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**AFI 51-503**  
**USAF AIRCRAFT**  
**ACCIDENT**  
**INVESTIGATION**  
**BOARD**

**25 OCT 94**  
**HILL AIR FORCE BASE, UT**

**F-16CJ AIRCRAFT**  
**S/N 90-8014**

**388 FW**  
**4 FS**

**INVESTIGATION OFFICER**  
**DREW N. METCALF, LT COL, USAF**

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

**COPY NUMBER 1 OF 11**

**ORIGINAL**

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**PFS Exh. 174**

NUCLEAR REGULATORY COMMISSION

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 Reporter CM



DEPARTMENT OF THE AIR FORCE

HEADQUARTERS TWELFTH AIR FORCE (ACC)  
DAVIS-MONTHAN AIR FORCE BASE, ARIZONA

8 JUN 1995

MEMORANDUM FOR HQ 12 AF/JA

FROM: 12 AF/CC  
5340 E. Gafford Way, Ste 130  
Davis-Monthan AFB, AZ 85707-4250

SUBJECT: Aircraft Accident Investigation: F-16CJ, SN90-8014,  
25 Oct 94, 388 FW, Hill AFB, UT

Subject aircraft accident investigation is approved.

A handwritten signature in black ink, reading "Thomas R. Griffith", is positioned above the printed name.

THOMAS R. GRIFFITH  
Lieutenant General, USAF  
Commander

# AIRCRAFT ACCIDENT INVESTIGATION

## FORMAL REPORT OF INVESTIGATION

Hill AFB, UT                      25 October 1994  
F-16CJ, Block 50                S/N 90-0814

### 1. AUTHORITY AND PURPOSE:

The Commander, Twelfth Air Force, Air Combat Command (ACC), appointed Lieutenant Colonel Drew N. Metcalf, Chief, Operations Inspections Division, Office of the Inspector General, Headquarters Twelfth Air Force, Davis-Monthan AFB, AZ, on 10 November 1994, under AFI 51-503, to investigate and determine the facts and circumstances surrounding the destruction of Aircraft F-16CJ, S/N 90-0814, which occurred 25 October 1994, near Wendover, UT. Second Lieutenant Earl R. Bennett, 389 FS/MA, Mountain Home AFB, ID, was appointed on 10 November 1994, as a maintenance technical advisor. Captain Kevin L. Cutler, Chief Civil Law Branch, Ogden Air Logistics Center, Hill AFB, UT, was appointed on 10 November 1994, as a legal advisor (TAB Y-1 thru Y-3).

The purpose of the investigation was to obtain and preserve all available evidence for claims, litigation, disciplinary and administrative actions, and for all other purposes deemed appropriate by competent authority.

### 2. SUMMARY OF FACTS:

#### a. History of Flight:

(1) Summary of the Flight. Four F-16CJ aircraft, Tartan 1, Tartan 2, (the accident aircraft piloted by Capt Miguel F. Torrealday), and Tartans 3 and 4 took off at 0927 Mountain Daylight Time (MDT) (1527 Zulu) on a training mission to the Utah Test and Training Range (UTTR) (TAB K-2). The flight flew at medium altitude until inside the limits of the UTTR where they joined their planned low level route. At 0956 MDT, following their first attack on Craners Gunnery Range and while setting up for a subsequent attack, the pilot of Tartan 2 felt several violent bangs and heard what he described as a grinding, growling, metal on metal sound. Simultaneously, he experienced a low altitude engine failure. The pilot called "knock it off", advised lead of his engine failure, began a zoom maneuver (rapid climb), jettisoned his centerline fuel tank over the range, turned toward Wendover Airfield, Utah, (an emergency landing field) and tried to restart his engine (TAB V-1-3). After three unsuccessful airstart attempts in the Secondary Engine Control (SEC) mode and while passing through what he thought was minimum ejection altitude, he applied maximum backstick to zoom the aircraft and successfully ejected at approximately 0959 MDT. The aircraft impacted the ground on public land near the Bonneville Salt Flats and was totally destroyed (TAB A-2 & P-2). The pilot was uninjured and after 4-5 minutes was joined by the Chief of Police, Wendover, Utah (TAB V-1-6). As he was uninjured, the pilot waited for a rescue helicopter dispatched from Hill AFB by the Supervisor of Flying (SOF). Captain Torrealday was examined on-scene by a flight surgeon and a Pararescue Specialist (PJ) and taken, via 545th Test Group HH-1H Huey Helicopter, to the Hill AFB Hospital (TAB AA-6-1). No injuries were noted (TAB X-1).

