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OFFICE OF THE SECRETARY  
RULEMAKINGS AND  
ADJUDICATIONS STAFF

**AFR-110-14  
USAF AIRCRAFT**

**ACCIDENT**

**INVESTIGATION**

**BOARD**

**7 FEB 94**

**F-16 AIRCRAFT**  
  
**138FG**

**S/N 90-0764**  
  
**125FS**

**INVESTIGATION OFFICER**  
**RICHARD M. PEDERSEN, LT COL, USAF**

**HQ**  
**12TH AIR FORCE**

PFS Exh. 164

57817

**COPY NUMBER 2 OF 9**

NUCLEAR REGULATORY COMMISSION

Official Exh. No. 164  
in the matter of PPS  
Staff IDENTIFIED  
Applicant RECEIVED  
Intervenor REJECTED  
Other ADMITTED  
DATE 7/1/68  
Clerk [Signature]

## 2. SUMMARY OF FACTS:

### a. History of Flight:

(1) Two F-16CG aircraft, call signs Tulsa 11 and 12, took off from Tulsa IAP at 0914 CST (TAB Z-1). They were to conduct a Basic Fighter Maneuver (BFM) mission in the Rivers MOA (TAB V-1). At approximately 0945 CST while setting up for the third engagement, [REDACTED] experienced an explosion and severe engine and airframe vibrations, followed by an engine stall and stagnation (TAB J-5, V-1). [REDACTED] attempted two airstarts, but was unable to start the engine and regain useable thrust. For an unknown reason, the engine had experienced a high cycle fatigue fracture of a fourth stage turbine blade below the blade platform and subsequent damage to the low pressure turbine (LPT) (TAB J-5, S-4, S-5, V-1). At approximately 0948 CST, [REDACTED] ejected successfully without injury while approaching minimum recommended ejection altitude (TAB A-2, N-10, V-1). The aircraft crashed on private property used for cattle grazing 1 1/2 nautical miles (NM) north of Soper, OK., approximately 120 NM south-southeast of Tulsa International Airport (IAP), Tulsa, OK (TAB A-2, P-2). Actual damage to private property was minimal (TAB P-2).

(2) All following times are based on Tulsa 11's recorded takeoff time of 0914 plus event data recorded by the aircraft's Seat Data Recorder (SDR) (TAB Z-1, AA-1). The SDR records flight profile data, system status data, and Digital Backup Unit data. Aircraft impact and destruction are based on SDR data termination (TAB AA-1).

### b. Mission:

The mission was scheduled as a 2 ship BFM 3 training mission to be flown IAW MCI (ANG) 11-208, the Flying Training F-16 Pilot Training instruction (TAB A-2, V-1, V-2, AA-2). The primary objective of the mission was to increase the pilots' air-to-air proficiency. The mission overview planned for single ship takeoffs with 20 second spacing, weapon systems checks enroute to the area, a G-awareness maneuver, one heat-to-guns cine track exercise, both visual and Beyond Visual Range (BVR) BFM engagements, and a return to Tulsa IAP for recovery and landing (TAB V-1). Tulsa 11 was flown by [REDACTED] and Tulsa 12 was flown by [REDACTED] (TAB K-4).

c. Briefing and Preflight:

Both flight members reported adequate crew rest for the mission (K-4). The preflight briefing began at 0715 CST and was briefed in detail by [REDACTED]. Emergency divert fields were specifically briefed. The briefing covered all applicable items required by existing regulations (TAB V-2). Both members of the flight indicated they clearly understood the objectives, the general flow of the mission, and had no questions about the flight briefing. Both pilots arrived at their jets IAW briefed times and began preflight inspections. Preflight, start, taxi, marshaling and arming were uneventful (TAB V-1, V-2).

d. Flight Activity:

(1) Tulsa 11 flight was filed and cleared for the Zebra 4 stereo flight plan (TAB K-4). At approximately 0914 CST, they accomplished single ship takeoffs with 20 seconds spacing between aircraft (TAB V-1, Z-1). They rejoined into a 2 ship formation while accomplishing air-to-air systems checks enroute to the working area. The outbound portion of the stereo flight plan terminated when entering the River MOA (TAB V-1, V-2).

