

AFI 51-503 ACCIDENT INVESTIGATION REPORT

AUTHORITY. In a letter dated 19 Feb 1997, General Billy Boles, Commander, Air Education and Training Command, appointed Lieutenant Colonel Kenneth A. Montague, 64 OG/CC, Reese AFB, Texas, to conduct an investigation pursuant to Air Force Instruction (AFI) 51-503 into the circumstances surrounding an aircraft accident involving F-16C, tail number 83-1134, assigned to the 61st Fighter Squadron, 56th Fighter Wing, Luke Air Force Base, Arizona. Lieutenant Colonel David A. Northup, Assistant Staff Judge Advocate, HQ AETC/JA, Randolph AFB, Texas was appointed to act as Legal Advisor. Major Kevin A. Booth, Command F-16 Flight Examiner, HQ 19 AF/DOK, Randolph AFB, Texas, was appointed as the Pilot Technical Advisor and Mr. Robert Trullender, Aircraft Maintenance Manager, 47 FTW/MA, Laughlin AFB, Texas, was appointed as maintenance advisor. (TAB Y).

PURPOSE: To preserve evidence for claims, litigation, disciplinary, and adverse actions, and to determine the facts surrounding the accident that occurred on 29 January 1997 near Gila Bend, AZ.

SUMMARY OF FACTS

1. HISTORY OF FLIGHT:

On 29 January 1997, an upgrading pilot (ORCA 2), his instructor pilot (ORCA 1A), and a Quality Air Force Assessment (QAFA) observer (ORCA 1B) were scheduled for a two ship Surface Attack Tactics (SAT) mission for the upgrading pilot. ORCA 1B was observing a typical student training sortie in conjunction with an ongoing QAFA. Their call sign was ORCA 1, and their mission was to takeoff from Luke Air Force Base, Arizona, and fly a low level route (VR-241) to the East Tactical (TAC) Range of the Goldwater Range complex, which is located approximately 50 miles southwest of Phoenix, Arizona. Ground operations, takeoff, and low level ingress to the target area were uneventful. While egressing the target area after the planned attack, ORCA 2 felt a thump and experienced heavy aircraft vibrations and subsequent engine failure. ORCA 2 initiated a climbing turn toward the nearest emergency airfield and attempted an unsuccessful airstart (TABS J, V-2). ORCA 2 then initiated a controlled ejection and landed safely via parachute. The aircraft crashed on government property at 1510:45 MST (TABS A, N-3, V-3) and there were no deaths or injuries (TAB X).

The 56 FW Public Affairs sent out a news release which resulted in video and print media inquiries from local news organizations (TAB AA).

ORCA 2, the mishap pilot was Captain Robert D. Churchill, Jr., Student Pilot, 61st Fighter Squadron, Luke AFB, Arizona. ORCA 1A, the instructor pilot and flight lead, was Lt Col Dave Pollock, Assistant Operations Officer, 61st Fighter Squadron, Luke AFB, Arizona. ORCA 1B, the QAFA observer, was Major Russell Walden, HQ ACC/IG, Langley AFB, Virginia.

PFS Exh. 188

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NUCLEAR REGULATORY COMMISSION

Docket No. _____ Official Exh No. 188
 In the Matter of PCS
 State _____ IDENTIFIED ✓
 Applicant ✓ RECEIVED ✓
 Rejected _____ REJECTED _____
 Date of Off'r _____ DATE 7/1/02
 Co. tractor _____ Witness _____
 Other _____ EW
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2. MISSION:

The mishap aircraft (MA) was number two in a two ship SAT training sortie. This sortie is designed to teach SAT skills and familiarize the student with Close Air Support (CAS) procedures. ORCA 1A, in the lead aircraft, was performing instructor duties for ORCA 2 in the mishap aircraft and was being evaluated by ORCA 1B as part of the QAFA (TABS K-2, V-2). This mission was a syllabus sortie for the mishap pilot.

3. BRIEFING AND PREFLIGHT:

Crew rest was not a factor. ORCA 2 had last flown in the morning, two days prior to the mishap. The day prior to the mishap, he was the Student Duty Officer (SDO) from 0730 to 1600, and had no official duties after 1600. The scheduled brief time of 1215 on 29 January was 20 hours and 15 minutes after the previously scheduled function, and exceeded the mandatory twelve hours required for crew rest. The flight briefing began on time and all appropriate items were briefed. Ground operations were uneventful. (TAB AA-8).

