AIRCRAFT ACCIDENT INVESTIGATION

FORMAL REPORT OF INVESTIGATION

Hill AFB, UT — 4 February 1997
F-16D, Block 30 — S/N 87-0385

1. AUTHORITY AND PURPOSE:

The Commander, Twelfth Air Force, Air Combat Command (ACC), appointed Lieutenant Colonel Chase J. Johnson, 132d Fighter Wing Air Force Advisor, Des Moines Iowa Air National Guard, on 2 April 1997, under AFI 51-503, to investigate and determine the facts and circumstances surrounding the destruction of Aircraft F-16D, S/N 87-0385, which occurred 4 February 1997, near Wendover, Nevada. Major Roger L. Jones, 419FW/JA, Hill AFB, UT was appointed on 7 March 1997 as legal advisor. Captain David C. Adams, 96BS/SGP, Barksdale AFB, LA was appointed as medical advisor on 2 April 1997. First Lieutenant Reginald G. Short, 421FS/MA, Hill AFB, UT was appointed maintenance advisor on 19 March 1997. (TAB Y-1 thru Y-4)

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 Flight . Two F-16 Block 30 aircraft took off from Hill AFB on 4 Feb 97 at 1808 local (L) Mountain Standard Time (MST), 0108 Zulu (TAB AA-2). Cyborg 1 was a D model with pilot Major Edward G. Goggins and flight surgeon Captain Mark C. Snyder and Cyborg 2 was a single seat C model. (TAB K-3) The flight flew a night instrument departure, climbing to medium altitude into the Utah Test and Training Range (UTTR) to conduct night air refueling operations. Following air refueling, the flight descended to approximately 7000' mean seal level (MSL), about 2900' above ground level (AGL), to conduct night bombing events on Eagle range. The flight lead canceled the range work due to weather conditions and the flight climbed to 25,000' MSL to execute the alternate mission of night 1v1 tactical intercepts. During the first intercept Cyborg 1 was the target for Cyborg 2 (TAB V-67). At 1851L both the pilot and flight surgeon in Cyborg 1 heard and felt a quick series of loud bangs, transmitted "knock it off", and advised Clover control, the ground controlled intercept (GCI) agency, and his wingman of an engine failure (TAB N-2, V-7, V-27) . At the same time, approximately 14 miles away and not visual with Cyborg 1, the wingman observed a "trail of sparkles" from Cyborg 1's general area and quickly acquired Cyborg 1 and began to rejoin (TAB V-67). Passing 24,000' MSL Cyborg 1 attempted a spooldown airstart without success. Passing 20,000' MSL Cyborg 1 jettisoned external stores and attempted three jet fuel

NUCLEAR REGULATORY COMMISSION

Docket No _____ Official Exh No 189

In the matter of PFS

Staff ✓ IDENTIFIED ✓

Applicant _____ RECEIVED _____

Intervenor _____ REJECTED _____

Cont'g Off'r _____

Contractor _____ DATE 7/1/02

Other _____ Witness _____

Reporter GH

starter (JFS) assisted airstarts, all unsuccessful (TAB V-7 thru 10). Clover advised Cyborg flight the minimum vectoring altitude in the area of 10,100' MSL (TAB N-2). At 1857L, passing 10,100' MSL with the engine rpm still at 15%, Cyborg 1 zoomed the aircraft for ejection (TAB N-4, V-10). The pilot in the front cockpit (FCP) initiated ejection and a reverse ejection sequence occurred, the FCP seat ejected first followed by the RCP seat (TAB J-60,V-11, V-31). The aircraft impacted the ground approximately 11 miles northeast of Wendover, Nevada on federal land managed by the Bureau of Land Management (BLM) (TAB DD-2). The aircraft was totally destroyed (TAB M-2). The pilot received a broken ankle and the flight surgeon sustained burns to the face, neck, wrists, and inner thighs (TAB X-2,3). An H-60 Blackhawk from the Army National Guard located at Salt Lake City Airport Number 2 recovered the crew and flew them to the Wendover airport where they were transloaded to a civilian Air Med helicopter and taken to the University of Utah hospital in Salt Lake City TAB V-73,74, V-75). Major Goggins was treated for a broken ankle, kept over night for observation, and transferred to the Hill AFB hospital the next morning (TAB X-2). Captain Snyder was admitted to the University of Utah hospital's burn center for observation and treatment of his burns (TAB X-3). There were no other injuries sustained by the crew (TAB X).