(2) Tulsa 11 flight completed a G-awareness maneuver, one heat-to-guns exercise and two visual BFM engagements as briefed. [REDACTED] had some minor problems with [REDACTED] air-to-air radar, but this had no effect on the overall mission conduct. After the second engagement, Tulsa 11 and 12 split up with approximately 35-40 NM separation for a one-v-one BVR setup to a visual engagement. Tulsa 11 went to the southwest part of the River MOA and Tulsa 12 went to the northeast (TAB V-1).

(3) [REDACTED] first indications of any problems were an explosion followed by severe airframe and engine vibrations. The vibrations seemed related to engine revolutions per minute (RPM) - the higher the RPM, the more severe the vibrations and inversely, the lower the RPM, the less severe. The vibrations continued for the rest of the flight and regardless of engine RPM, were so severe that it was difficult to read the cockpit instruments at any time (TAB V-1). At approximately 31 minutes after takeoff at 0944:52 CST, the aircraft engine stalled and then stagnated. The fatigue fracture of a fourth stage turbine blade had resulted in the ensuing damage to and drag on the LPT which drives the engine fan. This produced drag on the engine fan which limited and disrupted airflow to the engine compressor inlet, producing an engine stall and stagnation. From this point on, [REDACTED] engine was no longer capable of producing useable thrust (TAB J-5).

(4) As [REDACTED] analyzed [REDACTED] situation, [REDACTED] simultaneously turned toward the nearest suitable emergency airfield, Grayson County, approximately 60-65 NM south-southwest of [REDACTED] position (TAB V-1). Grayson was the specifically briefed emergency airfield for [REDACTED] position at the time of the emergency (TAB V-2). The airfield has a 9000 FT runway (TAB AA-3). [REDACTED] knew Grayson was beyond engine out gliding distance, but turned in that direction hoping the engine would begin to produce enough thrust to continue flying. If that were the case, [REDACTED] wanted to land at the nearest suitable airfield as soon as possible because the engine had already shown it was unreliable. [REDACTED] also knew that there were small civilian airports in Antlers and Hugo, OK. Although [REDACTED] felt [REDACTED] might have been able to glide and complete flameout approach at either airfield, [REDACTED] felt neither was suitable (TAB V-1). Both airfields were less than 3500 feet long and were only used by light civilian aircraft (TAB V-1, AA-4). Minimum recommended runway length for the F-16 is 8000 FT. [REDACTED] notified [REDACTED] of [REDACTED] problem. [REDACTED] immediately turned southwest and attempted to rejoin on [REDACTED] aircraft. [REDACTED] had difficulty finding [REDACTED] due to [REDACTED] radar problem and could only provide assistance over the radio. [REDACTED] was not able to locate [REDACTED] until [REDACTED] visually acquired [REDACTED] during the ejection (TAB V-2).

(5) Just prior to the incident, [REDACTED] had been flying with the engine set at full military power while climbing through approximately 11,000 feet (FT) above mean sea level (MSL)/10,300 FT above ground level (AGL) and at 364 knots calibrated airspeed (KCAS) (TAB J-5, V-1). Average terrain elevation near [REDACTED] position was approximately 700 FT MSL (TAB AA-5). Based on cockpit indications,

initially interpreted the engine malfunction as an engine rollback pulled the throttle back to the idle position at 0945:21 (TAB J-5, V-1). Despite difficulty reading the engine instruments, soon noticed that engine RPM was decreasing and fan turbine inlet temperature (FTIT) was increasing, giving indications of an engine stagnation. In addition to the stagnation, felt that the problem was much worse due to the explosion and continuing vibrations. then accomplished the emergency checklist procedures which called for an engine shutdown to clear the stagnation and an airstart attempt (TAB V-1).

