AIRCRAFT ACCIDENT INVESTIGATION

FORMAL REPORT OF INVESTIGATION

Kirtland AFB, NM 5 February 1995
F-16CG, Block 40 S/N 89-2000

1. AUTHORITY AND PURPOSE:

The Commander, Twelfth Air Force, Air Combat Command (ACC), appointed Lieutenant Colonel Richard F. Duhachek, Air Force Advisor, 132 Fighter Wing, Des Moines IAP, IA, on 28 February 1995, under AFI 51-503, to investigate and determine the facts and circumstances surrounding the destruction of Aircraft F-16CG, S/N 89-2000, which occurred 5 February 1995, near Blue Springs, NM. Major Theodore Eaton, 388 FW/LST, Hill AFB, UT, was appointed on 28 February 1995 as maintenance technical advisor. Captain Pamela Duncan, Claims Officer, 377 ABW/JA, Kirtland AFB, NM was appointed on 28 February 1995 as a legal advisor, Major Arne Hasselquist, 377 AMDS, Kirtland AFB, NM was appointed on 13 March 1995 as medical advisor (TAB Y-1 thru Y-5)

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-16CG aircraft, Taco 61, 62, 63, and 64 (the accident aircraft piloted by 1st Lieutenant Michael E. Holzer, Jr.) took off at 1240 Mountain Standard Time (MST) (1940 Zulu) on a training mission to the White Sands Missile Range (R5107 B and C) (Tab K-3,4, AA-1-1). The flight flew at medium altitude until inside the limits of VR-176 (a low level training route). They proceeded at low altitude along VR-176 into R5107. At 1305 MST, following a low altitude intercept exercise with Taco 51, the pilot of Taco 64 observed the Secondary Engine Control (SEC) caution light illuminate (indicating the engine had sensed a problem or failure in the engine's primary mode of operation) and transferred itself to SEC operation (T.O. F-16CG-1, p 1-22,24) He initiated a climb and pointed the aircraft toward Kirtland AFB. He noted the need to continue to lower his pitch attitude to maintain a 350 Knots Calibrated Airspeed (KCAS) climb. Finally, at 13,880' Mean Sea Level (MSL), he was in level flight and still decelerating. At this point a "discernible noise" accompanied by RPM rollback convinced him he had lost engine operation (Tab V-1-4). The pilot set up a 300 KCAS glide and performed the critical action procedures (CAPs) for airstart with no success At 1309 MST passing approximately 3000 feet above ground level (AGL) (8800' MSL), the pilot initiated a successful ejection (Tab V-1-6 thru 1-8). The aircraft impacted the ground on private property and was destroyed (Tab AA-1-2). After parachuting to the ground, the pilot walked over to a road where passers-by took him to the Police Department in Mountainair, NM. He was examined there by the ambulance crew from Mountainair Hospital. He returned to Albuquerque on a helicopter provided by the New Mexico Army National Guard. He was examined by the 377 ABW Hospital and released (Tab V-1-9,10; X-4).

(2) All accident sequence times are approximate based on Taco flight's 1240 MST takeoff added to the event data recorder 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-9, O-5,7; AA-3-1,2).

NUCLEAR REGULATORY COMMISSION

Docket No _____ Official Exh No. 177

In the matter of _____ EPS

Staff _____ IDENTIFIED ✓

Applicant ✓ RECEIVED _____

Intervenor _____ REJECTED _____

Cont'n Off'r _____

Contractor _____ DATE 7/1/82

Other _____ Witness _____

Reporter _____

(3) Media coverage. The accident generated little local news interest It was reported by the local television stations and newspaper (Tab AA-5). News releases were provided by the 150th Fighter Group (FG) Public Affairs Officer (Tab AA-5).

b. Mission: This mission was briefed and flown as a 4 ship Surface Attack Tactics (SAT) sortie to Red Rio Range within R5107 (Tab V-1 thru V-3). R5107 is approximately 45 NM south of Kirtland AFB (Tab AA-1-1). Mission objectives were to bomb targets on Red Rio Range while denying shot opportunities to Taco 51 who acted as an adversary. Following the initial ingress, multiple reattacks were planned to practice other weapons delivery tactics Mission overview included single ship takeoffs, 20 second spacing, G-warm up, low altitude ingress, threat reactions, air-to-ground attacks, egress and recovery back to Kirtland AFB (Tab V-3).

