AIRCRAFT ACCIDENT INVESTIGATION

AUTHORITY: Pursuant to provisions of Air Force Instruction (AFI) 51-503, the Ninth Air Force Commander, Lieutenant General Carl E. Franklin, appointed Colonel John S. Childress to investigate and determine the facts and circumstances surrounding the destruction of Aircraft F-16D S/N 87-0372 which occurred within the confines of the Buckeye Military Operating Area (MOA), OH on 27 Nov 1996. Major Michael A. Fleming, HQ AFMC/JA, Wright-Patterson AFB, OH, was appointed as a legal advisor.

PURPOSE: An aircraft accident investigation is convened under AFI 51-503. The investigation is intended primarily to gather and preserve evidence for claims, litigation, disciplinary and administrative purposes. In addition to setting forth factual information concerning the accident, the investigating officer is also required to state his opinion concerning the cause or causes of the accident (if there is clear and convincing evidence to support that opinion), or to describe those factors, if any, that in the opinion of the investigating officer substantially contributed to the accident. The report is available for public dissemination under the Freedom of Information Act (5 USC 552) and AFI 37-131.

SUMMARY OF FACTS:

a. History of Flight: On 27 Nov 96 Captains Barry G. James, mishap pilot (MP) and Brian D. MacLeod, mishap instructor pilot (MIP), were scheduled to fly a single ship training mission in F-16D, S/N 87-0372. Both pilots are members of the Ohio Air National Guard's 162 Fighter Squadron, 178 Fighter Wing, Springfield ANGS, Ohio. The flight departed Springfield-Beckley Municipal Airport at 1008L, flew instrument approaches in the local area, and then proceeded at medium altitude to the Buckeye Military Operating Area (MOA) located approximately fifty miles south of Springfield. In the MOA the pilots performed aerobatics, advanced handling characteristics (AHC) maneuvers, and horn awareness recovery training series (HARTS) maneuvers. At 1051L, while performing a nose high HARTS maneuver the aircraft stalled and went out of control. During the out of control recovery the engine failed. After recovery from the departure, at approximately 4000 feel AGL, the pilots performed the critical action procedures (CAPS) for engine failure/airstart, including jettison of external stores. Airstart attempt was unsuccessful. The pilots ejected at 2000 feet above ground level (AGL). Aircraft attitude at ejection was wings level with a slight sink rate at 170 knots. The mishap aircraft (MA) impacted in a heavily wooded and sparsely populated area within the confines of the MOA, at N3901 W8315, and was destroyed. Pilots landed within close proximity to one other, received only minor injuries, regrouped and walked to a local farmhouse. From there they telephoned the squadron and informed the Operations Group Commander of the mishap.

b. Mission: MP had been in duties not involving flying (DNIF) since April 96 due to a compound fracture to his right leg. Mishap sortie was the second in a series of requalification sorties for the MP. He had flown one sortie the day prior with a similar

NUCLEAR REGULATORY COMMISSION

Docket No. _____ Official Exh No. 186

In the matter of PFS

Staff _____ IDENTIFIED ✓

Applicant _____ RECEIVED ✓

Intervenor _____ REJECTED _____

Contractor _____

Contractor _____ DATE 7/1/02

Other _____ Witness _____

Reporter _____ CH

profile (instruments, acro, AHC, HARTS maneuvers, traffic patterns and landings) in an F-16D with an IP in the rear cockpit. The 26 Nov sortie had been uneventful, and the MP had performed well. (Tab V-23 thru V-28)

c. Briefing and Preflight: MP and MIP reported for duty at approximately 0730L. Briefing was conducted on time and in accordance with all applicable directives. MIP conducted the briefing with MP covering some of the maneuvers to be performed. Both pilots knew their respective roles and were well prepared. Pilots stepped to the aircraft on time. Aircraft configuration was a category I loading and included external wing fuel tanks on stations 4&6, TERs on stations 3&7, and captive AIM 9L/Ms on stations 1&9. (Tab L) Preflight, start, taxi, and ground operations were unremarkable.