(6) began to execute the Critical Action Procedures (CAPs) for an engine airstart (TAB AA-6). Based on current parameters and cockpit indications, planned to attempt a SEC spooldown airstart and established a 270-290 KCAS glide (TAB V-1, AA-1). A SEC airstart is required when attempting an airstart below 10,000 FT AGL (TAB AA-6). was flying at approximately 10,300 FT AGL at the time (TAB AA-1). did not jettison empty centerline fuel tank due to concentration on other airstart procedures. felt the weight and drag of the empty centerline fuel tank would not appreciably affect glide nor increase time aloft (TAB V-1). At 0945:21, placed the throttle to off to clear the engine stagnation. next moved the engine control switch from the PRI to the SEC position at 0945:28, which is confirmed by the SDR. At 0946:33, selected START 2 on the Jet Fuel Starter (JFS) to assist with the airstart. Approximately 1 second prior to selecting JFS START 2, the SDR shows the engine control switch was placed back in PRI (TAB J-5, V-1). While working to maintain the recommended spooldown airspeed of 275 KCAS, noticed the engine RPM had decreased below the minimum recommended 25% RPM. According to testimony, immediately moved the throttle to IDLE at 18-20% RPM to initiate an airstart at 0945:36 (TAB J-5, V-1). The SDR shows the throttle was advanced to idle at 17% RPM and 698°C FTIT (TAB J-5). Despite the lower than recommended 25% RPM, the airstart began as soon as the throttle was advanced from OFF to IDLE, appearing to progress normally although the vibrations were still present (TAB J-5, V-1). At some time between 0945:33 and 0946:00, the JFS started running (TAB O-14). continued to maintain 270-290 KCAS glide (TAB V-1).

(7) The SDR indicates that the engine appeared to approach normal idle power indications, then stalled a second time at 0946:45. At some time between 0946:30 and 0946:50, the throttle was advanced to MIL (TAB J-5). quickly recognized the second engine stall and stagnation. Although engine instruments showed that the attempt appeared to progress normally, felt still had the same problems had prior to initiating the first airstart due to the second stagnation and continuing severe vibrations (TAB V-1).

(8) At 0947:05 and an estimated 5000 FT MSL/4300 FT AGL, moved the throttle to OFF a second time to attempt to clear the second stagnation (TAB J-5, AA-1). Since the JFS was now running, planned to do a JFS assisted PRI airstart. This would allow to hold a slower airspeed in order to decrease descent rate and give more time. does not remember what airspeed finally slowed to (TAB V-1). The SDR shows airspeed decreasing during this time, with a last recorded airspeed of 243 KCAS approximately 19 seconds prior to ejection (TAB AA-1). The Statement of Damage to Private Property estimated aircraft ground impact at approximately 210 KCAS (TAB P-2).

(9) As reached to move the engine control switch from what thought was SEC, noticed it was already in PRI. elected to continue the airstart in PRI again because was running out of time and approaching the minimum recommended controlled bailout altitude of 2000 FT AGL (TAB V-1, AA-7). was skeptical about getting a successful airstart since had noticed no improvement after the first attempt (TAB V-1). advanced the throttle to IDLE at 0947:15 and an SDR estimated 4200 FT MSL/3500 FT AGL to initiate the second airstart attempt (TAB J-5, AA-1). Testimony indicated that he thought he was higher at an estimated 7300 feet MSL (TAB V-1).

(10) At 3300 FT MSL/2500 FT AGL, had made a conscious decision to eject if the engine did not produce any usable thrust on this attempt. The engine again tried to start, but stalled

and stagnated a third and final time at 0947:54 and an estimated 2200 FT MSL/1500 FT AGL (TAB J-5, TAB AA-1). [REDACTED] began a zoom maneuver in preparation for ejection. Simultaneously [REDACTED] advanced the throttle to mil one last time to see if [REDACTED] could get any usable thrust from the engine, but the stagnation continued. The aircraft apexed at an unknown altitude and slowed to approximately 150 KCAS (TAB V-1). At 0948:19, [REDACTED] ejected based on a "Canopy Open" signal recorded by the SDR (TAB O-15). [REDACTED] indicated that [REDACTED] had plenty of time to complete all post ejection procedures, watch [REDACTED] aircraft crash, and then prepare for [REDACTED] parachute landing (TAB V-1).

e. Impact:

Aircraft 90-0764 crashed and was destroyed at 0948:38 CST (TAB AA-1). The aircraft impacted on private property used for cattle grazing approximately 1 1/2 NM north of Soper, OK (TAB P-2, A-2). Actual damage to private property was minimal. Some damage to fencing was done by the crash recovery team and some by several head of cattle who were apparently spooked by the crash. A gate was also damaged by the cattle. Actual cost of this damage, not including soil and environmental work associated with the crash site itself, has not been determined because of wet conditions at the site, but is expected to be less than \$1000.00 (TAB P-2 thru P-4).

f. Ejection:

[REDACTED] ejected from [REDACTED] aircraft at 0948:19 CST (TAB O-15). [REDACTED] stated [REDACTED] could not locate the 4-line jettisons on [REDACTED] parachute, but was not concerned. The parachute ride was very stable with no oscillations. [REDACTED] landed 1 to 1 1/2 NM north of the crash site (TAB V-1).

g. Personal and Survival Equipment:

- (1) All personal and survival equipment inspections were current (TAB AA-8).
- (2) Other than the pilot's inability to locate the parachute 4-line jettisons during the parachute descent, no personal/survival equipment difficulties were noted during ejection (TAB V-1).

h. Rescue:

(1) The crash occurred at approximately 0949 CST on 7 February 1994 (TAB A-2). At this time, [REDACTED] notified Fort Worth Center by radio of the ejection. [REDACTED] next contacted squadron operations and the Supervisor of Flying. [REDACTED] flew one low pass over [REDACTED] position. [REDACTED] was waving and appeared to be unhurt. [REDACTED] then returned to Tulsa IAP (TAB V-2).

(2) Immediately after completing [REDACTED] parachute landing fall, [REDACTED] was approached by two civilian males in a pickup truck who wanted to know if [REDACTED] needed any help. [REDACTED] did not contact [REDACTED] on [REDACTED] survival radio because [REDACTED] felt it was more important to get to a telephone to call squadron operations at Tulsa IAP (TAB V-1).

(3) [REDACTED] was transported to the crash site by the two civilians in the pickup truck. [REDACTED] noticed there were 20 to 30 civilians standing around the burning wreckage of [REDACTED] aircraft. Concerned about their safety, [REDACTED] asked a local sheriff to clear the personnel away from the wreckage for at least 1/2 mile. [REDACTED] then went to a local farmhouse (TAB V-1).

(4) [REDACTED] was driven by the Highway Patrol to the Hugo airport where [REDACTED] was picked up by a fellow squadron member in a privately owned Cessna 182 and transported back to Tulsa IAP (TAB V-1).

i. Crash Response:

Local sheriff's deputies and the state highway patrol secured the crash site almost immediately (TAB V-1). They maintained security of the crash site until the arrival of 138th Fighter Group crash recovery team (P-2). The wreckage was removed on 12 February 94 (P-3).

j. Maintenance Documentation:

(1) AFTO Form 781 and Core Automated Maintenance System (CAMS) records were reviewed. Examinations of pilot-reported discrepancies and maintenance actions for the 90 days proceeding the accident revealed no significant discrepancies which related to the mishap (TAB U-3). [REDACTED] preflighted the MA at 0800 on 7 February 1994 and [REDACTED] signed the Exceptional Release prior to the mishap (TAB U-1-6).

(2) Review of AFTO Form 781 and CAMS documents revealed two Time Compliance Technical Orders (TCTOs) were not completed as of the mishap date. Neither were overdue and did not affect safety of flight (TAB U-4).

(3) AFTO Forms 781 and CAMS documents reflect one overdue inspection for an operational check of the Arresting Gear Release which was due on 20 January 1994. This overdue inspection was properly documented and was not related to safety of flight. All other scheduled inspections on the mishap aircraft (MA) were completed (TAB U-5).

(4) Review of the Joint Oil Analysis Program (JOAP) documentation for the F100-PW-220 engine (#PW-0E713391) installed in the MA did not reveal any adverse trends or problems with measurements exceeding tolerances (TAB U-6).

(5) Review of the AFTO Forms 781 and the Inspection and Time Change Forecast revealed no overdue time change requirements (TAB U-5).

(6) The Equipment Review Report did not reveal any discrepancies on component inspections (TAB U-7).

(7) The mishap occurred on the second flight after the mishap aircraft (MA) had transferred to the 138th Fighter Group from the 363rd Fighter Wing at Shaw Air Force Base on 14 January 1994 (TAB U-1). Prior to transfer, a transfer inspection was done by the 363 FW and an acceptance inspection was done by the 138th FG (TAB 3). Both inspections were conducted at Shaw AFB. Borescope and visual inspections of the engine were done during both the transfer and acceptance inspections. During the acceptance inspection, [REDACTED] noted a small oil leak above the engine gear box, however subsequent investigation revealed oil consumption was within tolerances (TAB V-9). Both the flight from Shaw AFB on 14 January and the first flight at Tulsa International Airport on 3 February 1994 generated no pilot reported discrepancies nor significant unscheduled maintenance actions (TAB U-3). Five TCTOs were completed following transfer of the aircraft, but none affected safety of flight. (TAB U-3).