c. Briefing and Pre-Flight: All flight members had adequate crew rest, IAW AFI 11-206, for their afternoon mission on 5 February 1995 (Tab V-1 thru V-3). The day's activity began with roll call and mass briefing conducted by the Supervisor of Flying (SOF), Captain Alan H. Gabel. The mass briefing included forecast weather for Kirtland AFB and alternates and NOTAMs for applicable airfields A mission briefing was conducted by Captain J. P. Dismukes utilizing the 150th FG briefing guide. Special emphasis was placed on low altitude tactics against radar-missile-equipped adversaries. The briefing was conducted IAW AFI 11-416, F-16 Pilot Operating Procedures. Taco 61 flight departed the squadron at 1155 MST for a 1210 MST engine start. Preflight, start and taxi were uneventful (Tab V-1 thru V-3).

d. Flight Activity:

(1) Taco 61 flight was filed on a TCLM1 stereo flight plan The TCLM1 requests an Instrument Flight Rules (IFR) clearance routing to White Sands Mission Range (R5107), and following a delay, IFR pickup to a recovery back at Kirtland AFB (Tab K-3,4).

(2) Taco 61 flight took off at 1240 MST and proceeded at medium altitude to the entry for VR-176 where they flew at low altitude into R5107 (Tab AA-1-1). While at low altitude in R5107, the flight engaged Taco 51 (acting as an airborne adversary). Shortly after termination of the engagement with Taco 51, Taco 64 noticed the SEC caution light illuminated on the aircraft caution panel indicating the engine had sensed a problem or failure in the engine's primary mode of operation and transferred itself to SEC operation (T.O F-16CG-1, p. 1-22,24). Training activity was terminated, Taco 63 advised Taco 64 to climb and review his situation Taco 64, then decided to fly directly back to Kirtland AFB (Tab N-12). Lieutenant Holzer initiated a 4-5 degree climb initially maintaining his airspeed at 350 KCAS. During the climb, he was continually forced to lower the pitch attitude to maintain his airspeed. At 13,880' MSL he leveled off the aircraft to maintain 350 KCAS (Tab O-5). Shortly after the level off, he felt a further loss of thrust accompanied by a "discernible noise" (Tab J-9, V-1-4) This coincided with a fairly rapid decrease in RPM (which had been holding around 92%). Lieutenant Holzer felt he had lost any useable thrust at that time and initiated CAPs for Engine Failure in Flight and Airstart (IAW AFI 11-416, F-16 Pilot Operating Procedures) He lowered the pitch of the aircraft to 3 degrees of dive to maintain 300 KCAS while he attempted to restart the engine. Following the procedures, he was unable to achieve a restart (Tab O-7; AA-3-1).

(3) Taco 63 joined to assist Taco 64 as he went through his restart attempt. Due to a missed radio channel change Taco 63 was unable to have continuous communication with Taco 64. After one unsuccessful airstart attempt, approaching 8800' MSL (3000' AGL), Lieutenant Holzer accomplished a successful ejection (Tab V-1-6 thru 1-8). At the point of ejection, engine RPM had decayed to 37% (Tab O-10). The aircraft continued approximately two and one half miles further before it impacted the ground and was destroyed (Tab AA-1-2,3-1,3-2).

(4) Post accident analysis of the engine showed the engine failure to be the result of multiple origin fatigue brought about by non-uniform loading which created a high stress cantilevered point load near the clockwise and counter-clockwise corners of four high pressure turbine (HPT) aft disk rabbets causing primary and secondary cracks to form. These cracks continued to grow and caused the four rabbets disks to fracture (Tab J-14,15). Once the disks fractured, a fatigue failure developed in the area of the HPT aft blade retainer ring adjacent to the four fractured rabbets and liberation of a 7.5 inch section of the HPT aft blade retainer ring occurred (Tab J-2 thru J-19). The aft blade retainer ring section exited through the Combustion Discharge Nozzle (CDN) case and punctured the A-1 fuel tank which allowed fuel to leak into the engine bay and exit the aircraft around the nozzle/speed brake area (Tab J-7,8; N-2) The rabbet fragments continued into the low pressure turbine (LPT) creating some domestic object damage (DOD). Additionally, the missing aft blade retainer ring section caused asymmetric rotation of the HPT. The asymmetric rotation caused the turbine blades in the HPT to rub the turbine wall grinding down to between 70% and 30% of their original height. The asymmetric rotation also caused grinding of the three-tooth seal on the HPT rear shaft and LPT rotor assembly (Tab J-4,13,17,18) These failures rendered the engine incapable of further operation (Tab J-4,13,17,18)

e. Airmanship: To clarify the decision process followed by Lieutenant Holzer, the following areas will be reviewed: decision to recover to Kirtland, airstart procedures, ejection procedures, post-landing procedures.