d. Flight: The flight, call sign "Saber 21", took off at 1008 local on an instrument flight rules (IFR) clearance to do instrument approaches in the local area and then proceed to the Buckeye MOA for airwork. Flight prior to MOA entry was uneventful. Maneuvers performed prior to the mishap included a G awareness maneuver, aerobatics, advanced handling characteristics maneuvers, and two HARTS maneuvers. Both pilots stated that up to the mishap maneuver the flight was progressing smoothly and as briefed (Tab V-40 thru V-41 and V-80 thru V-81)). MP was flying the maneuvers, performing well, and MIP was instructing and making verbal corrections as necessary. Maneuver leading to loss of control (LOC) was a HARTS 5 (Tab AA). MP started the maneuver at approximately 16,500 feet mean sea level (MSL) and 300 knots. Recovery was initiated when the warning horn sounded at 70-80 degrees of pitch, 20 degrees angle of right bank, and approximately 180 KIAS. During the recovery the airspeed dropped to zero, the nose yawed left and the angle of attack pegged at -6 degrees. Recognizing that the aircraft had departed controlled flight the MIP directed the MP to start the critical actions procedures for out of control recovery. Fourth step in the out of control recovery is "MPO (Manual Pitch Override) Switch-Override and Hold." (Tab BB) Due to the severe oscillatory nature of the departure, the sustained negative G forces on both pilots, and the location of the MPO switch, neither pilot was able to "override and hold" the switch in the "override" position for the first 25 seconds of the departure(Tab V-48, V-82, Tab O-49). MP did eventually engage the MPO switch, however flight data recorder tape indicates that the switch was disengaged and reengaged eight times during the recovery (Tab O-9). Passing through approximately 14,000 feet the engine seized. Aircraft recovery (the stall was broken) was initiated at approximately 10,000 feet, with recovery from the ensuing dive being wings level at approximately 5500 feet. Immediate restart procedures were initiated by the MP, as directed by the MIP. Passing 2000 feet AGL, with the engine seized at zero rpm, the MIP called for ejection and initiated the ejection sequence. Both pilots ejected. The aircraft impacted within the confines of the MOA and was destroyed. Pilots landed with minor injuries, regrouped and walked to a local farmhouse to seek assistance.

e. Impact: All the MA wreckage impacted the ground in the confines of the Buckeye MOA near N3901 W8315 and was destroyed. Residual fires were minimal and self extinguished. Damage occurred to approximately 50 to 60 small and medium sized trees and brush. Wreckage was confined to an area approximately 220 yards by 50 yards in a

very heavily wooded and sparsely populated area. Owners of property have expressed no intention to file a claim against the U.S. Government. (Tab P-2)

f. Ejection Seat: Ejection was initiated from the rear cockpit. The ejection sequence deployed properly for the existing flight conditions. No abnormalities noted with either seat.

g. Personal and Survival Equipment: Aircraft and personal egress equipment had been properly inspection and serviced and were fully functional in accordance with all technical orders and command directives. Both pilots were current in ejection seat, hanging harness, and survival training. MIP (rear cockpit) had a momentary twisted riser that self corrected with no input from him. He jettisoned his survival kit, prepared for tree penetration and landed on the ground with minimal tree contact. MP (front cockpit) also jettisoned his survival kit and prepared for a tree landing. He got hung up in trees approximately 25 feet above ground level and used his tree lowering device to get to the ground. Neither pilot performed the four line jettison due to close proximity to the trees upon initial parachute canopy opening. Both walked to a local residence. Neither used personal hand held radio. Systems used worked as advertised.

h. Rescue: Due to the severity of the departure and subsequent urgency to attempt engine restart both pilots full attention was devoted to handling the emergency situation, and neither made a "Mayday" radio call prior to ejection. Therefore, there was no immediate rescue operation. Local Sheriff insured that both pilots were taken as soon as possible by ambulance to the Pike Community Hospital. From there unit personnel transported them to the nearest military medical facility at Wright Patterson AFB, OH.

i. Crash Response: Once notified of the mishap the unit responded in accordance with local directives and command guidance. Response team was dispatched immediately to secure the area and government property (including classified), retrieve the pilots, and initiate all required actions to set up the interim safety investigation board.