(2) All accident sequence times are approximate based on Tartan flights recorded take-off time of 0927 MDT added to the event data recorded by the Crash Survivable Flight Data Recorder (CSFDR) and the Seat Data Recorder (SDR). Aircraft impact data is based on the CSFDR data termination and analysis of post-crash aircraft instruments (TAB J-15 thru J-18, O-1 thru O-27, AA-7-1 thru AA-7-16).

(3) Media coverage. The accident generated some local news interest and was reported by the local television stations and newspapers (TAB AA-1-2 thru AA-1-6). News releases were provided by the 388th Fighter Wing Public Affairs Office (TAB AA-1-1). Additionally, the Air Force Times and Aviation Week and Space

Technology mentioned the accident in articles questioning the reliability of General Electric F-110 Powerplants (TAB AA-1-7 thru AA-1-9).

b. **Mission:** This mission was briefed and flown as a 4 ship dry Surface Attack Tactics (SAT) sortie to Craners Gunnery Range within R-6404A/B. R-6404A/B falls within the UTTR and is approximately 75 NM west of Hill AFB (TAB AA-4-2). Mission objectives were to deny valid missile shots to Cajun (4 ship exiting the range and acting as Bandits) and to simulate destruction of the factory (TGT #115) on each of three separate attacks. Planned attacks included a fly-up to 45° High Angle Dive Bomb, fly-up to 30° Dive Bomb and Pop to 10° dive toss (TAB V-1-2). Mission overview included single ship take-offs, 15 second spacing, rejoin to tactical formation, medium altitude flight to a low altitude start point, and low altitude ingress to the Initial Point (IP) (TAB V-1-2).

c. **Briefing and Pre-Flight:** All four flight members had adequate crew rest, IAW AFR 60-16, for the 25 October mission (TAB V-1-1, V-2-1, V-3-1, & V-4-1). The mission briefing was conducted in two parts. Lt Col Jeffrey S. Gordon conducted the mass brief and covered local and range weather, NOTAMS, and special subjects. (TAB W-3, W-4, & AA-2-1). A specific mission briefing was conducted by Captain John D. Whittenberger utilizing the 388 FW briefing guide. Special emphasis during this briefing was on low altitude engine failure and divert decisions while on range. This emphasis was as a result of the 20 September engine stall/failure by a 421 FS F-16 while in the UTTR (TAB V-1-1). The briefing was conducted IAW AFR 55-116. Tartan flight departed the squadron at 0830 MDT for an 0850 engine start. Preflight, start, and taxi were uneventful (TAB V-2-1).

d. **Flight Activity:**

(1) Tartan flight was filed on a IL-04 stereo flight plan. IL-04 requested an Instrument Flight Rules (IFR) clearance routing to restricted area R-6404, via the Lucin Military Operating Area (MOA) and, after a delay, requests an IFR pick-up for return to Hill AFB (TAB AA-8-1)

(2) Tartan flight took off at 0927 MDT and proceeded at medium altitude to join the planned low level route. While low level enroute to the IP, Tartan flight reacted to a low altitude airborne threat (Cajun flight, the briefed Bandit) to update their Low Altitude Awareness Training (LOWAT) currency (TAB V-1-1). At 0955 MDT, after the first dry SAT attack and while at 2500' Above Ground Level (AGL), 480 Knots Calibrated Airspeed (KCAS), and repositioning the formation for the planned second dry SAT attack, the aircraft experienced an engine failure (TAB A-2, C-2, & O-20).