(2) All accident sequence times are referenced to local Mountain Standard Time, Zulu minus 7, and are accurate based on Clover control radar tapes and transcripts of communication with Cyborg flight and witness testimony (TAB N, V). Aircraft impact data is based on the analysis of post-crash flight and navigation instruments (the crash survivable flight data recorder and engine monitoring system computer were not recovered) (TAB J-70).

(3) Media coverage. The accident generated some local news interest and was reported by the local media (TAB GG-5 thru 11). News releases were provided by the Ogden Logistics Center Public Affairs Office, Air Force Materiel Command, and 419th FW Public Affairs Office of the Air Force Reserve Command (TAB GG-2 thru 4).

b. Mission: The mission was briefed as 2 ship night air refueling in R6406 followed by night surface attack to Eagle range within R6404, with a weather backup of 1v1 tactical intercepts (TAB V-2, V-66). R6406 and R6404 lie within the UTTR and is approximately 50-70 miles west of Hill AFB (TAB AA-6). Mission overview was single ship take-off, 20 second radar trail departure, tanker rendezvous and air refueling, range entry and range work, and instrument recovery to Hill AFB (TAB V-2, V-66).

c. Briefing and Pre-Flight: All flight members had adequate crew rest for the 4 February mission (TAB V-3,4, V-24, V-66). According to the flight members all aspects of the mission planning were normal. Major Goggins conducted the briefing using the 466 Fighter Squadron (FS) briefing guide. Special emphasis during the briefing was on engine problems and egress procedures. Flight members stated the briefing was thorough and adequate and conducted IAW Air Force Instruction (AFI) 11-F16 VIII (TAB V-4, V-66). Preflight events, step, start, and taxi were uneventful (TAB V-4, V-66).

d. Flight Activity:

(1) Cyborg flight was filed on a Island 06 (IL06) stereo flight plan (TAB K-3). IL06 is an instrument flight rules (IFR) departure clearance routing for delays in restricted areas R6406 and R6404 followed by an IFR recovery to Hill AFB (TAB AA-3).

(2) Cyborg took off at 1808L, sunset was 1748L (TAB K-4, AA-2). The flight proceeded with the IFR clearance climbing through the weather to join on the tanker orbiting around 20,000' MSL (TAB V-5). All ground navigation and communication equipment were in operation (TAB V-4, V-25, V-66). Cyborg 1 and 2 estimated their flight entered the weather about 6500 - 7000' MSL and were in and out of layers up to at least 15-16,000' MSL. Weather conditions were clear on top at 20,000' MSL and pitch black with no moon illumination (TAB V-4, V-66). Neither the Cyborg pilots nor any other 466 Fighter Squadron pilots flying that night observed any icing conditions (TAB V-57, V-61).

(3) Cyborg flight completed an uneventful air refueling, resumed radar trail formation, and received vectors for course alignment and altitudes for descent from Clover control for entry onto Eagle range. Range weather was reported workable and Cyborg flight, in radar trail, flew across the range at approximately 7000' MSL, about 2900' AGL. Cyborg 1 and 2 agreed that the lack of a visible horizon and poor visibility made the range unworkable and started a climbing left turn to the west to set up for intercepts. After climbing back above the weather and passing 20,000' MSL, Cyborg 1 turned back to the east and cleared Cyborg 2 to continue west for separation. Cyborg 1 was the designated target for Cyborg 2 as they turned back towards each other for the intercept. Cyborg 1 was in a left climbing turn towards the west, passing 25,000' MSL, approximately 370 knots calibrated airspeed (KCAS), and roughly midrange afterburner when the crew felt and heard several very loud and very explosive bangs and at 1851L called "knock it off" for an engine failure (TAB N-2, V-5 thru 7, V-27).

(4) Cyborg 2 was about 14 miles away without sight of Cyborg 1 and acknowledged the knock it off. Looking towards the general vicinity of his radar target he observed a "trail of sparkles" and then shortly gained sight of Cyborg 1 and began to rejoin (TAB V-67).

