

AIRCRAFT ACCIDENT INVESTIGATION

AUTHORITY: Under the provisions of Air Force Regulation (AFR) 110-14, the Ninth Air Force Commander appointed Lieutenant Colonel Alden A. Williams to conduct an Aircraft Accident Investigation of the F-16CG (SN 88-0523) accident which occurred at Deer Island in Lake Sinclair, Georgia on 23 February 1993. The investigation was conducted from 12 April 1993 to 22 April 1993. Technical Advisors were Captain Randy J. Psyk (Operations), SMSgt Hugh N. Orr (Maintenance), Captain Gregg A. Schochenmaier (Legal), Major David B. Roberts (Flight Surgeon), and Sergeant Brian L. Burwell (Administrative Support). (Y-1 thru Y-6).

PURPOSE: An aircraft investigation is convened under AFR 110-14. The investigation is intended primarily to gather and preserve evidence for claims, litigation, disciplinary, and administrative needs. 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 U.S.C. 552) and AFR 4-33.

SUMMARY OF FACTS

- History of Flight:** On 23 Feb 93, 1Lt Ted D. Satcher was scheduled as number 2 of a two-ship (K-1) night LANTIRN Category II checkride. Lt Col Robert W. Penar led the mission filed under callsign Wolf 01. The flight departed Moody AFB, GA at 1836 EST and proceeded to VR 95 point Alpha. Shortly after entering the low level the mishap pilot (MP) experienced a loss of thrust and initiated the airstart sequence (V-1-5). When it became apparent the aircraft would not restart, Lt Satcher ejected safely (V-1-6). The aircraft crashed and was destroyed. The crash site was located approximately 5NM north of Milledgeville, GA on a small uninhabited island in Lake Sinclair, coordinates 33 degrees nine minutes north latitude, 83 degrees 13 minutes west longitude (R-1). The Moody AFB Public Affairs office handled news inquiries.
- Mission:** The mission was scheduled and planned as a two-ship night LANTIRN Category II low level checkride. The planned profile included single-ship afterburner (AB) takeoffs, rejoin to 2 NM FLIR assisted trail, high level cruise to VR 95 start route point, letdown, low level navigation 8NM trail to a bunt attack, return to Moody via individual ILS approaches to full stop landings (V-1-3).
- Briefing & Preflight:** All members of the flight reported for duty at approximately 1030. Both reported being well rested. The flight briefing began at 1640 and both pilots reported that the briefing was comprehensive and that they had a clear understanding of the planned events and their responsibilities (V-1-4, V-2-1). During ground operations when checking the AFTO 781, Lt Satcher noticed the aircraft had a Pacer engine installed and

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also that a fuel leak was written up and corrected on the previous mission (U). Engine start was accomplished without any abnormalities. After engine start the crew chief notified Lt Satcher that only 5 boost pump lights were illuminated. After the EPU check the crew chief reported that all six boost pump lights were on. Just prior to taxi the crew chief discovered a fuel leak and had it checked to see if it would preclude the aircraft from flying. Moments later he notified Lt Satcher the leak was within limits and the aircraft was safe to fly. The remainder of the ground operations were performed without any unusual occurrences or deviations (V-1-4).

4. Flight: Wolf 01 flight took off at 1836 EST (V-1-4). The takeoffs were single-ship using afterburner with 20 seconds spacing between aircraft. Engine response during the takeoff and enroute portions of the flight was reported to be normal by the MP (V-1-5). The MP rejoined to a two nautical mile (NM) FLIR assisted radar trail for the departure leg cruise at FL240 to the VR 95 low level. Lt Satcher entered the low level 6-8 NM in trail of Wolf 01 as briefed and accomplished his IANT checks on leg 1 to verify his systems operability (V-1-5). All systems were working and the flight continued the low level. As Lt Satcher was approaching steerpoint 5, an ENG AB FAIL PFL appeared on the PFL display. The display confused the pilot because he did not have the AB selected at the time. Approximately 10 - 15 seconds after the PFL appeared, Lt Satcher noticed a significant loss of thrust (V-1-5). The MP checked the engine instruments and verified the RPM and FTIT were both decreasing. The pilot began to zoom the aircraft and execute the critical action procedure for low altitude engine failure/airstart (O-38). The MP placed the throttle to off and back to midrange, jettisoned external stores, put the engine control switch to SEC and started the JFS (V-1-5). The pilot estimated his apex at about 6500 feet and started a glide between 220-250 KIAS. The EPU was running and the appropriate lights were back on as the MP began his descent. He radioed Wolf 01 and stated "Wolf 01, Wolf 2's got an engine failure" (N-1). The flight lead called "knock it off" and queried Wolf 2 as to his progress in performing the CAPS. The MP continued to monitor the engine instruments for any indication of a start. Passing approximately 3400 feet the pilot reiterated to the flight lead that his motor had not restarted. Wolf 01 replied "Okay, throttle off then midrange, try it again, engine control switch (garbled)" (N-1). The MP confirmed the engine control switch was in SEC and cut the throttle off and back to midrange. The engine instruments did not indicate a start (V-1-6). Passing through 2500 feet MSL the MP prepared himself for ejection. At 1800 feet the pilot initiated the ejection sequence (V-1-6).