(3) Tartan 4, trailing the accident aircraft by approximately 2 Nautical Miles (NM) saw what he described as gray/black smoke and a small orange fireball exit out the back of the engine. In what he estimated to be within 2 seconds, he observed the aircraft start a zoom maneuver (TAB V-4-1).

(4) The pilot, described the engine failure as "a loud bang" with a violent reaction like hitting a brick wall and an accompanying rapid deceleration. He zoomed the jet, jettisoned his centerline fuel tank, turned toward Wendover Airfield, and after determining that he had an engine failure, placed the throttle to off then to mid-range IAW the F-16CJ block 50 Airstart Procedures (TO 1F-16CJ-1 page 3-75). During the zoom he heard what he described as a "grinding, growling, metal-on-metal friction" sound coming from an area below and aft of his seat (TAB V-1-3 & 1-6). The pilot then noticed his Fan Turbine Inlet Temperature (FTIT) at or above 1100° C, placed the throttle to off, selected SEC with the engine control switch and started an engine out glide toward Wendover Airfield at an average airspeed of 192-212 KCAS (TAB O-20 thru O-26). The pilot attempted three separate airstart attempts but never observed an RPM rise above zero. During the third airstart attempt, the pilot noticed a ground rush in his peripheral vision and estimated his altitude to be 2000' AGL (TAB V-1-4). At 0959 MDT IAW flight manual procedures, the pilot attempted to zoom the aircraft and successfully ejected in the mode 1 envelope (TO 1F-16CJ-1 pages 3-36/37). The aircraft flew approximately 1.5 more miles before impacting the ground and was destroyed (TAB A-2 & AA-4-2).

(5) Post accident analysis of the engine showed the engine failure to be the result of an in-flight liberation of blade #19 of the stage one fan section. Subsequent in-flight damage to the engine included, a 13 inch by 14 inch burn through in the lower outer fan duct 4 inches aft of the forward flange, evidence of a titanium fire in the High Pressure Compressor (HPC), liberation or consumption of all HPC blades above the platform, compressor Outlet Guide Vanes (OGVs) plugged with broken/molten metal, and molten metal inside the compressor discharge nozzle case (TAB J-3, J-4, & R-5).

**e. Airmanship:**

(1) Captain Torrealday accomplished sequentially the Critical Action Procedures (CAPs) for a low altitude engine failure as prescribed in AFR 55-116, ch 9, atch 2 (TAB T-12). However, four areas deserve closer scrutiny.

(2) The flight manual recommends that a zoom climb be accomplished using a 3G pull-up to 30° climb angle until approaching the desired airspeed (using a 50 knot lead point) and then initiating a zero G pushover (TO 1F-16CJ-1, page 3-72.2). Using data extrapolated from figure 3-9 of the flight manual, and using the entry conditions at the time of the engine failure (480 KCAS, 2500' AGL, 5200 lbs fuel/stores) the pilot should have reached a zoom apex of 11,280' Mean Sea Level (MSL) at 221 KCAS. His actual parameters were 11,360' MSL at 196 KCAS (TAB O-21). The most likely reason for the airspeed difference was due to the pilot's need to make an approximate 151° turn to the right, toward his divert airfield, during the zoom

(3) Capt Torrealday did not accomplish step 6 of the low altitude engine failure CAPs (JFS-Start 2). The F-16CJ flight manual contains a warning which reads:

**WARNING**

DO NOT START THE JFS IF ENGINE SEIZURE HAS OCCURRED OR IS ANTICIPATED  
OR IF ENGINE FAILURE IS A RESULT OF FUEL STARVATION. STARTING THE JFS  
MAY RESULT IN NO BRAKES/JFS ACCUMULATOR PRESSURE FOR THE BRAKES.  
(TO 1F-16CJ-1 page 3-82.2)