(1) Approximately four minutes 26 seconds passed from the time Taco 64 experienced the SEC caution light until the pilot ejected (Tab AA-3-3 thru 3-9, J-8,9, O-5,6). During that time he covered approximately 20 miles Extrapolating the CSFDR data prior to ejection, the aircraft was 22 miles closer to Kirtland than to Holloman AFB at the time of the SEC light (Tab AA-1-1, 3-3 thru 3-9). Therefore, Kirtland was the closest suitable runway.

(2) Lieutenant Holzer elected to maintain 300 KCAS during his engine start attempt He then proceeded with the airstart IAW T.O. F-16CG-1 page 3-81. He maintained his 300 KCAS glide even after he had confirmed the Jet Fuel Starter (JFS) run light was on The following note appears in the T.O. F-16CG-1:

NOTE

If maximum gliding range is not a factor, consider maintaining 250 knots or more above 10,000' AGL to provide best restart conditions (in case of JFS failure). Below 10,000 feet AGL with the JFS preserving rpm, maintain a minimum of 170 knots plus 5 knots per 1000 pounds of fuel/store weight over 1000 pounds.

Lieutenant Holzer's decision to glide at 300 KCAS with the JFS running below 10,000' AGL lost him approximately one minute and 10 seconds (using T.O. F-16CG-1-1, figure B6-3) of gliding time to achieve an engine start prior to ejection. However, the engine was not capable of restart (Tab J-13).

(3) Lieutenant Holzer ejected at 296 KCAS, approximately 3300' AGL in a 3 degree dive (Tab AA 3-1,3-8). The T.O. F-16CG-1 states on page 3-36 "Ejection should be accomplished at the lowest practical airspeed". His decision to eject at the above parameters created a situation where the seat functioned in Mode 2 (T.O F-16-1, figure 3-5). In addition to exposing himself to additional windblast at ejection, Mode 2 provides a full parachute 1.1 seconds later than Mode 1 (at 8840' MSL, the seat would have operated in Mode 1 below 180 KCAS), reducing the margin for error in a low altitude ejection (T.O F-16-1, figure 3-5). However, Lieutenant Holzer

ejected well within the safe ejection envelope (T.O. F-16CG-1, figure 1-48) and landed with only minor injuries (Tab V-1-9,10, X-2).

(4) Upon landing, Lieutenant Holzer identified a road he thought to be a mile away with a ranch house another 3/4 mile beyond the road He decided to walk to the road where a passing vehicle drove him to the ranch house (no one was home) and then on to Mountainair, NM to the Police Station (Tab V-1-9). He made no attempt to contact his flight on the survival radio. Training for post-ejection actions is provided at the direction of AFR 55-2 in the form of an Air National Guard standard training plan. Although the plan teaches operation of the survival radios, it provides no guidance for the need to make radio contact with recovery forces. By not using his survival radio to make contact, he left rescue forces unaware of his location or condition for approximately 40 minutes. (Tab N-3; AA 2-1,2).

f. Impact: F-16CG, S/N 89-2000 crashed and was destroyed on 5 February 1995 at 1310 MST (Tab AA 2-1,3-2). The impact was on arid ranch land covered by low brush, approximately 5500' MSL, near Blue Springs, NM in Socorro County (Tab P-2). The location was 149 degrees/39 NM from Kirtland AFB (Tab AA 2-1). This is privately owned land used by the owner to graze cattle. Additionally, the impact site was in close proximity to a buried gas line owned by El Paso Natural Gas (EPNG) (Tab P-2; AA 1-2). No claim has been made, at this time, by the property owner or EPNG (Tab AA-11). Flight instruments and final CSFDR data at impact are approximate and indicate the following parameters (Tab AA 3-2, 3-9):

Heading	330 degrees True
Pitch	7 degree dive
Roll	17 degree left bank
Airspeed	288 KCAS
Angle of Attack (AOA)	4.7 degrees
Engine N1	27% RPM
Engine N2	34.5% RPM
Nozzle	-2% open
Fuel Flow	64 Pounds Per Hour
FTIT	948 degrees

g. Egress System: The pilot initiated a successful ejection at approximately 8840' MSL (3000' AGL) in a slight nose low, slight left bank attitude at approximately 296 KCAS (Tab O-8; AA-3-1, 3-8). This is well within the performance envelope of the ejection system (TO 1F-16CG-1, page 3-37). All pyrotechnic components functioned as designed (Tab A-2,V-1-7,8) The initial parachute canopy configuration displayed approximately six twists in the risers causing the canopy not to be fully open. Following a "bicycle kick" motion by the pilot, the risers untwisted and the canopy became fully open (Tab V-1-7). An Emergency Locator Transmitter (ELT) was installed and functioned properly (Tab N-3).