4. FLIGHT ACTIVITY:

ORCA 1 Flight took off from Luke AFB, Arizona five minutes after scheduled takeoff time at 1435 MST on a Visual Flight Rules (VFR) North flight plan to VR-241 and the East TAC Range of the Goldwater Range complex. Takeoff, departure, and flight enroute to the range were uneventful.

After performing the first attack and egressing the target area at an altitude of 4120 ft MSL and an airspeed of 564 knots indicated air speed (KIAS), ORCA 2 felt a thump, and initially assuming he had hit a bird or bomb fragment, made the radio call, "ORCA 2's had a bird strike, climbing and pointing towards Gila Bend." A few seconds later, ORCA 2 felt the MA vibrate violently and, realizing he had lost engine power, continued a zoom climb toward Gila Bend AFAF, Arizona approximately 12.5 miles to the northwest. He intended to land at Gila Bend by performing a straight-in flameout approach. ORCA 1A rejoined to a chase position, established contact with the Gila Bend control tower and informed them of the emergency. ORCA 2 attempted an unsuccessful airstart. ORCA 2 then determined that he did not have sufficient altitude to glide to Gila Bend so he pulled the nose of his aircraft up and ejected at approximately 840 feet above ground level (AGL) and at approximately 1510:45 MST. (TAB,V-2).

5. IMPACT:

The aircraft impacted the ground on government property approximately 2.5 miles southeast of Gila Bend AFAF, AZ (Coordinates 32 degrees 50.0 minutes north, 112 degrees 42.4 minutes west), on 29 Jan 97, 1510:45 MST, at 180 KIAS, in a right bank, with a shallow descent. No structures were nearby and there was no private property damaged. The aircraft was destroyed upon impact. (TABS J, M-1, P, R, S-2).

6. EGRESS SYSTEMS:

ORCA 2 initiated ejection at the following estimated parameters:

- between 800 - 840 feet AGL (1800 - 1840 feet MSL)
- 164 KIAS
- 11 degree nose up attitude
- 5 - 6 degree right bank

The ejection was initiated within the performance envelope of the egress system. No deficiencies with the egress system were identified. ORCA 2 encountered twisted parachute risers after ejection, but was able to clear them prior to his parachute landing fall. (TAB V-2).

7. PERSONAL AND SURVIVAL EQUIPMENT:

The radio beacon, survival radio, and a signal kit personal distress flare were used. All personal and survival equipment inspections were up to date. ORCA 2 did not have any problems using the equipment. (TAB V-2).

8. RESCUE:

The time of the crash was 1510:45 MST on 29 January 1997 (TAB A). The flight lead, ORCA 1A, monitored the ejection and aircraft impact. ORCA 1A transmitted ORCA 2's location to Gila Bend tower who then coordinated with SNOW 41, a flight of two A-10s, who visually located ORCA 2 on the ground and informed him of the location of an approaching military vehicle. The occupants of the military vehicle spotted ORCA 2, picked him up at 1518 (L) MST, and returned him to Gila Bend AFAF. ORCA 1A remained on station until ORCA 2 was picked up and then returned to Luke AFB. Emergency Medical Technicians (EMT) at Gila Bend AFAF treated ORCA 2 for shock and immobilized him until medical personnel arrived from Luke AFB. ORCA 2 was then transferred by car to Luke AFB where he was treated and released with no serious injuries (TABS S,X,V).

9. CRASH RESPONSE:

Contract security personnel (NAA Services) responded first to the scene and secured the crash site. Later that evening, they turned the site over to Luke AFB security police (TAB AA-5).

10. MAINTENANCE DOCUMENTATION:

Aircraft documentation reflected no defects or errors. There were no discrepancies in the AFTO 781 series forms that related to the mishap engine (TAB H-5). There were no overdue time change items or time compliance and technical orders (TCTO'S). Scheduled aircraft inspections were up to date. (TAB H-3).