Since the accident engine showed zero RPM and the pilot had heard/felt "grinding, growling, metal-on-metal friction" during the failure sequence, it was reasonable to expect engine seizure, and in fact, the engine had seized (TAB V-11-1). Wendover Airfield consists of a 9100' runway at 4240' elevation with no barriers (TAB AA-4-3). Without barriers or brakes it would be virtually impossible to stop or steer a landing F-16 on a 9100' surface (TO 1F-16CJ-1, page 3-79, 3-83).

(4) At the top of the zoom, the aircraft was approximately 7100' AGL, 196 KCAS and 13 NM from Wendover Airfield and roughly on the extended centerline of Wendover Airfield runway 21 (TAB O-21 & AA-4-2). The F-16CJ flight manual recommends a straight-in flame out landing be started at a minimum of 8 NM (no wind) and 7000' AGL at maximum range airspeed (200 KCAS plus 5 knots for every 1000 lbs fuel/stores over 1000 lbs). This assumes a maximum range glide to 2000' AGL followed by a landing gear down glide at optimum landing gear down airspeed to the runway (TO F-16CJ-1, page 3-79, ch 5). Additionally, the flight manual states that "each 10 knots above or below maximum range airspeed decreases glide range up to 1/4 NM" (TO 1F-16CJ-1, page 3-75). Average winds during his decent were 150/10 (TAB K-6). Optimum glide speed for the F-16CJ based on fuel/stores weight of 5300 lbs is 221 KCAS (TO 1F-16CJ-1, page 3-76). This profile was flown twice in the F-16CJ simulator using the accident aircraft parameters. Results based on simulator and flight manual data show the pilot was never in a position, after the engine failure, to execute a successful flame out landing at Wendover Airfield (TAB AA-9-1 & AA-9-2).

(5) Capt Torrealday ejected at approximately 1380' AGL (TAB O-20 & AA-7-5). The flight manual states that "ejection should not be delayed below 2000' AGL unless the engine is producing thrust capable of

maintaining level flight or safely controlling the sink rate or unless a flameout landing can be accomplished" (TO 1F-16CJ-1, page 3-72.2). The terrain at the point of ejection is near the Bonneville Salt Flats and can best be described as flat and featureless, making visual altitude estimation difficult (TAB AA-4-2). Additionally, the radar altimeter is on the essential DC Bus, which is disconnected when the Emergency Power Unit (EPU) comes on the line following engine failure (TO 1F-16CJ-1, page 3-47, Figure 3-7). Without a radar altimeter it is virtually impossible to accurately judge one's height above ground level.

f. **Impact:** F-16CJ, S/N 90-0814 crashed and was destroyed on 25 October 1994 at 0959 MDT (TAB A-2 & P-2). The impact was on barren, dry land, approximately 4200' MSL, near the Bonneville Salt Flats (TAB S-2 & AA-4-2). This land belongs to the Bureau of Land Management (BLM) and is in Box Elder County, 4 NM N.E. of Wendover UT, or 244 degrees/95 NM from Hill AFB (TAB A-2). Flight instruments and final CSFDR data at impact are approximate and indicate the following parameters (TABs J-15, J-16, O-2, thru O-5, O-26 & O-27):

Heading	230°
Pitch	30° dive
Roll	50° left bank
Airspeed	156 KCAS
Angle of Attack (AOA)	10°
Engine N1	12.5% RPM (minimum reading)
Engine N2	0% RPM
Nozzle	47° open
Fuel Flow	0 Pounds Per Hour
FTIT	358°

g. **Egress System:** This pilot initiated a successful ejection at approximately 5600' MSL (1380' AGL) in a nose up, wings level attitude at approximately 123 KCAS (TAB O-20 & AA-7-5). This is well within the performance envelope of the ejection system (TO 1F-16CJ-1, page 3-37). All pyrotechnic components functioned as designed (TAB J-7). An Emergency Locator Transmitter (ELT) was installed and functioned properly but was not required to locate the aircraft or pilot (TAB C-2).