h. Personal and Survival Equipment: All personal and survival equipment inspections were current. The equipment functioned properly during the flight and ejection (with the exception of the parachute canopy deployment discussed in para. g: above) (Tab V-1-7,8; AA 6-1 thru 6-5)

i. Rescue:

(1) Pilot actions: Following his parachute landing, the pilot walked to a nearby road and was met by passers-by who transported him to a ranch house (no one was home), then to Mountainair Police Station where he was met and examined by the Mountainair Hospital ambulance crew and provided with adequate medical attention which consisted of ice for his ankle which had suffered a mild sprain (Tab V-1-10, X-3) Following a call to 150th

FG Operations at approximate[ ]0 MST, Lieutenant Holzer was transported to Mountainair Airport by the ambulance where, at approxim[ ]1502 MST, a New Mexico National Guard helicopter then flew him back to Kirtland AFB (Tab V-1-9; 4-4,5, AA-2-2, 10).

(2) Coordination: The SOF contacted the Rescue Coordination Center (RCC) at Langley AFB, VA to coordinate Search and Rescue (SAR) operations at approximately 1320 MST (Tab AA-2-1; V-4-4). The 58th Special Operations Wing (SOW) Wing Operations Center (WOC) at Kirtland AFB received notification of a SAR effort along with a SAR mission number (their authorization to fly the SAR mission) at approximately 1330 MST from the RCC (Tab AA-9; V-9). The WOC, in turn, notified wing supervisors (Tab V-10, AA-9). The 150th FG SOF and Group leadership continued to work the SAR effort and contacted the 812th Medical Detachment at Santa Fe AP, NM (Tab V-4-5, AA-10). Their organization was conducting flying operations and began coordinating a mission at approximately 1345 MST to proceed to the crash location (Tab AA-10). The 58th SOW commander, Colonel Farage, contacted the 150th FG SOF at approximately 1350 MST and was notified the pilot was at Mountainair and that their services would not be required. The 812th recalled a helicopter training mission, reconfigured the aircraft and crew for SAR and launched at approximately 1410 MST. Major Apadaca, the helicopter pilot-in-command, proceeded to Mountainair, NM where he picked up Lieutenant Holzer at 1502 MST and returned him to Kirtland AFB (Tab V-1,8; AA-10). Air Combat Command (ACC) Command Post called at 1350 MST and was advised the pilot had called in. The 58th SOW was notified at 1415 MST that their SAR mission was on hold. At 1420 MST the 58th WOC was notified by the RCC that their mission was canceled (Tab AA-9-2).

(3) On-site Rescue effort: The on-site effort to find the pilot began with an initial response by the New Mexico State Police (NMSP) and Socorro County Sheriff (Tab AA-12). The Socorro County Sheriff arrived at the crash site at 1400 MST and found no pilot at the crash site (Tab AA-2-2) NMSP officers searched surrounding ranches and, on information from the 150th Command Post, proceeded to Mountainair where they made contact with Lieutenant Holzer at the Mountainair Police Department (Tab V-4-5; AA-2-2).

j. Crash Response: The Socorro County Sheriff arrived at the crash site at 1400 and maintained security until 377 ABW Security Police took over the site (Tab AA-2-2; AA-12). The 377 ABW Security team arrived and assumed crash site security at 1700 MST (Tab V-13). Additionally, the Army National Guard helicopter which transported Lieutenant Holzer to Kirtland flew a site survey team to the crash site arriving at approximately 1600 MST (Tab AA-10)

k. Maintenance Documentation:

(1) **AFTO Forms 781.** No discrepancies were noted in the active, or jacket filed Aircraft AFTO Form 781 Series for aircraft F-16C 89-2000 that relate to this accident (AFTO Forms 781, Tab H).

(2) **TCTO STATUS.**

(a) TCTO's not completed at the time of the accident (Automated records check (ARC), Tab U-1) are listed below:

Aircraft	
1F-16-1894	Install Director element in ILS antenna
1F-16-1998	Inspect canopy seal
1F-16-2000	Inspect DTA Tee and connectors for corrosion, F.O.
L940009	Inspect Rudder Pedal wiring
1F-16-1894	ILS Antenna modification
1F-16-1931	Inspect LE Rotary Actuator

Engine

2J-F110-678	Modify Augmentor Fuel Tube
2J-F110-683	Inspect 2nd stage Fan Blades for Waviness
2J-F110-692	MEC inspection
2J-F110-687	Inspect 2nd Stage Fan Disk

(b) Completed TCTOs. A review of completed TCTOs did not reveal any actions related to the mishap.