(5) Both the pilot and flight surgeon described the engine failure as a series of aspirated, loud bangs (about five) with associated engine surging (TAB V-7, V-27). The pilot brought the throttle to military power and experience three more bangs and called "knock it off". The pilot retarded the throttle to idle and as the rpm fell below 60% with the fan turbine inlet temperature (FTIT) in excess of 1000 degrees (Celsius) brought the throttle to off. With FTIT decreasing and the rpm approximately 45% he placed the throttle to midrange for a spooldown airstart. The rpm had stagnated at 45% and the FTIT immediately rose quickly to 800-850 degrees and kept rising. He placed the throttle to off, jettisoned his external stores and passing 20,000' MSL selected JFS start 2. As the airspeed slowed to about 220 KCAS he manually selected SEC for engine control,

noticed the SEC light on, JFS run light on, and rpm steady at 15%. At 1854L, passing 19,500' MSL, he placed the throttle to midrange for a JFS assisted airstart. FTIT immediately began to rise rapidly towards 1000 degrees with no associated increase in rpm. The throttle was again placed to off and the FTIT decreased rapidly. The pilot nosed the aircraft over slightly to increase the airspeed, placed the throttle to midrange, and transmitted they might have to get out of the aircraft. Again the FTIT rose rapidly with rpm still at 15% and the throttle was positioned to off (TAB V-7 thru 10).

(6) The pilot, the flight surgeon in the RCP, Cyborg 2, and Clover control were all monitoring Cyborg 1's altitude in reference to the minimum vectoring altitude of 10,100 feet MSL while on a southwesterly heading toward Wendover airport, the emergency runway (TAB N-2, V-9, V-28, V-67). At this time they were roughly 20-25 miles northeast of Wendover (TAB R-2). Approaching 14-15,000' MSL in a descent, Cyborg 1 began to enter the weather and Cyborg 2 broke off from his chase position and notified Clover control he could not maintain visual and directed them to track the aircraft (TAB V-67).

(7) At 1856L Cyborg 1 began crew coordination on the potential ejection as they attempted a third and final JFS assisted (fourth total) airstart. Passing 11,000' MSL Clover gave a cautionary altitude warning (TAB N-4). At 10,100' MSL with no change in rpm and the FTIT rising rapidly, the throttle was positioned to off and the aircraft zoomed for ejection. In the final seconds the pilot placed the throttle to idle and made a radio transmission they were getting out (TAB N-4, V-67). With the RCP flight surgeon in a proper sitting position for ejection and the aircraft apexing at about 10,400 feet MSL (6200' AGL) the FCP pilot initiated the ejection at 1857L (TAB N-4, V-11). The ejections were reverse sequence with the FCP ejection seat firing first followed by the RCP ejection seat (TAB J-69, V-31). The aircraft continued to descend, traveled about 1 1/2 miles, impacted the ground, and was destroyed (TAB A-2, R-2).

e. Impact: F-16D, S/N 87-0385 crashed and was destroyed on 4 February at 1858L (TAB A-1). The impact was in mud flats, approximately 4200' MSL, near the Bonneville Salt Flats, approximately 11 miles northeast of Wendover, Nevada (TAB A-2, R-2). The impact site is on BLM land in Tooele County, Utah (TAB A-2, DD-2). Flight instrument data analysis are approximate and indicate the following parameters at impact (TAB J-70 thru J-72, J-57):

Pitch	35 degrees nose low
Roll	60 degrees right
Airspeed	320 KCAS
Angle of Attack	10 degrees
Vertical Velocity	6000 feet per minute down
Fuel Flow	Approximately 500 pounds per hour
Engine RPM	Little or none

f. **Egress System:**

(1) The pilot initiated the ejection sequence from the FCP. The canopy came off followed by the FCP ejection seat (TAB V-10). The flight surgeon recalls seeing a white, bright flash and then felt the impulse of his seat firing. He did not recall pulling his handle (TAB V-31). Post-crash analysis indicated the both ejection seat handles had been pulled (TAB J-60). The RCP ejection mode select valve was in the AFT position as noted by the flight surgeon and post-crash analysis of the valve (TAB J-58, V-30). Analysis of the egress system revealed one likely scenario for the out of sequence ejection would be crossed ballistic hose connections (TAB J-60).