h. **Personal and Survival Equipment:** All personal and survival equipment inspections were current (TAB T-33/38).

i. **Rescue:** Initial response to the downed pilot was by the Chief of the Wendover, Utah, Police Department, in a four wheel drive vehicle, who arrived about 4-5 minutes after the pilot ejected (TAB V-1-6). The pilot was in contact with Tartan 1 on UHF CH 282.8 during this period. After a brief discussion between the pilot, the police chief, Tartan 1 and the 388 FW Supervisor of Flying (SOF), it was decided that the pilot, being uninjured, would wait for the rescue helicopter vice accompanying the police to the Wendover Clinic (TAB V-5-1). Sport 55, a 545th Test Group HH-1H, launched at 1031 MDT to recover the pilot. The pilot was examined and helped into the helicopter by the Flight Surgeon and PJ, and the helicopter returned to Hill AFB where an ambulance took the pilot and Flight Surgeon to the hospital (TAB AA-6-1 & V-1-6).

j. **Crash Response:** There were no delays encountered in responding to the crash site. Civilian agencies secured the site until the initial Crash Support Recovery Team arrived at 12:34 MDT on Sport 50, a HH-1H helicopter operated by the 545 Test Group (TAB AA-6-4).

(1) The first person on the accident scene (approximately two miles from the downed pilot) was a Utah Highway Patrol (UHP) officer who secured the area. Other law enforcement agencies on the scene were Wendover Police and Tooele County Sheriff's Department. The scene was handed over to the 388th Security Police when they arrived (TAB AA-6-9, AA-6-11 & AA-6-12).

(2) Wendover Fire Department was the first fire fighting equipment on scene. They were held away from the crash site by the UHP officer due to the danger of hydrazine exposure. The Wendover Fire Department was replaced by UTTR fire units from Eagle Range (AA-6-7, AA-6-11 & AA-6-12).

**k. Maintenance Documentation**

(1) **AFTO Forms 781.** No discrepancies were noted in the active, or jacket filed Aircraft AFTO Form 781 Series for aircraft 0814 that relate to this accident (AFTO Forms 781 TAB H).

**(2) TCTO Status (Time Compliance Technical Order):**

(a) TCTOs not completed at time of accident (Automated Records Check (ARC), TAB U-1-5) and (Serial Number Detail Listing TAB U-2) are listed below:

<u>TCTO#</u>	<u>STATUS</u>	<u>RECESSION DATE</u>
11L1-2-30-505	NO KIT	25 MAR 96
1F-16-1790	ABEYANCE	24 FEB 95
1F-16-1931	NO PARTS	28 FEB 96
2J-F110129-517	NO KIT	31 MAY 95
2J-F110129-520	NO KIT/PARTS	31 JAN 96
2J-F110129-538	NO KIT	24 MAY 96
2J-F11-129-544	NO PARTS	08 AUG 98
L388409	READY	24 OCT 95
L388411	READY	24 OCT 95

(b) **Completed TCTOs.** Review of completed TCTOs revealed no actions which relate to this mishap (TAB U-3).

(c) **TCTO Discrepancies.** There are no TCTO discrepancies that relate to this mishap.

(3) **Scheduled Aircraft Inspections.** All scheduled aircraft inspections were documented as satisfactorily completed on time, and a records check was in progress on the day of the accident (TAB H-11). No scheduled inspection discrepancies relate to this accident (ARC TAB U-1). On 13 Oct 94, a 100 hr midspan shroud eddy current inspection was performed. This inspection checks for cracks in the midspan shroud section of the stage one fan blades. No defects were found, and a review of the Non Destructive Inspection (NDI) technician's training records indicate she was qualified to perform this procedure (TAB U-7-1 thru U-7-3, & V-10).