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

(3) **Scheduled Aircraft Inspections.** The mishap aircraft was overdue a wash however there were no other overdue inspections on the mishap aircraft All scheduled inspections were properly documented in the AFTO Form 781K and the ARC. (TAB U-1, and U-2).

(4) **Status of Oil Analysis Records.** No significant adverse trend in oil samples was apparent for the mishap engine (TAB U-6). Post impact oil samples were taken and revealed no abnormalities. (Tab J-20).

(5) **Status of Time Change Requirements.** There were no overdue time changes (Tab U-1).

(6) **Unscheduled Maintenance.** The following is a list of unscheduled maintenance on aircraft 89-2000 since its last scheduled inspection on 23 September 1994 (Routine unscheduled maintenance such as tire changes, panels , etc. and LANTIRN discrepancies are not listed.) (Maintenance History Report Tab U-3, and Aircraft 781 series Forms, Tab H):

DATE	MAINTENANCE PERFORMED
23 SEPT 04	MULTIPLE MUX MFLS/CND
30 SEPT 94	REMOVED AND REPLACED LEFT REAR MUX BUS ASSEMBLY
03 OCT 94	REPLACED HIGH PRESSURE BLEED AIR DUCT SEAL
04 OCT 94	REPAIRED AVTR RECORDER
04 OCT 94	HUD DEGRADED/CND
04 OCT 94	EMS BIT BALL TRIPPED/NO DEFECT
04 OCT 94	REPLACED #4 BOOST PUMP LITE
05 OCT 94	CHARGED INS BATTERY
05 OCT 94	REMOVE AND REPLACED CARA R/T
05 OCT 94	REMOVED AND REPLACED RADIO TRANSMITTER
06 OCT 94	REMOVED AND REPLACED RT-1505 (UHF RADIO)
12 OCT 94	REMOVED AND REPLACED #4 BOOST PUMP PRESSURE SWITCH
18 OCT 94	VHF RADIO W/N TRANSMIT/CND
19 OCT 94	CLEANED VHF MICROPHONE SWITCH
19 OCT 94	TIGHTENED COAX ON POWER DIVIDER
20 OCT 94	CLEANED VHF RADIO
25 OCT 94	REMOVED AND REPLACED IGNITION EXCITER BOX AND HIGH ENERGY LEAD
26 OCT 94	RETORQUED FUEL LINE
27 OCT 94	REMOVED AND REPLACED PSP

31 OCT 94	REMOVED AND REPLACED ENGINE AC GENERATOR
01 NOV 94	REMOVED AND REPLACED RADAR ALTIMETER
08 NOV 94	REMOVED AND REPLACED VHF RT
10 NOV 94	VHF SWITCH LOOSE/CND
11 NOV 94	BLED HYDRAULIC SYSTEM
15 NOV 94	VHF W/N TRANSMIT/CND
22 NOV 94	RWR FAIL/CND
23 NOV 94	TIGHTENED LOOSE OXYGEN CONNECTOR
30 NOV 94	REMOVED AND REPLACED GENERATOR CONTROL UNIT
03 DEC 94	REMOVED AND REPLACED HUD EU
03 DEC 94	ADJUSTED L/H GEAR RETRACT ACTUATOR HOSE
03 DEC 94	REROUTED R/H ANT-SKID WIRES
03 DEC 94	TIGHTENED HYDRAULIC B-NUT
04 DEC 94	REPAIRED AVTR
06 DEC 94	REMOVED AND REPLACED ENGINE MONITORING SYS COMP
06 DEC 94	RECONNECTED # 3 BOOST PUMP CANNON PLUG
14 DEC 94	RESEALED FORWARD AND AFT FUEL FLOW TRANSMITTER COUPLINGS
19 DEC 94	REPAIRED LMLG ANTI-SKID HARNESS
03 JAN 94	REPLACED CAUTION LITE
03 JAN 94	REKEYED MODE IV
07 JAN 95	REMOVED AND REPLACED HEAT MONITOR
09 JAN 95	REMOVED AND REPLACED RMLG SPEED SENSOR
09 JAN 95	REMOVED AND REPLACED RT-1159
12 JAN 95	REMOVED AND REPLACED FIRE OVERHEAT CONTROL UNIT
13 JAN 95	A/A TACAN 4/5 MILES FURTHER THAN ACTUAL/CND
17 JAN 95	CARA FAIL/CND
19 JAN 95	REMOVED AND REPLACED HUD EU
19 JAN 95	REMOVED AND REPLACED TACAN RT
20 JAN 95	REMOVED AND REPLACED UHF RT
20 JAN 95	REMOVED AND REPLACED LUBE AND SCAVENGE FILTER
23 JAN 95	COMM CORD INOP/CND
27 JAN 95	REMOVED AND REPLACED SIGNAL PROCESSOR
30 JAN 95	ADJUSTED CARA R/T
31 JAN 95	REMOVED AND REPLACED RADAR ALTIMETER PIN