(2) Cyborg 2 was approximately 4-5000' above Cyborg 1 at the time of the ejection, and although Cyborg 1 had descended into the weather, Cyborg 2 was able to see a flash and then heard the emergency locator transmitter (TAB V-67).

(3) Both crewmen felt the opening shock of their parachutes and assessed they had good chutes with no blown panels, broken lines, or twisted risers and the survival kits had deployed (TAB V-10, V-32). The flight surgeon noticed his flight suit and long underwear were gone from his mid to upper thigh and he had to tap out small flames on the upper portion of his anti-gravity suit (G suit) (TAB V-33). The crew could see each other in their chutes and were able to shout at each other that they were all right and estimate they were in the chutes about 8-10 minutes (TAB V-11, V-34). As they descended in the clouds it was dark with no horizon, there were snow showers in the area, and they could not see the ground but could see the burning wreckage of their aircraft (TAB V-12, V-34). The pilot was the first to reach the ground and heard a snap and felt extreme pain (TAB V-11). The pilot broke his left ankle during his parachute landing fall (PLF) (TAB V-11, X-2). The flight surgeon heard the pilot scream which alerted him to prepare for his PLF and at the last second noticed the ground coming up at him (TAB V-35). The crew found themselves in about 6" of very cold water with the underlying ground was as hard as concrete (TAB V-35).

g. **Personal and Survival Equipment:** All personal and survival equipment inspections were current and all equipment functioned properly. The darkness and the problem of having been soaked in very cold water initially made it difficult for the crew to locate and use some of the equipment. A flashlight the flight surgeon had stowed in his G suit just prior to ejection proved invaluable in locating some wool gloves so they could operate their survival equipment (TAB V-12, V-48).

h. **Rescue:**

(1) The ejection occurred at 1857L and the aircraft impacted the ground at 1858L (TAB A-2, N-4). Cyborg 2 transmitted to Clover the crew from Cyborg 1 had ejected and flew over the location and used onboard equipment to note the latitude and longitude coordinates of the point of ejection. Cyborg 2 witnessed the fireball of the aircraft impact and was able to obtain coordinates of the crash site (TAB V-67). The

initial call for rescue came from Clover control at approximately 1857L. They simultaneously contacted the 419FW Supervisor of Flying (SOF), the Tooele County Sheriff's office and the Hill AFB Consolidated Command Post (HCCP). Clover control then started working who was available to stay airborne over the crash site, make contact with the crew, and control the rescue effort (TAB V-69). It was about 15 minutes after the ejection when Cyborg 1 came up on UHF 282.8 and made initial contact with Cyborg 2 with their status (TAB V-13).

(2) The impact was reported to be about 15 miles northeast of Wendover, Nevada so the Tooele County sheriff's office dispatched one of their deputies to attempt to drive to the crash site and assist the survivors. The deputy made two attempts to reach the survivors. Initially he was able to locate their position by relaying a request to Clover on his cellular phone to have the crew pop a flare. Moments later he was able to see the flare and pinpoint their position. An attempt from Interstate 80, south of the crew, and a westerly approach were both aborted due to the mud and water. The deputy called other civil authorities, searching for all terrain vehicles and a flat bottom boat (TAB V-70, FF-4,5).

(3) Cyborg 2 was running low on gas and was replaced by another 419th pilot, callsign Alta 1 who was diverted from his training mission. Alta 1 orbited the crew at about 15,000' MSL and relayed information between the survivors, Clover control, and the SOF (TAB V-57). An MC-130, who had been scheduled for intercept training with Alta 1, was airborne in southern portion of the UTTR and offered assistance. The MC-130 was equipped with terrain following radar (TFR) and night vision goggles (NVGs). After proceeding to the KC-135 tanker and getting more gas, they descended through the weather and located the crew with their NVGs and set up a low altitude orbit over their location. The MC-130 crew reported the weather in the area as 500' ceiling, snow showers, and visibility 2-3 miles. They made contact with the crew on UHF 282.8 and dropped flares over their position (TAB V-76).