j. Maintenance Documentation: A thorough review of the maintenance records for aircraft 87-0372 revealed no discrepancies which would have caused or contributed to the accident. A review of the AFTO Form 781 was accomplished. There were no open discrepancies which would have prevented the MA from flying (Tab H-1 thru H-14). All airframe and engine scheduled inspections were current. This was the first flight for the aircraft with engine 509551 installed. The installation and all inspections and servicing were accomplished with no abnormal trends noted (H-14 and Tab V). Review of the Jet Engine Intermediate Maintenance (JEIM) and Test Cell records indicated a detailed history and accurate documentation of the maintenance performed. Joint Oil Analysis records indicated no abnormal trends. A complete review of the MA's previous 90 day maintenance revealed normal procedures and no trends. The 781H indicated that the preflight and exceptional release were completed on 27 Nov 96 and the airframe time was 2080.1 hours. The aircraft was last serviced with JP8 (fuel truck 4). Oil was serviced with three half pints from oil cart #3, and the liquid oxygen (LOX) was serviced to five

liters from LOX cart #1. The hydraulic system was last serviced from hydraulic servicing cart SC 4 on 31 Oct 96. The 781J indicated that engine 509551 was installed on 22 Nov 96 at 1974.9 engine flight hours. The airframe time was 2080.1 and the JFS had a total of 214 starts.

k. Maintenance Personnel and Supervision: Aircraft 87-0372 was properly serviced, inspected and prepared for flight by qualified maintenance personnel. Training records were reviewed and all personnel involved in the preflight and launch of the aircraft were qualified. There was no evidence of maintenance malpractice associated with the mishap.

l. Engine, Fuel, Oil, and Hydraulic Inspections Analysis: There is no evidence to associate the fuel or hydraulic systems to the mishap. According to documentation the MA was properly serviced, inspected, and prepared for flight by qualified personnel (H2-H7). General condition to the failed engine is documented in Tab J (J2-J8). Engine failed and seized due to failure of the number three bearing (J6-J8). Propulsion engineers conducted a test to better understand the oil supply system capability to supply oil to the number three bearing during dynamic negative G conditions. It was concluded that "During dynamic movement of the tank we observed significantly reduced flow rates along with a weak and sporadic jet stream. This would suggest the possibility that the auxiliary oil supply system could become ineffective during some inverted dynamic flight conditions." (J9-J11)

m. Airframe and Aircraft Systems: All aircraft and airframe systems were operating normally and as designed throughout the flight, including the mishap. During the engine failure and subsequent loss of the main and standby generators the emergency power unit (EPU) automatically activated as advertised. All associated warning lights and aural warning systems activated as advertised. Up to and throughout the mishap sequence the flight control system (FLCS) operated as advertised. No evidence of airframe or aircraft systems failures or abnormal operations were noted.

n. Operations Personnel and Supervision: All required supervisor briefings and actions were accomplished in accordance with local a command guidance and directives. MIP conducted the pre mission briefing in accordance with MCI 11-116 and applicable unit directives. Mission was accomplished under the authority of the 178FW and the 162FS.

o. Pilot Qualifications: Captain James was current and qualified to perform the scheduled mission (Tabs G and T). Flying experience is as follows:

Student Time (T37,T-38)	194.1 hours
AT-38	25.3 hours
A-7	447.2 hours
F-16	340.9 hours
Total	1007.5 hours

Hours/Sorties 30 days/60 days/90 days:	30 days	60 days	90 days

	1.4/1	1.4/1	1.4/1

Captain MacLeod was current and qualified to perform the scheduled mission (Tabs G and T). Flying experience is as follows:

Student Time (T37,T38)	179.1 hours
AT-38	29.9 hours
A-7	1075.5 hours
F-16	401.9 hours
Total	1685.4 hours

Instructor/Evaluator Time 425.2 hours

Hours/Sorties 30 days/60 days/90 days:	30 days	60 days	90 days
	4.0/3	7.5/6	23.4/14

p. Medical: Both MP and MIP were medically qualified to fly (Tab EE). Toxicology specimens contained no alcohol, elevated carbon monoxide levels, or illegal substances (Tab CC).