(a) All unscheduled maintenance was performed by 150th Group maintenance personnel. A review of unscheduled maintenance (Tab U-3) did not disclose maintenance actions which related to the mishap

(b) Unscheduled/ scheduled engine maintenance: A review of unscheduled engine maintenance (Tab U-4) did not disclose any maintenance actions related to the mishap. A review of engine records disclosed that the LPT assembly was time changed for cycle limits in January 1994 (Tab U-8) . There was no unit maintenance performed to the HPT assembly .Unscheduled and scheduled maintenance do not appear to be related to the mishap. A detailed engine history is located at para n(1).

(7) Maintenance Procedures and Practices. There were no maintenance practices, procedures or performance factors which appear related to the mishap

l. Maintenance Personnel and Supervision:

(1) Aircraft 89-2000 received a basic post flight/preflight on 04 Feb 1994 and a walkaround inspection on the morning of the mishap.(AFTO Form 781 H ,Tab U-2-2). AF forms 623, and the special certification roster were reviewed and indicate personnel were qualified to perform assigned tasks.

(2) The mishap aircraft had an incorrect crash survivable flight data recorder Part number installed The P/N installed was for a block 30 aircraft instead of a block 40 aircraft. The unit ordered a correct stock number but received a block 30 part This problem was identified to the item manager and has been corrected. Maintenance procedures and practices did not appear to be factors in the mishap.

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

(1) All fuel in the aircraft was burned upon, or shortly after, the impact, therefore, no post accident fuel samples could be taken. Post accident oil samples did not reveal abnormalities (Tab J-20) Fuel samples were taken from all fuel trucks and revealed no abnormalities (Tab J-21).

(2) A review of oil sample data and engine monitoring system data did not reveal pre-accident adverse trends or metal wear (Tab U-5,6).

n. Airframe and Aircraft System:

(1) Engine history: The mishap engine was received from Tinker AFB OK on 18 December 1992 after having undergone routine depot level maintenance Both the mishap HPT and LPT were installed on the mishap engine after its arrival at Tinker AFB OK. The HPT rotor assembly (00GWNE7006) received a time change and minor overhaul completed 25 November 1991. The LPT assembly was given a minor overhaul on 6 January 1994 [The interval for overhaul of both the HPT and LPT is 3000 Time Accumulated Cycles (TACs). Once the overhaul is completed, the TACs to the next overhaul start again at zero. During overhaul the forward and aft retaining rings are replaced.] The HPT was installed on the mishap engine F110-GE-100 S/N 509796 on 12 June 1992. The LPT was shipped to the 150 Fighter Group and installed on the mishap engine on 28 Jan 1994. The mishap engine was originally installed in aircraft S/N 88-0482 and was removed for an LPT rotor assembly time change The mishap engine was installed on the mishap aircraft on 19 April 1994 There is no indication that these actions related to the mishap The following engine operating times (EOT) in hours apply (Tab U-8, Tab H):

NOMENCLATURE	EOT AT OVERHAUL	EOT AT MISHAP	ACCRUED TIME IN M/A
COMPLETE ENGINE	1172.1	1959 1	333.1
HPT ROTOR ASSEMBLY	1517.9	2312 5	333 1
HPT DISK	1086.8	1881.1	333 1
LPT ROTOR ASSEMBLY	1769.5	2105 5	333 1

The following TAC figures apply to the mishap engine:

	TACS SINCE OVERHAUL/REPLACEMENT
HPT DISK	1522
AFT RETAINING RING	1522
LPT ASSEMBLY	539

(2) Technical and engineering evaluations of the engine and associated components (Tab J-2 thru J-19) revealed that multiple origin fatigue brought about by non-uniform loading created a high stress cantilevered point load near the clockwise and counter-clockwise corners of four high pressure turbine (HPT) aft disk rabbets causing primary and secondary cracks to form. These cracks continued to grow and caused the four disk rabbets to fracture. This resulted in fatigue failure of the aft blade retainer ring adjacent to aft rabbets (No. 48-50, and 55) (Tab J-13,17; U-7-2). The section of the aft retainer ring which fractured was 7.5 inches in arc length at the outside diameter and 4.25 inches in arc length at the inside diameter (Tab J-3). The failure of the aft retaining ring adjacent to aft rabbet 55 resulted in the failure of bolts 51-54. Bolts 51-54 failed due to sheer loading caused by the centrifugal force of the rotating HPT rotor. These failures in turn resulted in tensile loading and failure of bolt No. 50 and the failure of the aft blade retainer ring adjacent to aft rabbets No. 48-50. These bolt failures resulted in the fractured aft blade retainer section separating from the rotating HPT. (Tab J-17) The following damage resulted from the internal failure of the aft retaining ring section and caused the engine to no longer provide useable thrust.

