2 turbine blade fracture and an High Pressure Turbine Stator (HPTS) Stage 1 shroud segment drop. However, there is not clear and convincing evidence as to which mechanical failure occurred first or whether or not one failure precipitated the other.

The mechanical failure that caused the most extensive damage to the ME was the fracture of a HPTR Stage 2 blade, S/N A4346, which broke off and damaged the subsequent turbine sections of the ME. The fracture was determined to be the result of an intergranular oxidation (IGO) crack, which began to form along the fourth cooling passage, internal to the blade, and extended to the external surface of the suction side of the blade. The other mechanical failure was a HPTS Stage 1 shroud that experienced what is known as "shroud drop." The shroud segment dropped into the path of the HPTR Stage 1 turbine blades causing excessive wear on the HPTR Stage 1 blades. One of the HPTR Stage 1 blades experienced more wear than the other HPTR Stage 1 blades. The wear on this particular blade caused its blade tip cap to wear off which subsequently lead to mid-chord burn out of the blade.

Two factors, supported by substantial evidence, substantially contributed to the mishap. First, the HPTR Stage 2 pre-PIP blade was in the portion of its cycle life where it is prone to IGO. Second, the HPTS Stage 1 shroud segment had been repaired three times, increasing the probability of shroud drop.

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report may not be considered as evidence in any civil or criminal proceeding arising from an aircraft accident, nor may such information be considered an admission of liability by the United States or by any person referred to in those conclusions or statements.