5. Impact: The aircraft crashed on a small uninhabited island in Lake Sinclair (R-1). After the initial impact much of the debris was scattered over the island and also just offshore in the water (S-1). The aircraft was damaged beyond economical repair. The impact heading was approximately 195 degrees, and wreckage was scattered along a 200-foot x 480-foot area.

6. Ejection Seat: The ejection seat functioned normally.

7. Personal and Survival Equipment: All inspections of the mishap pilot's personal and survival equipment were current (U 13-14). The seat kit deployed normally (V-1-6). Four-line jettison was not performed. The locator beacon functioned normally but transmissions were weak due to a low battery (V-1-7). The pilot used the survival radio in his vest to attempt contact on 243.0 but received no response. The MP changed the battery and contacted Wolf 01 on 243.0 (V-1-7). Rescue parties arrived by boat and helicopter shortly thereafter. Several night flares were also expended.

8. Crash Response: Wolf 01 notified Atlanta ARTCC that an aircraft was down. Almost immediately a CH-53 PAVE LO helicopter offered its assistance. Two Baldwin County Deputies arrived on scene by boat at 1945 EST. They were accompanied by three emergency medical team members and several volunteer firefighters. A search for survivors was undertaken (A-1). A KC-135 arrived on scene to offer assistance to any airborne assets. Viper 01, an F-16 in Moody 1N MOA, acted as a communications link between Wolf 01 and the Moody command post. The local authorities located Lt Satcher as did the helicopter. The MP was transported by boat to the Baldwin County airport, then by ambulance to the waiting helicopter. Lt Satcher was then flown to Robins AFB and transported by ambulance to the base hospital (V-1-9). Testimony from the flight lead, LTC Penar, applauded the response of Atlanta ARTCC and also the efforts of the helicopter crew, tanker crew, and local citizens.

9. Maintenance Documentation: A thorough review of the AFIO Forms 781 was accomplished and there were no open discrepancies which would have prevented the aircraft from flying (U). The aircraft had a Red-X fuel leak around the main fuel shutoff valve area prior to the first sortie of the day. This was corrected by reseating the fuel flow transmitter clamp (U-5). A review of the maintenance records from the 90-day period preceeding the mishap (AFIO Forms 781) revealed eight other Red-X discrepancies relating to the fuel and engine system (H-1). There were no overdue Time Compliance Technical Orders, Time Changes, or inspections. One engine TCIO and four aircraft TCIO's were awaiting completion, but were not overdue (H-2). A thorough review of engine historical records was accomplished with the following results:

a. On 18 December 1989, the mishap engine was removed to comply with Time Compliance Technical Order (TCIO) 2J-F110-584, inspection of fuel manifold sectors (O-41). As a result of the TCIO, all three fuel manifold sectors were replaced. One of the final steps of the fuel manifold installation procedures is to safety wire the fuel manifold coupling nuts ("B-nuts").

b. No other maintenance actions on the fuel manifolds or nozzles were documented in the engine historical records between the time of the December 1989 fuel manifold change and the time of the mishap. However, it is possible that during any of three subsequent shop visits, when the fuel manifolds were exposed, any number of fuel manifold safety wires may have been replaced without the actions being documented.

c. The engine investigation report and the materials engineering report conclude that rubbing of safety wire on the fuel tube caused the fuel tube

failure (J-6, J-9). Testimony from Mr. Mike Hoban, a flight safety and accident investigations engineer from General Electric (the engine manufacturer), confirmed that if a fuel manifold were to break, the engine would flame out leaving the pilot unable to restart the engine (V-4-2).

d. Chafing of the fuel manifold was caused by the tip of the safety wire (pigtail). After being cut, the tip was bent toward the fuel tube and was actually touching it (J-5).

e. Two Technical Orders (T.O.'s) which address general safety wiring practices are T.O. 2J-1-32 and T.O. 2J-F110-6-1 (Standard Maintenance Practices Manual, General Electric Aircraft Engines). Both T.O.'s direct the technician to "bend pigtail in toward part to prevent it from becoming a snag" (O-42, O-43). The last five words of paragraph h in O-42, "or chafing against adjacent hardware", were added by a T.O. change in November 1992. Prior to this T.O. change, the paragraph did not specifically mention the possibility that a bent pigtail could cause a chafing problem against adjacent hardware.