(a) HPT Rotor Assembly. In addition to the damage described above, the forward outer rotating air seal was rolled and had smeared metal at the seal tooth outside diameters typical of heavy rub. Rotor blades showed severe signs of over temp and Domestic Object Damage (DOD) Out board ends of air foils were cropped at the leading and trailing edges. Typical leading edge height was .75 inch, approximately half of the original height. There were some signs of bending and displaced material in the direction opposite of rotor rotation The remaining aft retainer exhibited signs of over temp due to metal-on-metal friction A pattern of distortion resembling a wavy ribbon ran circumferentially along the radial surface outboard of the knife seal. The forward two teeth of the three tooth seal rack were missing along a 250° section of arc. This entire section exhibits ductile deformation where the rack has rolled radially outward from its normal 8° conical form to one between 60° and 80 °. this deformation resulted from the HPT aft shaft wearing against the LPT1 stationary front airseal. (Tab J-3,4,19).

(b) Low Pressure Turbine First Stage Nozzle Assembly. The nozzle was heavily damaged with numerous dents, nicks, and displaced metal. The direction of gouging and material displacement were consistent with deformation resulting from a liberated aft blade retaining ring. Additional severe mechanical and temperature damage occurred to the air seal Most of the honey comb seal was missing along with 90% of the backing material caused by the HPT aft shaft three tooth rack rubbing against it.. All aft surfaces of the seal structure exhibited a prominent blue tint indicative of temperature damage (Tab J-4,17)

(c) LPT Rotor and 2nd Stage LPT Stator. The 1st stage disk was severely damaged by machining and gouging. Recast and splattered metal was present on most surfaces outboard of the seal arm. The condition of all flow path surfaces and components from the 1st stage blades aft was indicative of catastrophic failure due to ingestion of relatively large objects. (Tab J-4)

(d) CDN Case. The CDN case contained a hole approximately 5 inches long (circumferential) by 3.75 inches wide (axial) and several cracks located at a split line between the rear of the HPT rotor and the front of the LPT1 nozzle assembly at approximately 1:00 o'clock. These fractures were caused by the liberated aft blade retainer (Tab J-18).

(e) Outer Fan Duct . The outer fan duct contained a tear approximately 0.500 inches long and two holes approximately 1.00 inches long (circumferential) by .75 inches wide (axial) and approximately 2 50 inches long (circumferential) by 1 00 inches wide (axial) located at the split line between the rear of the HPT rotor and the front of the LPT1 nozzle at approximately 2:00 o'clock These fractures resulted from the liberated aft blade retainer. The duct inside diameter contained metal splatter adjacent to the tear and holes. The metal was analyzed and was either the HPT aft shaft or the LPT 1 stationary airseal, both components had severe wear (Tab J-18,19)

o. Operations Personnel and Supervision: The flight was authorized by Colonel Thomas P. Whitman, the 150th Fighter Group Commander, as a local training sortie and documented on a computer generated ANG Form 35 (Tab AA-8; K-3, V-11). The briefing was conducted in two segments, a mass briefing by Captain Gabel, at roll call, and a mission briefing by Captain Dismukes, the flight lead (Tab V-3). Captain Dismukes was qualified and authorized to lead the flight (Tab AA-7). After the engine failure, supervisory involvement was evident although a radio frequency change directed by Taco 63 was missed by Lieutenant Holzer preventing him from directly conferring with his chase, Taco 63, during the last two minutes prior to ejection Taco 63 was able, however, to confirm Taco 64 had completed CAPs with no success prior to Taco 64's ejection (Tab V-3; N-2, 3, 12,13). Supervision did not appear to be a factor in the mishap.

p. Crew Qualifications:

(1) Examination of individual flight records indicated that Lieutenant Holzer was qualified and current in the F-16 since 23 August 1993 and had amassed 230.8 hours in the F-16 and 456.8 hours total time (Tab G-2).