(4) The 419FW anticipated problems with the ground rescue party and contacted the 211th Aviation Group, Utah Army National Guard located at Salt Lake Airport Number 2, to determine whether they had a helicopter they could send to the crash site. Additionally, the 419FW contacted a civilian helicopter air ambulance service, Air Med, associated with the University of Utah hospital (TAB V-53, V-55, V-64). Decisions as to the medical care of the crew were left to the medical experts (TAB V-53).

(5) The HCCP initiated a recall and the 75ABW/CC and his staff convened in the command post. A flight surgeon from the Hill AFB hospital was a member of this team and was making recommendations for medical care (TAB V-94).

(6) The Army National Guard received the 419th request at approximately 1925L and launched an H-60 Blackhawk helicopter at 2000L. Using NVGs and following Interstate 80 to the west, the Blackhawk crew flew under low weather ceilings and through poor visibility to a position south of the survivors. At about 2100L, referencing

the flares from the MC-130, they were able to locate the survivors. Initial concern for the pick up was the depth of the water and the strength of the ground below the water. They set down and brought the Cyborg 1 crew onboard the Blackhawk at 2110L (TAB V-73,74).

(7) Air Med launched a helicopter for the rescue. The pilot flew IFR to Wendover airport and knowing the Blackhawk was approaching the survivors landed at Wendover at approximately 2115L (TAB V-75).

(8) Three plans were being considered for the rescue (TAB V-55, V-73).

(a) The Blackhawk would pick up the crew and transport them to Hill AFB.

(b) A faster way was for the Blackhawk to go to Wendover airport and transload the crew to the MC-130 for transport to Hill AFB. An option to this plan was for the Blackhawk to take the crew to Wendover, and along with the Air Med medics, everyone would board the MC-130.

(c) The final option was for the Blackhawk to transload the crew to the Air Med helicopter at Wendover and transport to Hill AFB.

(9) The executed plan centered on the Blackhawk bringing the crew to Wendover and transload them to either the Air Med helicopter or the MC-130 for transport back to Hill AFB (TAB V-15, V-39 thru 41). The Blackhawk arrived at Wendover at approximately 2120L and since the MC-130 was just landing, the Air Med medics loaded the crew into their helicopter for transport to Hill AFB (TAB V-74,75). Enroute to Hill AFB the medics felt that because of the burns to the flight surgeon, they would go to the University of Utah hospital burn center (TAB V-75).

i. Crash Response: There were no delays encountered in responding to the crash site. The Tooele County Deputy Sheriff secured the closest access road until handed over to security police from the UTTR. At 0041L the site was turned over to a member of the 75th Security Police Squadron who was part of the 75ABW initial response element (TAB V-77, HH-3). One law enforcement officer from Wendover was at the airport and recorded the crew's names for his report (TAB V-77).

j. Maintenance Documentation

(1) **AFTO Forms 781.** No discrepancies were identified that relate to the aircraft mishap in either the active 781 forms or the jacket files for aircraft 87-0385.

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

(a). There were seven uncompleted airframe-related TCTOs at the time of the mishap sortie (TAB H-3, TAB EE-1, TAB U-76). They are summarized below in Table 1, Uncompleted Airframe Related TCTOs.

Table 1. Uncompleted Airframe-Related TCTOs

TCTO	Narrative Translation	Note
1F-16-1790	*Replacement of Have Quick Radio ARC-164*	**Note 1.1**
F-16-1950	*Replacement of Airborne Video Tape Recorder*	**Note 1.2, 1.6**
1F-16-1957	*Replacement of An/ALE-40 Sequence Switch with AN/ALE-47*	**Note 1.2**
1F-16-2018	*Modification of Dispensing Set A1/ALE-40 Programming Assembly Event Type*	**Note 1.2**
1F-16-1966	*Modification of Enhanced A/C Power Lever Signal System*	**Note 1.4**
1F-16-2099	*Seat Removal for Inspection and Rework of P4 Lead*	**Note 1.3**
1F-16-2093	*Inspection of 16P3180-1 Duct Seal Installation For Proper Engine Seal*	**Note 1.5**