(4) **Status of Oil Analysis Records.** No significant adverse trend in oil samples were apparent for the mishap engine (TAB U-4-1 thru U-4-5). The Joint Oil Analysis Program (JOAP) lab (388 MS/MAFN) was in fully certified status at the time of the accident (TAB U-4-6).

(5) **Status of Time Change Requirements.** All time changes were completed on time. No discrepancies were noted (ARC, TAB U-1).

(6) **Unscheduled Maintenance.** The following is a list of unscheduled maintenance performed on Aircraft 90-0814 since its last scheduled inspection (routine unscheduled maintenance, such as tire changes, omitted) (excerpts are from jacket file in TAB U-5):



<u>DATE</u>	<u>MAINTENANCE PERFORMED</u>
14 JUL 94	AVTR REMOVED FOR REPAIR AND REINSTALLED
17 AUG 94	REPAIR LEADING EDGE OF VERTICAL TAIL UNDER FUSELAGE FLOOD LIGHT
28 AUG 94	REMOVE AND REPLACE HUD PDU
18 SEP 94	REMOVE AND REPLACE GAC
11 OCT 94	REMOVE AND REPLACE LEFT FORWARD RF RECEIVER
18 OCT 94	REMOVE AND REPLACE ANALYSIS PROCESSOR
19 OCT 94	CHANGED CRU-94/P
20 OCT 94	REMOVE AND REPLACE RIGHT FLAPERON ISA

(a) All unscheduled maintenance was performed by 4 FS and 388 MS personnel. None of the maintenance performed had a relationship to the accident.

(b) Unscheduled engine maintenance: the accident engine was installed during the aircraft's last scheduled phase inspection (phase 3; 28 Jun - 5 Jul 94), having been rolled back to repair a broken safety wire on the 9 o'clock position fuel nozzle (TAB U-5-11 & U-5-12). The last time the engine was in the Jet Engine Intermediate Maintenance Shop was from 5 Jan - 7 Jan 94, having been removed from Aircraft 90-0811 to comply with TCTO 2J-110129-531F. The TCTO involved an inspection of the augmentor; subsequent failure of the inspection required the augmentor liner to be removed and replaced. All required In Process Inspections (IPI) were properly documented in the engine work packages (TAB U-6). After its initial installation in Aircraft 90-0814, on 11 Jan 94, the engine operated trouble free for 252.2 flying hours, up to the accident sortie.

(c) No documentation was discovered to indicate that any maintenance/inspections were required or performed on the dovetail area of any stage one fan blades (Automated history record TAB U-3-5 thru U-3-7) and (engine work packages TAB U-6). This dovetail forms an interlocking joint between the fan blade and the rotor disk assembly (TAB S-6).

(7) **Maintenance Procedures and Practices.** No evidence was discovered to indicate that Technical Order (TO) procedures were not strictly complied with on the accident aircraft or engine.

#### **I. Maintenance Personnel and Supervision**

(1) Aircraft 90-0814 received a Basic Post Flight/Preflight inspection on 24 Oct 94, 1700 hrs, and a Walkaround inspection on 25 Oct 94, 0500 hrs, (AFTO Form 781h, TAB H-2). All personnel were qualified to perform the tasks they accomplished according to AF Form 623, AF Form 797, and special certification roster.

(2) No maintenance procedures or practices appear related to this accident.

#### **m. Engine, Fuel, Hydraulic, and Oil Inspection Analysis:**

(1) Post accident fuel, and hydraulic test report data was reviewed and found to be normal; however, the servicing cart hydraulic fluid did not meet standards (TAB U-8). This did not appear to be related to the accident. Engine post impact inspection results are detailed in section n below. No useable post impact oil sample was obtained from the engine.