10. Maintenance Personnel and Supervision: According to maintenance documentation, aircraft SN 88-0523 was properly serviced, inspected, and prepared for flight by qualified personnel (U). There is no evidence of maintenance malpractice associated with this crash. Training records were reviewed and all maintenance personnel involved with preflight and launch were qualified.

11. Engine Fuel, Oil, and Hydraulic Inspection Analysis: Engine oil samples from aircraft SN 88-0523 prior to the mishap were all normal with regard to wear metal readings (O-22). Engine oil sampled from the MA after the mishap revealed significantly increased wear metal readings (O-21). This was a result of the impact. The hydraulic fluid sample taken from the MA after the mishap was not large enough to test for particle count, although the water test was normal (O-32). No fuel sample was taken from the mishap aircraft after the accident. However, fuel samples were taken from the facility's fuel storage system. These were normal (O-33 through O-37).

12. Airframe and Aircraft Systems:

a. Flight controls and related systems: There is no evidence to indicate that flight controls were a contributing factor to this accident. The pilot didn't mention any problem with the flight controls or any related systems in his testimony (V-1-4,5).

b. Avionics, hydraulic, instrument, and electrical systems functioned normally.

c. Engine: The engine was examined by an accident investigation engineer from Oklahoma City Air Logistics Center (OC-ALC). His report is at Tab J-1 through J-6. His investigation found:

(1) The engine fuel delivery system was in good condition.

(2) The fuel crossover tube from the fuel boost pump to the main fuel pump was fractured as a result of impact.

(3) A brown stain was present on the lower-outer fan duct at the 6:30 position. A similar stain was found at the same location on the combustor diffuser nozzle (CDN) case. Both stains corresponded to the position of the #11 fuel nozzle -- where a broken main fuel manifold pigtail was found. The main fuel manifold was sent to the Physical Sciences Branch at OC-ALC for analysis. They concluded that the tube failure was a result of the safety wire rubbing against the fuel tube, wearing nearly through the tube wall (J-9). Fatigue had initiated in the worn area and progressed until the tube separated.

13. Operations Personnel and Supervision: The mission was accomplished under authority of 347 FW and 69 FS (K-1). All supervisor briefings and actions were accomplished.

14. Pilot Qualifications: Lt Satcher was current and fully qualified to perform the scheduled mission (G-1 through G-5). He had flown a similar mission on the previous night (V-3-3). His flying experience is as follows:

F-16 C/D	401.7
AT 38 B	32.1
<u>STUDENT TIME</u>	<u>191.3</u>
TOTAL TIME	625.1

HOURS/SORTIES

Last 30 days	24.1/15
Last 60 days	38.3/24
Last 90 days	55.2/34

15. Medical: 1Lt Satcher was medically qualified to fly (X-1,5-9). He suffered no injuries related to the ejection (X-2). Toxicology specimens contained no alcohol, elevated carbon monoxide levels, or illegal substances (X-4).

16. NAVAIDS and Facilities: All applicable NAVAIDS were in operation. There were no NOTAMS applicable to this accident (W).

17. Weather: The WX was clear with seven-plus miles visibility, winds 280 at eight knots, and altimeter 3012 (W).

18. Directives and Publications:

TACR 55-116, F-16 Pilot Operational Procedures
TACR 55-116, MAFB Sup 1 Local Operating Procedures
T.O. 1F-16CG-1, Flight Manual
T.O. 1F-16CG-1CL-1, Flight Manual Checklist

There are no indications of deviation from directives.

19. Opinion as to the Cause of the Accident: Under 10 U.S.C. 2254(D), any opinion of the accident investigator 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 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 upon evidence which I found to be clear and convincing, it is my opinion as investigating officer that the cause of the accident was engine fuel manifold tube failure due to the rubbing of a safety wire against an engine fuel tube causing the engine fuel tube to break. When the tube broke, the engine failed due to the lack of fuel going into the combustor.

Alden A. Williams

ALDEN A. WILLIAMS, Lt Col, USAF
AFR 110-14, Aircraft Accident Investigating Officer

GLOSSARY

Note: Acronyms, jargon, and terms are explained in the context in which they appear in this report. The application of these definitions is not universal and may be limited to this report.

AB	- Afterburner
AB PFL	- Afterburner Pilot Fault List
AF	- Air Force
AFB	- Air Force Base
AFISC	- Air Force Inspection Safety Center
AGM	- Air-To-Ground Missile
AFR	- Air Force Regulation
AFTO	- Air Force Technical Order
AGL	- Above Ground Level
ALC	- Air Logistics Center
AMU	- Aircraft Maintenance Unit
Arming Area	- Waiting area next to runway, where aircraft are armed and checked.
ARTCC	- Air Regional Traffic Control Center
BDU	- Bomb Dummy Unit
CAM	- Consolidated Aircraft Maintenance
CAP	- Critical Action Procedure
Code One	- A "Code One" flight is a flight without aircraft malfunctions.
DELTA	- Change
DME	- Distance Measuring Equipment: By measuring the round trip times of signals to known ground stations, this device furnishes distance information with a high degree of accuracy.
DO	- Deputy Commander for Operations
EGT	- Exhaust Gas Temperature

EOD - Explosive Ordnance Disposal

EOR - End of Runway; also applies to the "last chance" maintenance inspection performed immediately prior to takeoff.