(2) Review of his training records indicated no discrepancies or weaknesses, Lieutenant Holzer's 30/60/90 day flying experience prior to this accident sortie are as follows (Tab G-2):

	30	60	90
Flying Hours	10.6	18.5	27.1
Sorties	7	13	20

q. Medical: Lieutenant Holzer was medically qualified to fly (Tab T-2) Although no documentation was found to verify his 28 February 1995 physical, Major Graham, 150th FG Flight Surgeon performed the physical and found him qualified to continue flying (Tab V-12). Laboratory results showing a low hemoglobin on Lieutenant Holzer's 7 August 1993 physical were not evaluated but complete blood count performed on the day of the mishap was normal (Tab X-3). Injuries incurred by Lieutenant Holzer as a result of the mishap included superficial abrasions on his neck, chest and arms and a mildly sprained right ankle. These injuries are consistent with trauma from the parachute risers and the parachute landing respectively. Toxicological evaluation performed on the day of the mishap was negative for alcohol and drugs (Tab X-2,3)

r. Navaids and Facilities: All NAVAIDS and facilities relevant to this mission were operating and functional (Tab K-5,6; V-1-11).

s. Weather: Weather was clear throughout the flight and not a factor in this accident. The Red Rio Range observation was clear and 20 miles visibility. The forecast for the morning was the same, with no weather warnings, thunderstorms, or turbulence (Tab K-5,6). The accuracy of the weather forecast and observation was verified by pilots airborne at the time (Tab V-1,2,3).

t. Governing Directives and Publications: There is no evidence of violations of regulations, directives, or publications relevant to this accident Two minor deviations occurred from technical order guidance:

(1) Optimum glide speed was not maintained once the JFS was operating denying approximately one minute ten seconds of additional gliding time (T O F-16CG-1, figure B6-3). This appeared to have no effect on the final outcome, the engine was not capable of restart (J-13).

(2) Ejection was performed at 296 KCAS rather than the "lowest practical airspeed" as stated in T.O. F-16CG-1, figure 3-5. The ejection did, however, occur well within the ejection envelope for a safe ejection (T.O. F-16CG-1, figure 1-48). Lieutenant Holzer's decision to eject at 296 KCAS appeared not to be a factor in the mishap, he ejected successfully and sustained only minor injures (Tab X-2; V-1-7,8).

Primary regulations applicable to this mission were:

AFI 11-206, General Flight Rules
AFI 11-208, Aircrew Training
AFR 50-46, Weapons Ranges
MCI 11-416 F-16 Pilot Operational Procedures
MCM 3-3 Vol 5, Mission Employment Tactics, F-16
MCM 3-1 Vol 5, Mission Employment Tactics, F-16 (S)
T.O 1F-16CG-1 Flight Manual
150th Fighter Group Inflight Guide

RICHARD F. DUHACHEK, Lt Col, USAF,
AFI 51-503 Investigating Officer

3. STATEMENT OF OPINION:

a. Under 10 U.S. Code 2254(d) any opinion of the accident investigator's 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 5 February 1995 aircraft accident involving F-16CG (Block 40) S/N 89-2000, has resulted in the following opinions:

(1) (CAUSE) Multiple origin fatigue brought about by non-uniform loading created a high stress cantilevered point load near the clockwise and counter-clockwise corners of four high pressure turbine (HPT) aft disk rabbets causing primary and secondary cracks to form. These cracks continued to grow and caused the four rabbet disks to fracture. [The cause of the non-uniform loading could not be determined.]

(2) (CAUSE) The failure of the four rabbet disks created an overstress and overtemp condition on the aft blade retainer ring which fractured. This fracture caused DOD as well as asymmetric rotation of the high pressure turbine (HPT). The asymmetric rotation caused the HPT blades to grind down against the turbine wall and caused the grinding of the three-tooth seal located on the HPT rear shaft against the LPT rotor assembly. The combination of these damages made the engine incapable of further operation.

(3) Lieutenant Michael Holzer was confronted with a SEC caution light. He terminated his training mission and began a recovery to the closest suitable airfield. The problem progressed to a complete engine failure. He applied the correct critical action procedures and attempted to restart his engine. His glide speed was faster than recommended but an optimum glide would not have helped, the engine was inoperable. One minute and five seconds after the engine failed, at approximately 3000' AGL and 296 KCAS, he successfully ejected from the aircraft. Once again, he was not in optimum ejection parameters (he had not pulled the aircraft into a climb to reduce his speed to minimum practical), but he ejected well within safe parameters and suffered only minor injuries. With no engine operating and no emergency airfield within gliding distance, Lieutenant Holzer's decision to eject was correct.

RICHARD F. DUHACHEK, Lt Col, USAF,
AFI 51-503 Investigating Officer