q. Navaids and Facilities: All applicable NAVAIDs were in operation. Runways and taxi ways had been swept to clear FOD. All parking areas and end of runway (EOR) areas had been swept and walked by maintenance personnel to clear of all FOD. (Tab V)

r. Weather: Weather at Springfield-Beckley MAP was broken cloud at 2000 feet, overcast at 3500 feet and clear above. Visibility was seven miles. Winds were 340 degrees at 10 knots. Altimeter was 30.54. inches. Temperature was 26 degrees F. Weather in the Buckeye MOA and surrounding area within approximately 100 miles was similar. Weather conditions were not a factor to the accident. (Tab K and Tab W)

s. Directives and Publications:

MCI 11-F16, F-16 Pilot Operational Procedures
MDS Specific Changes for ANG to MCI 11-F16
T.O. 1F-16C-1, Flight Manual
T.O. 1F-16C-1CL-1, Flight Manual Checklist
T.O. 2J-F110-6-5, Major Assembly Removal and Installation
T.O. 2J-F110-4, Turbofan Engine

Directives and publications were not a factor to the accident.

JOHN S. CHILDRESS, Colonel, USAF
AFI 51-503 Aircraft Accident Investigating Officer

58455

OPINION AS TO THE CAUSE OF THE ACCIDENT: Under 10 USC 2254(d), any opinion of the accident investigator as to the cause or causes 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 proceedings 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. Based on the evidence, which I find to be clear and convincing, there is one main cause and two contributory causes to the accident. The main cause is the inability of either pilot to engage and hold the MPO switch in the "override" position. Contributory causes are loss of aircraft control, and the failure/seizure of the engine due to oil starvation to the number three bearing.

It is clear that if the aircraft had not departed controlled flight, the mishap would not have occurred. Therefore, aircraft departure from controlled flight is the initial event (i.e. contributory cause) in the mishap series of events. The HARTS 5 maneuver recommended entry airspeed is 250-275 KIAS for the MA's configuration (Tab AA). MP initiated the maneuver at approximately 300 KIAS. The higher entry airspeed is significant because it puts the aircraft in an area where departure susceptibility increases significantly (Tab AA). MP initiated HARTS recovery procedure at warning horn activation, as directed by MIP. Warning horn activation occurred at 81 degrees of pitch, 184 knots, and 17,700 feet. Ten seconds later, the aircraft was at zero airspeed. Fourteen seconds after horn activation, the aircraft yawed left and entered a negative G departure at 19,600 feet. Both MP and MIP state that the MP's HARTS recovery procedure inputs were essentially correct and in accordance with published procedures. Ensuing "Out of Control" recovery procedure was also essentially correct. However, because of the negative G forces induced on both pilots, and the location of the MPO switch, neither pilot was able to initially perform step four of the recovery procedure: "MPO Switch - Override and Hold" (Tab BB). A full fifteen seconds, and the loss of approximately 5000 feet of altitute, elapsed between out of control recovery procedure initiation and activation of the MPO switch. When the MPO switch was finally engaged, recorded data shows that it was disengaged and reengaged eight times during the recovery, which required six pitch rocking cycles. Time from initial MPO engagement until final engagement (the one that held and effected recovery/broke the stall) was thirty-eight seconds, with an altitude loss of 10,000 feet. F-16 flight tests conclude that an aircraft configured similar to the MA should have recovered from the out of control departure (assuming a single MPO switch activation is successful) with an altitude loss of approximately 5000 feet, and require a maximum of two pitch rocking cycles, with time required to effect recovery of approximately fifteen to twenty seconds.

During the recovery from out of control, the aircraft engine seized due to oil starvation to the number three bearing. Testing by propulsion engineers to determine what would cause oil flow disruption from the oil tank to the number three bearing showed that: "During dynamic movement of the tank we observed significantly reduced flow rates along with a

weak and sporadic jet stream. This would suggests that the auxillary oil supply system could become ineffective during some inverted dynamic flight conditions." The aircraft was under inverted dynamic flight conditions for well over sixty seconds. Once the engine seized, restart was impossible, forcing the pilots to eject.

In conclusion, once the aircraft departed controlled flight, if the pilots had been able to successfully engage and hold the MPO switch, the first time, recovery would have been nearly immediate. Because of the pilots inability to effectively engage and hold the MPO switch in the "override" position, the recovery was excessively delayed, causing oil starvation and engine seizure, leading ultimately to aircraft abandonement.

JOHN S. CHILDRESS, Colonel, USAF
AFI 51-503 Aircraft Accident Investigating Officer

58457