(8) No maintenance procedures, practices or performance appear to be related to the accident.

k. Maintenance Personnel and Supervision:

Personnel assigned to service, preflight and launch the MA were qualified in their duties. Review of personnel training records for involved maintenance personnel reflect no deficiencies in documentation (TAB U-8).

1. Engine, Fuel, Hydraulic, and Oil Inspection Analysis:

Post mishap samples were taken from the servicing equipment last known to service the MA. Samples taken from servicing carts included engine oil, hydraulic fluid, liquid oxygen. In addition, Jet A Fuel was sampled from refueler #12 and the bulk storage tank. All samples were analyzed by the USAF Aerospace Fuels Laboratory at Wright-Patterson AFB and were found to be within applicable technical order tolerances (TAB U-9).

m. Airframe and Aircraft Systems:

(1) Post-accident analysis of the engine by San Antonio Air Logistics Center (SA-ALC) indicated that most of the engine appeared normal except for damage incurred in the crash impact. However, one blade in the fourth stage low-pressure turbine was broken off below its platform at the top of the blade/disk attachment area (TAB S-4). Examination of the fracture surface revealed indications of a fatigue fracture mode. The fatigue area appeared to originate on the pressure side of the blade just forward of the aft face of the blade root. It then propagated all the way across the aft face and approximately one-half inch forward along the pressure side of the root. Based on existing procedures used at the time, this area was not easily nor normally inspected by maintenance personnel. The location of this blade was almost directly opposite the location of a heavy rub on the fourth stage airseal knife-edges. Further, the SA-ALC investigator determined that domestic object damage (DOD) caused by the fourth stage blade fatigue failure and the resultant damage to the LPT rendered the engine incapable of producing usable thrust (TAB J).

(2) Engine Manufacturer:

Pratt and Whitney  
179600 Beeline Hwy.  
Jupiter, FL 33478-9600

(3) All maintenance performed on the subject engine since it was placed in service on 13 May 1991 was done by the 363rd Fighter Wing at Shaw Air Force Base. None appeared related to the mishap (TAB J).

n. Operations Personnel and Supervisors:

This flight was authorized by [REDACTED] on a computer generated local flight clearance form number O-29 (TAB K-4). The mission was briefed IAW applicable guidance (TAB V-1, V-2).

o. Crew Qualifications:

(1) Examination of aircrew flight records revealed that [REDACTED] was qualified and current in the F-16 CG. [REDACTED] is a flight commander and a 4 ship flight lead (TAB G, T-1, V-1).

(2) [REDACTED] has 6000 hours total flying time (TAB V-1). Of that [REDACTED] has 2648.3 hours of military flight time, the majority of which is in fighters. At the time of the accident [REDACTED] had 130.5 hours in the F-16, all of it in the Block 42 F-16CG powered by the Pratt and Whitney 220 engine. [REDACTED] 30/60/90 day totals were 8.8/24.5/47.6 hours (TAB G-3). Although relatively inexperienced in the F-16 [REDACTED] had earned an Exceptionally Qualified on [REDACTED] initial mission checkride (TAB T-2, T-3).

p. Medical:

[REDACTED] was medically qualified at the time of the mishap (TAB AA-9).



q. Nav aids and Facilities:

All nav aids and facilities were operating and functional during the mission (TAB K-6).

r. Weather:

Weather was VMC and not a factor (TAB K-5, K-6, V-1).

s. Directives and Publications:

The following publications were applicable to this mission:

MCI (ANG) 11-208  
MCR 55-116  
T.O. 1F-16CG-1

Flying Training - F-16 Pilot Training Instruction  
Operations - F-16 Pilot Operational Procedures  
F-16CG Flight Manual

d. Statement of Opinion

(1) Maintenance personnel at both Shaw AFB and Tulsa IAP had no reasonable way of preventing this accident.

(2) [REDACTED] displayed exemplary situational awareness and outstanding airmanship through out this entire incident. Despite [REDACTED] unknowingly hopeless situation and the loss of the aircraft, [REDACTED] should be commended for [REDACTED] actions on 7 February 1994.

*Richard M. Pedersen*

RICHARD M. PEDERSEN, Lt Col, USAF  
Investigating Officer