Note 1.1. Accomplished 29 Jan 97. (TAB U-72)

Note 1.2. Systems are unrelated to mishap. (TAB H-3, TAB U-76)

Note 1.3. Involves work on an area unrelated to gas generators, initiators, and sequence valves described in the seat ejection initiation sequence. (TAB J-60, TAB J-62, TAB EE-8)

Note 1.4 This TCTO was in abeyance at the time of the mishap, an area unrelated to the mishap

Note 1.5 Accomplishment of this TCTO relates only to configuration management, and is therefore unrelated to mishap

Note 1.6 This TCTO was not identified in the TAB H review of open TCTOs. See TAB EE-1 for explanation

(b) Twelve engine-related TCTOs were not completed on the engine at the time of the mishap sortie (TAB H-4 and TAB U-76). These are summarized in Table 2, Uncompleted Engine-Related TCTOs.

Table 2. Uncompleted Engine-Related TCTOs

TCTO	Narrative Translation	Note
2J-F110-665	*Bearing #3 Retourque Required*	Note 2.1
2J-F110-711	*Inspection of #4 Bearing for Matched Set*	Note 2.1
2J-F110-671	*Install HPT Damper Sleeve*	Note 2.1
2J-F110-714	*Inspection of HPT Turbine Disk*	Note 2.2
2J-F110-718	*Inspection of Turbine Disk Bobbit Contour*	Note 2.2
2J-F110-700	*Install HPT Rotating Air Seal*	Note 2.2
2J-F110-674	*Replacement of the Safety Wire on Fuel Manifold Sectors*	Note 2.2
2J-F110-720	*X-ray Inspection of the MEC and Hydroclone Filter*	Note 2.3
2J-F110-705	*DEC Modification*	Note 2.4
2J-F110-703	*Installation of Locking Ring Assembly P/N 1864M50P01 on Main Fuel Nozzle*	Note 2.5
2J-F110-663	*Rework of Exhaust Nozzle Assembly to Improve Hinge Wear and Reduce Corrosion*	Note 2.6
2J-F110-701	*Removal of HPT Damper Ring and Installation of Sleeve*	Note 2.2

Note 2.1 Evaluated by the experts as being in good condition prior to the mishap (TAB J-51,53)

Note 2.2 Judged unremarkable by technical experts. No signs of pre-impact failure identified. (TAB J-51, TAB J-52, TAB J-53, TAB J-54)

Note 2.3 There was a material deficiency report submitted on the MEC (TAB I-9). No information on the status of the materiel deficiency report is available.

Note 2.4 This TCTO calls for the replacement of the MEC by the Digital Engine Control (DEC). Slower fuel scheduling rates can be expected in some circumstances (TCTO 2J-F110-720).

Note 2.5 Replaces safety wire on attach points for fuel nozzles (TCTO 2J-F110-703). The stated purpose of the TCTO is to eliminate a concern over broken safety wire from these areas (TCTO 2J-F110-703).

Note 2.6 Overtemperature discoloration and sooting were observed in the combustor section (TAB J-56). No remarks about corrosion or hinge wear noted in tear down analysis (TAB J-56).

(c) One completed TCTO relates to the mishap. TCTO 2J-F110-719, Inspection of F-110-GE-100 Engines for Serviceability of Stage One Fan Blades, involves an examination of stage one fan blades for signs of cracking (TCTO 2J-F110-719). It was completed within the specified time period on 24 Jan 97 with no defects noted (TAB U-69. The individual who completed that TCTO was trained and qualified to

perform the inspection of this area (TAB EE-43 thru EE-48). This was the only occasion that an individual trained in the new engine intake inspection criteria examined the first stage of the fan blades (TAB U-69)

(d) There were no discrepancies that relate to TCTO scheduling or accomplishment that relate to this mishap.

(3) Scheduled Aircraft Inspections.

(a) The only aircraft scheduled inspection overdue at the time of flight was an aircraft wash, an event unrelated to the mishap (TAB U-86, TAB U-3). This event was documented properly in the aircraft forms. The overdue inspection listed for the battery capacitance check due on 15 January, 1997 refers to a backshop check of an aircraft battery previously removed from the aircraft (TAB U-86).The aircraft battery check was not due until 17 February, 1997 (TAB U-89). All other scheduled maintenance actions were completed and documented correctly (TAB U-86 thru U-103, TAB U-3 thru U15) A 30-day records check was coming due the day after the mishap sortie (TAB U-86).