All engine TCTO's were current. Two previous TCTO's, 2J-F100 (III)-566 and 2J-F100 (II)-564, Ultrasound Technique Inspection on 4th Stage Fan Drive Turbine (FDT) Blades, had no rejects but

did have "reportable conditions" to Pratt/Whitney on both inspections (TABS H-3,U). On 27 Jan 97, there was a 4th stage turbine blade borescope inspection performed that reflected "no defects noted." This inspection was performed approximately two flying hours prior to when the blade on the mishap aircraft failed. The last inspection performed was a "through flight" inspection on 29 Jan 97. The status of oil analysis reflected no adverse trends or spikes in any element related to the engine. (TAB D-2). The unscheduled maintenance performed on the aircraft was not related to the mishap. (TAB H-5).

11. MAINTENANCE PERSONNEL AND SUPERVISION:

A review of individual training records (AF form 623, STS 797) indicated that personnel were properly trained and qualified to perform assigned tasks. Personnel performing borescope inspections were trained and knowledgeable of the task being performed. No maintenance practice or procedure was a factor in the mishap (TABS U, V-5, V-6, V-7).

12. POST MISHAP AIRFRAME AND AIRCRAFT SYSTEM ANALYSIS:

A review of the crash survivable flight data recorder (CSFDR) and the flight lead's heads up display (HUD) tape substantiated the mishap pilot's account of the probable conditions of the airframe and aircraft systems during the engine failure, external stores jettison, restart attempt and ejection (TAB N, TAB O, TAB V). Further investigation of the right wing tank pylon indicated that no fire signal was received by the ORCA 2's impulse cartridges (TAB AA-11).

13. POST MISHAP FUEL, HYDRAULIC, OIL, AND ENGINE INSPECTION ANALYSIS:

Fluid samples for fuel, hydraulics and lox were not available. Post crash oil samples were higher in all areas. (TAB D-2).

ENGINE ANALYSIS: The fan drive turbine (FDT) was the only module that had received heavy damage prior to the crash impact. The heavy rub patterns on the FDT shaft and the airseals (both rotating and non-rotating) indicate that the FDT was operating with a significant imbalance for some period of time. The orientation of the rub marks indicates that the 'heavy' side of the disk was 180 degrees from the blade with the below-the-platform fatigue fracture, consistent with a primary failure of that blade. The sequence of events occurred as follows: (TABS J-8, J-9, J-10, and J-12).

- a. A fatigue crack in the attachment area of a fourth stage blade grew over time to the point at which the remaining material could no longer support the normal operating stresses to which the blade was subjected. The blade fractured due to over stress. (TAB J-10).
- b. The liberated blade platform/airfoil was thrown outward into the fourth stage blade outer air seals (BOAS), puncturing the BOAS and denting the turbine exhaust case. (TAB J-10).
- c. Neighboring blades rotated into the liberated blade, breaking off their tip shrouds and portions of their airfoils. (TAB J-10).

d. The loss of airfoils in the area of the fractured blades caused the rotor to have a 'heavy' side. This imbalance overcame the clamping ability of the W-support inner bolts, pulling them out of the bearing inner race support and allowing the rotor to 'wobble'. (TAB J-10).

e. Centrifugal loads pulled the rotor toward the heavy side, allowing the FDT to rotate non-concentrically with the engine cases. The FDT shaft corresponding to the heavy side of the fourth stage disk rubbed heavily against the inner surface of the HPT nut and the rear compressor drive shaft. Rotating knife-edge seals rubbed through their mating honeycomb and into the metal backing plates, flattening the seals on the heavy side of the rotor. The third and fourth stage blade tip shrouds rubbed heavily into the BOAS segments. The tip shrouds fractured from the increased loading. (TAB J-10).

f. Eventually, the damage progressed to the point at which the FDT could no longer extract sufficient energy from the hot gas stream to drive the fan. The engine then stalled and likely stagnated, with almost no chance of a successful restart. (TAB J-11).

g. The cause of the blade failure was a casting surface defect found on the root section of the blade on the fracture surface near the trailing edge that became a stress raiser site which led to a fatigue crack (TAB U-52).