(2) Review of JOAP, Engine Monitoring System (EMS) data, and engine historical records reveal no pre-impact adverse trends in either engine performance, or metal wear (TAB U-4, U-3-5 thru U-3-7).

**n. Airframe and Aircraft System:**

(1) Engine tear-down reports from the F110-GE-129 engine System Program Office (TAB J-2 thru J-5) indicate a liberation of the accident engine's #19 stage one fan blade below the blade platform at the dovetail contact pressure face. The dovetail section of this blade remained in the disk slot. This blade liberation led to large portions of eleven out of 32 stage one blades being liberated as the #19 blade struck other blades and subsequent Foreign Object Damage/Domestic Object Damage (FOD/DOD) to fan stages two and three. This liberated fan blade material moving through the engine started a titanium fire in the HPC consuming or liberating all HPC blades above the platform and consuming sections of the variable stator vane (VSV) activation rings. The platform is defined as the point where the fan blade meets the rotor assembly (TAB R-5, S-5, & S-6). As a result of the significant damage to the fan section and HPC, the engine was no longer able to operate and produce useable thrust. The following damage occurred to each component (TAB J-2 thru J-5).

- (a) Large portions of 11 out of 32 stage one fan blades liberated (TAB J-3).
- (b) Heavy damage (distortion, tears, dents, and small missing pieces) to all stage two and three fan blades (TAB J-3).
- (c) Burn through measuring 13 inches axially and 14 inches circumferentially, 4 inches aft of the forward flange at the 6 o'clock position on the lower outer fan duct (TAB J-4).
- (d) A titanium fire that consumed or liberated all HPC blades above the platform and consumed sections of the VSV activation rings (TAB J-4).
- (e) Other than molten titanium/aluminum deposits in the compressor outlet guide vanes and throughout the rest of the engine, there was no significant in-flight damage to the engine behind the HPC (TAB J-4 & J-5)

(2) All of the engines 5 bearings were found intact and rotated freely (TAB J-3 thru J-5).

(3) With the exception of blade #19, all stage one fan blades were inspected by Hill AFB NDI technicians and found to be free of organic material indicative of bird ingestion. No crack-like indications were found in any of the blade dovetails (TAB J-3). Blade #19 was inspected by the Engine Materials Technology Lab, GE Aircraft Engines, Evendale, OH, (TAB J-3) results of their analysis are detailed below.

(4) Blade #19's dovetail experienced a material failure, which by analysis of fatigue striations, indicates high cycle fatigue crack propagation (TAB J-3, S-8 thru S-10). The actual cause of the metal fatigue that caused blade #19 to liberate is unknown and still under investigation by the Propulsion Development System Office at this time (TAB V-11-1).

(5) Blade #19's midspan section failed due to tensile overload implying midspan shroud failure after blade liberation when the blade struck other stages while moving back through the engine (TAB J-3 & S-7).

(6) The dovetail section of blade #19 was found to have less than the required amount of Copper-Nickel-Indium (CU-NI-IN) coating. CU-NI-IN is a wear coating that is placed on the fan blades during the manufacturing process (TAB V-11-1). The required amount is 0.004-0.007 inches, and blade #19 had 0.003-0.004 inches. Additionally, some CU-NI-IN coating was completely missing on parts of the convex pressure face. Parent metal fretting was observed in the area of the missing coating (TAB J-3 & J-4). The effects of the missing and thinner than specified CU-NI-IN coating on blade #19 are unknown and still under investigation by the Propulsion Development System Office at this time (TAB V-11-1).

(7) The engine was seized and not able to windmill after it failed (TAB V-11-1).