(b) On 16 January, 1997, a 50-hour engine borescope was completed and signed-off by SSgt Scott Hurley (TAB U-105, TAB U-59) with no defects noted. The combustor dome, HPT aft blade retainer and blade platform, and combustor diffuser Nozzle case mid flange were all evaluated during this inspection, and a low-energy ignition check was performed (TAB U-105). He is trained and qualified to perform inspections in this area (TAB EE-47 thru EE-52). During the performance of this borescope, a right fuel nozzle was removed to allow borescope access (TAB U-68). The required In-Process Inspection was documented, and the work was performed by trained and qualified personnel (TAB EE-47 thru EE-52). The last 100-hour borescope occurred while the aircraft was in phase, on 20 October, 1996 (TAB U-104). Only one item was noted during this inspection, and that was that TCTO 2J-F110-674 was not completed on the bottom portion of the fuel manifold (TAB U-104). The TCTO specifically states that you may delay accomplishment of this portion until such time as you have JEIM exposure of the upper and/or lower fan ducts (See TCTO 2J-F110-674). SSgt Hurley was trained and qualified to perform this inspection (TAB EE-47 thru EE-52).

(c) A life support 30-day inspection was performed on 27 January, 1997 (TAB U-69). Technical data was current and employed, and the individuals who performed the task, SMSgt Anderson, and SSgt Burke, were trained and certified appropriately (TAB EE-37 thru EE-38, EE-36). An egress final was performed immediately following the 30-day life support, and no discrepancies were noted (TAB U-69). SSgt Thomas, the individual who performed the task, was in upgrade training status and was supervised adequately by a qualified individual, MSgt Chapman (TAB EE-22 thru EE-29, EE-30 thru EE-35).

(d) A walk-around intake inspection was performed in accordance with T.O. 1F-16C-6WC-1-11 on the day of the mishap by SSgt Yates with no discrepancies noted (TAB V- 81 and TAB U-4). An intake inspection was performed just prior to flight by TSgt Johnson with no discrepancies noted (TAB V - Johnson summary and TAB U-8). Both sets of 623s reflect initial training for intake inspections (TAB - EE-53 thru EE-66, EE-67 thru EE-81). Technical data employed in the task was current. A record of accomplishment of these inspections could be observed throughout the 90-day 781 forms summary (TAB H-5-H-47)

(4) **Status of Oil Analysis Records.** No significant adverse trends in oil samples were apparent. Pre-accident sampling did occur, with the last analyzed sample being collected just prior to the mishap sortie, the second sortie of the day (TAB O-2). The presence of tin (Sn) is considered negligible during analysis (T.O. 33-1-37-3, table on page A-134). The level of titanium in the sample was well inside established limits (T.O. 33-1-37-3 table on page A-134). Joint Oil Analysis Program (JOAP) sampling of oil carts used in servicing the aircraft all checked good as well (TAB O-13 thru O-15).

(5) **Status of Time Change Requirements.** There were no overdue time changes on the aircraft (TAB U- 86 thru U-103)

(6) **Unscheduled maintenance.**

(a) A 90-day review of the 781 forms for this aircraft showed that all unscheduled aircraft maintenance was performed by 419th FW personnel, and was unrelated to the mishap (TAB H5-H47).

(b) A 90-day review of the 781 forms for unscheduled engine maintenance produced an afterburner no-light problem that occurred on 07 January, 1997 (TAB H-20), an afterburner no-light problem that occurred on 07 December, 1996 (TAB H-32), an Engine No-Go Bit Ball on 12 November, 1996 (TAB H-42), and an Engine No-Go Bit Ball on 08 November, 1996 (TAB H-44). A comparison of these maintenance actions with the post-crash engine analysis (TAB J-49-J-57) produced no correlations between concerns about engine performance, and previous maintenance actions.