ENGINE HISTORY:

a. 14 May 93- The low pressure turbine (LPT), L003447, was installed on engine PWOE703801. At the same time, the engine was upgraded to an F220E. (TAB U).

b. 27 Sep 93- Engine PWOE703801 was received from Hill AFB, Utah and installed in mishap aircraft 85-1439. (TAB U).

c. 21-25 Mar 96- LPT L003447 blades removed, both sides dye checked by nondestructive inspection (NDI); LPT L003447 removed, repaired, and re-installed. (TAB U).

d. 2 Apr 96- Engine PWOE703801 installed in mishap aircraft, 83-1134. (TAB U).

e. 7 Oct 96- LPT L003447 had ultrasound inspection by Pratt and Whitney and number four blade designated "reportable." (TAB U).

f. 25 Nov 96- LPT L00347 had ultrasound inspection by Pratt and Whitney and number four blade designated "reportable." (TAB U).

14. OPERATIONS PERSONNEL AND SUPERVISION:

The mission was properly authorized by the Assistant Operations Officer. (TAB K-2) The flight lead, ORCA 1, was a squadron supervisor and instructor for the mission IAW governing directives, and covered all aspects of the mission during the pre-mission briefing. Evidence shows that everyone in the operations and supervisory chain performed their duties in a thorough and

responsible manner on the day of the mishap. There is no evidence that any operational directives were violated in the course of the mishap flight. (TABS T,V-2, V-3,).

15. CREW QUALIFICATIONS:

The instructor pilot (ORCA 1A), Lt Col Pollock, was current and qualified to perform the mission he was assigned on 29 January 1997.

The student pilot (ORCA 2), Capt Churchill, was making satisfactory progress in his program. He had completed all prerequisites and was well prepared for the mission he was assigned on 29 January 1997. ORCA 2 had completed F-16 Transition Phase training, including a satisfactory Instrument/Qualification evaluation. He had also completed 29 of 30 sorties in the air-to-air phase of training and 17 of 20 sorties in the air-to-surface phase of training. One sortie in the air-to-air phase was graded unsatisfactory for student non-progression. ORCA 2 had flown previous to the mishap as follows:

LAST 30 DAYS	LAST 60 DAYS	LAST 90 DAYS
Sorties/Hours	Sorties/Hours	Sorties/Hours
12/17.5	23/33.0	31/42.8

(TABS G,T).

16. MEDICAL:

- a. ORCA 2 was medically qualified to perform flight duty at the time of the mishap (TAB T-3).
- b. Toxicology studies performed on ORCA 2 after the mishap were reviewed and found to be negative. He did sustain minor lacerations, bruises and abrasions as a result of the accident (TAB X-2).

17. NAVAIDS AND FACILITIES:

Navigation aids and airfield facilities were not a factor in this accident. There were no significant published notices to airmen (NOTAMS) for the date of the accident that affected the flight. (TAB W).

18. WEATHER:

The forecast weather for the Goldwater Range complex was scattered clouds at 22,000 feet and 25,000 feet with seven (7) miles visibility. The forecast weather for Luke AFB was scattered clouds at 5,000 feet, 14,000 feet, and 25,000 feet with seven (7) miles visibility and winds 350 degrees at 15 knots. Observed weather at Gila Bend was scattered clouds at 6,000 feet and 12,000 feet with winds at 010 degrees at 11 knots. (TABS K,W). Weather was not a factor. (TAB W).

19. GOVERNING DIRECTIVES AND PUBLICATIONS. The following publications were applicable to the mission:

OPERATIONS:

- 1) AFI 11-205: Aircraft Cockpit and Formation Flight Signals, 19 May 94
- 2) AFI 11-206: General Flight Rules, 01 Dec 96
AETC Sup 1, 12 Apr 96
HQ AETC MSG, 24 Apr 96
- 3) AFI 11-214: Aircrew and Weapons Director Procedures Air Operations, 25 Jul 94
AETC Sup 1, 13 Oct 95
- 4) AFI 11-215: Flight Manuals Program, 06 May 94
AETC Sup 1, 21 Aug 95
- 5) AFI 11-218: Aircraft Operation and Movement on the Ground, 26 May 94
AETC Sup 1, 17 Apr 95
- 6) AFI 11-401: Flight Management, 01 Mar 96
AETC Sup 1, 09 Nov 95
Luke Sup 1, (on order/under revision)
- 7) AFPAM 11-404: G-Awareness for Aircrews, 19 Aug 94
- 8) MCH 11-F16 Vol 5: F-16 Combat Aircraft Fundamentals, 10 May 96
- 9) MCI 11-F16 Vol 1: Pilot Training F-16, 01 Oct 94
- 10) MCI 11-F16 Vol 3, Chap 8: Pilot Training Procedures F-16 Luke Sup 1, 21 Apr 95
- 12) AETCI 11-405: Flying Training Supervision, 11 Aug 95
Luke Sup 1, 08 Jan 97
- 13) MCR 60-2, Vol 3, Chg 1: Aircrew Standardization/Evaluation Program, 30 Nov 92
Aircrew Flight Evaluation Criteria—Tactical
Fighter/Attack/Trainer/FAC
- 14) LAFBI 13-201: Airfield Operations, 19 Jul 96
Chg 1, 27 Dec 96
- 15) OPORD 56-94: Operations Order (Luke Almanac), 01 Oct 96
- 16) FALCON FACTS: F-16 Pilot Aid, Sep 96
Chg 1, Dec 96
- 17) F16COBOOPL: USAF Basic Training Course, Jan 96
Chg 1, May 96
FCIF 97-10
- 18) T.O. 1F-16C-1, 27 Feb 95
Chg 3, 20 May 96
- 19) T.O. 1F-16C-1CL-1, 27 Feb 95
Chg 3, 20 May 96
- 20) T.O. 1F-16C-1-1, 14 Nov 94
Chg 3, 11 Mar 96
- 21) T.O. 1F-16C-1-2, 1 Aug 96

- 22) T.O. 1F-16C-34-1-1, 07 Sep 94
Chg 2, 29 Mar 96
- 23) T.O. 1F-16C-34-1-1CL-1, 07 Sep 94
Chg 2, 29 Mar 96

MAINTENANCE:

- 1) 1F-16C-6: Scheduled Inspection and Maintenance Requirements, 22 Apr 91
- 2) 1F-16C-2-70FI-00-21: Fault Isolation/ Power Plant, (F100-PW-220/220E), 6 Jan 89
- 3) 1F-16C-6WC-1: Combined Preflight/Postflight, End-of-Runway, Thruflight, Launch and Recovery, Quick Turnaround, Basic Postflight, and Walkaround Before First Flight of Day Inspection Workcards (Blocks 25 and 32), 4 March 91
- 4) 1F-16C-2-12JG-00-1: Servicing Job Guide (Block 25 and 32 Aircraft), 1 Aug 84
- 5) TCTO 2J-f100(III)-561, Ultrasonic Inspection of 4th Stage Turbine Blades, F100-PW-220/220E Fan Drive Turbine Modules, F-16 Aircraft, 9 Sep 96
- 60 TCTO 2J-f100(III)-566, Ultrasonic Inspection of 4th Stage Turbine Blades, F100-PW-220/220E Fan Drive Turbine Modules, F-16 and F-15 Aircraft, 18 Nov 96

There were no known or suspected deviations from governing directives or publications by aircrew members or others involved in the mission.



5 March 1997

Kenneth A. Montague
KENNETH A. MONTAGUE, Lt Col, USAF
Accident Investigation Officer

STATEMENT OF OPINION

UNDER 10 U.S.C. 2254 (D), ANY OPINION OF THE ACCIDENT INVESTIGATORS 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 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.

1. In my opinion, this accident was caused by a material failure due to a manufacturing defect. It was determined by San Antonio Air Logistics Center analysts that the engine experienced a failure of the fan drive turbine (TAB J). The engine failed without possibility of restart. There is no evidence that any action by the individual operating the aircraft or any individual supervising the operation contributed to this mishap. The pilot's decision to eject was correct.
2. The cause of the failure of the Fan Drive Turbine was the liberation of a blade from the 4th stage of the turbine. The cause of the blade failure was a casting surface defect that was found on the root section of the blade, on the fracture surface, near the trailing edge that became a stress raiser site which led to a fatigue crack (TAB U-52).
3. In summary, it is my opinion that the accident was caused by a material failure of the fan drive turbine which occurred in a manner that was not preventable by operations or maintenance supervision.

5 March 1997


Kenneth A. Montague
KENNETH A. MONTAGUE, Lt Col, USAF
Accident Investigation Officer