**o. Operations Personnel and Supervision:** The flight was authorized by Lt Col Gordon, 4 FS/DO, as a local training sortie and documented on a computer generated AF Form 35 (TAB T-11). The briefing was conducted in two parts: a mass briefing by Lt Col Gordon, and a mission specific briefing by Capt Whittenberger, the flight lead (TAB V-2-1). Capt Whittenberger was qualified and authorized to lead the flight (TAB T-7). After the engine failure, supervisory involvement included help from the Flight Lead and notification of the Supervisor of Flying (TAB V-2-1 thru V-2-3 & V-5-1 thru V-5-2).

**p. Crew Qualifications:**

(1) Examination of individual flight records indicated that Captain Torrealday was qualified and current in the F-16 since Sep 92 and had amassed 320 3 hours in the F-16 and 1227.4 hours total time (TAB G-3).

(2) Review of his training records indicated no discrepancies or weaknesses. Captain Torrealday's 30/60/90 day flying experience prior to this accident sortie follows (TAB T-6):

	30	60	90
Flying hours	13.9	29.9	35.4
Sorties	10	17	19

**q. Medical:** Captain Torrealday was medically qualified to fly at the time of the accident (TAB T-2). He suffered no injuries as a result of the accident (TAB X-1).

**r. NavAids and Facilities:** All NAVAIDS and facilities relevant to this mission were operating and functional (TAB AA-2-1).

**s. Weather:** The 0905 MDT weather observation at Hill AFB was 25,000' scattered, visibility 50 NM, winds 070/12. The weather at the accident site was 25,000' scattered, visibility greater than 7 NM, winds 150/10G15. The weather was not relevant to this accident (TAB W-1).

**t. Governing Directives and Publications:**

(1) The following publications were applicable to this mission.

AFR 60-1	Flight Management	4 Feb 90
AFR 60-16	General Flight Rules	27 Jan 92
MCR 51-50 Vol VIII	F-16 Pilot Training	14 Feb 93
MCR 55-116	F-16 Pilot Operations Procedures	7 May 93
TO 1F-16CJ-1	F-16CJ Flight Manual	5 Aug 91
Change 6		26 Sep 94

(2) There were no known or suspected deviations from the directives or publications by the pilot.

### 3. STATEMENT OF OPINION:

a. Under 10 U.S. Code 2254(b) any opinion of the accident investigators as to the cause of or 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.

b. Investigation of the 25 October 1994, aircraft accident involving F-16CJ (Block 50) S/N 90-8014, has resulted in the following opinions:

(1) (CAUSE) Blade #19 of the stage one fan section failed due to fatigue crack propagation below the blade platform at the dovetail contact pressure face. Analysis of fatigue striations in isolated areas of the fracture are indicative of high cycle fatigue. High cycle fatigue is defined as the tendency of a metal to crack and fail under repeated application of stress.

(2) (CAUSE) The failure of stage one fan blade #19 resulted in extensive engine damage and complete engine failure. Significant engine damage included: substantial FOD/DOD damage to all stage one fan blades, liberation of eleven stage one fan blades, a 13 inch by 14 inch burn-through at the 6 o'clock position of the lower fan duct 4 inches aft of the forward flange, a titanium fire in the high pressure compressor (HPC) which destroyed all HPC blades above the platform and compressor OGVs plugged with broken/molten metal.

(3) Captain Miguel Torrealday was confronted with a low altitude engine failure. He sequentially applied the correct critical action procedures and, with a vector from his flight lead, made an immediate turn toward an emergency landing field (Wendover). Using the proper procedures, Captain Torrealday unsuccessfully attempted three low altitude airtasks, and at 1380' AGL, 2 minutes and 41 seconds after the engine failed, he successfully ejected from the aircraft. Due to the catastrophic nature of the failure, the engine seized and could never be restarted. With no thrust and insufficient time/airspeed to reach the emergency airfield, Captain Torrealday's decision to eject was both timely and procedurally correct.

(4) In my opinion this engine failure and subsequent loss of F-16CJ S/N 90-0814, was due to a material defect of a manufactured item under warranty.



DREW N. METCALF, Lt Col, USAF  
AFI 51-503, Investigating Officer