EMER - Emergency

ENG - Engine

EPE - Emergency Procedures Evaluation

EPU - Emergency Power Unit

ER - Exceptional Release: A signature in the aircraft records which authorizes an aircraft to be flown.

EST - Eastern Standard Time

FL - Flight Level

FLIR - Forward Looking Infrared

FP/IP - First Pilot/Instructor Pilot: Terms used in logging flying time.

FTIT - Fan Turbine Inlet Temperature

GPS - Global Positioning System

GUARD - Standard emergency distress frequency: Monitored by all military aircraft as a source of emergency communications.

HPO - Hourly Postflight

HUD - Heads Up Display: A device which provides the pilot with flight information presented in symbolic form on a combining glass within the pilot's forward field of view. Although optimized for weapons delivery, most displays are capable of providing some references for instrument flight.

KIAS - Knots indicated airspeed

IFF - Identification Friend or Foe: A transmitter which sends information to ground radars to identify aircraft and provides some flight information to ground controllers.

IMC - Instrument Meteorological Conditions (generally, in clouds, fog or precipitation)

ILS	- Instrument Landing System
INS	- Inertial Navigation System: A primary source of groundspeed, attitude, heading, and navigation information.
JFS	- Jet Fuel Starter
JOAP (SOAP)	- Joint (Spectrometric) Oil Analysis Program
L	- Local Time
LANTIRN	- Low Altitude Navigational Terrain following and Targeting Infrared for Night
LOX	- Liquid Oxygen
LPU	- Life Perserver Unit
MA	- Mishap Aircraft
MFD	- Multifunction Display
MFL	- Maintenance Fault List
MILITARY POWER	- Maximum engine power setting without afterburner
MOA	- Military Operating Are
MP	- Mission Pilot
MQT	- Mission Qualification Training: Ground and flight training given to pilots to qualify them to perform the unit's mission.
MR	- Mission Ready: A fully qualified aircrew in the unit mission.
MSL	- Mean Sea Level: Used in conjunction with an altimeter, refers to altitude above sea level.
MSS	- Mission Support System
NAVAID	- Navigation Aid
NDI	- Non Destructive Inspection
NM	- Nautical Mile

NOTAMS

- Notice(s) to Airmen: A notice containing information on the establishment, condition, or change in an aeronautical facility, service, or procedure that may be a hazard to flight.

OAP

- Offset Aim Point

OWL

- Obstacle Warning Limit

PCA

- Positive Control Airspace

PDL

- Pilot Display List

PFL

- Pilot Fault List

Phase Inspection

- Scheduled inspection done after a specific number of aircraft/engine operating hours.

Pilot Aid

- Small book carried by pilots in flight containing operational information and local procedures.

PJ

- Parachute Jumper

PLF

- Parachute Landing Fall

QAFA

- Quality Air Force Assessment

Radar Lock

- Causing your radar to automatically track a target.

Radar Trail Departure

- Spacing maintained by use of radar during departure. Usually 20 seconds.

RDR

- Radar

Red Ball

- Quick response maintenance assistance.

Red-X

- Aircraft Grounding Condition

RPM

- Revolutions per minute

SA

- Situational Awareness

SEC

- Secondary Engine Control

SAR

- Search and Rescue

SAT - Surface attack: Also a mission designed to practice weapons delivery against ground targets.

SMS - Stores Management System

SN - Serial Number

SOF - Supervisor of Flying: An officer responsible for monitoring and supervising flying operations at a base. Works directly for DO when filling SOF position. SOF is an extension of the DO responsibility for overall operations.

Step Time - The time that the pilots go to their aircraft to fly.

SUU - Suspension Utility Unit

SWIM - System Wide Integrity Monitor

TACAN - Tactical Air Navigation: A system that gives direction (azimuth) and distance (DME) from ground stations.

TACR - Tactical Air Command Regulation

TAC SUP - Tactical Air Command Supplement

TCTO - Time Compliance Technical Order

T.O. - Technical Order - a manual or reference document.

TOS - Time Over Station

UHF - Ultra High Frequency

VFR - Visual Flight Rules

VHF - Very High Frequency

VICTOR - Term for VHF radio

VMC - Visual Meteorological Conditions

VTR - Video Tape Recorder

Z - Zulu (i.e., Greenwich Mean Time)