(c) The last time the seat and canopy were pulled from this aircraft was during the phase inspection on 23 October, 1996 (TAB U-22, TAB U-37). Both the front and aft seat was removed at this time (TAB U-22, U-37). The technicians who performed the work were certified and trained to complete their job (TAB EE-22 thru E-29, TAB EE-30 thru EE-35). All AFTO 781 forms documentation was complete and accurate (TAB U-22, TAB U-37). In addition, a number of ejection initiators and mortar cartridges were replaced for time change during this time as well (TAB U-74).

(d) The last time the engine was removed was during the phase inspection on 30 October, 1996, to aid in the completion of TCTO 1-F16-1891, Modification of Engine Control System (TAB U-46). The technician that performed the

work was certified and trained to perform the task (TAB EE-47 thru EE-52). All forms entries were done (TAB U-46 thru U-52).

(7) **Maintenance Procedures and Practices.** The only maintenance practice related to the accident involves the training of the two crew chiefs assigned to perform the aircraft intake inspection. New criteria were released for certifying people to perform this inspection in a message dated 071356Z Nov 96 (TAB EE-3 thru EE-5). Training on the new inspection criteria was delayed until arrival of GE contractor personnel to perform initial training to selected certifying officials and maintenance trainers, and then units were allotted 90 days to provide the training to all other relevant maintenance personnel. GE personnel trained TSgt Chatwin of the propulsion shop on 22 Jan 97, and his records reflected his new certification date as of that time (TAB EE-43). TCTO 2J-F110-719, Stage 1 Fan Blade Inspection, was performed by TSgt Chatwin on 24 January, 1997, after he received training in the new criteria (TAB U-69) Neither crew chief was certified in the new procedures until 08 February, 1997 (TAB EE-82, EE-83). It is impossible to determine the impact of training on the mishap.

k. Maintenance Personnel and Supervision

(1) **Preflight Servicing.** The aircraft was serviced with fuel (TAB U-8), LOX (TAB U-5) and oil (TAB U-7) in accordance with established maintenance procedures (TAB V-81). Supervision was adequate for the task, and there were no line supervisors filling unfamiliar roles (TAB V-81, V-79). Review of 90-day history of 781 forms shows a strong documentation trail for servicing actions, with the exception of tire pressure servicing (TAB H-5 thru H-47). However, this area is unrelated to the aircraft accident.

(2) **Training and Experience.** Both SSgt Yates, the Assistant Dedicated Crew Chief, and TSgt Johnson, The Dedicated Crew Chief, had at least three years worth of experience on the Block 30 F-16 airframe (TAB V-79, TAB V-81). A review of their training records shows they were trained and certified to perform all required tasks (TAB EE-53 thru EE-66, EE-67 thru EE-81). TSgt Chatwin, the individual who performed the last stage 1 Fan Blade inspection, had over three years of experience with the General Electric F-110 engine, and had sufficient training and certification to perform his tasks (TAB V-91, TAB EE-41 thru EE-46). SSgt Hurley, the individual who performed the last 50-hour borescope, was adequately trained and certified to perform that task (TAB EE-47 thru EE-52). Other specialists have their training and experience discussed under their corresponding maintenance action.

l. Engine, Fuel, Hydraulic, and Oil Inspection Analysis

(1) **Engine Inspection Data.** Comprehensive Engine Management System (CEMS) trending of Engine Monitoring System Computer (EMSC) data shows this particular engine to be an average performer with no measurements that would

indicate impending failure (TAB V-92 and TAB EE-3 thru EE- 5) . The last recorded pilot data save was on 08 November, 1996 (TAB EE-5). The EMSC was one of the components that was not recovered from the aircraft crash site.

(2) **Fuel Data.** Fuel samples taken from the KC-135 and from the ground servicing truck at Hill AFB, Utah tested as normal (TAB O-3, TAB O-5, TAB EE-10 thru EE-17).

(3) **Hydraulic Fluid Data.** Hydraulic fluid tested from aircraft brakes, horizontal tail flaperon, and right flaperon all returned normal results. One hydraulic cart tested failed for having a particle count too high, but it is unclear that this is related in any way with the mishap sortie (TAB EE-18 thru EE-21).

(4) **Oil Testing Data.** Oil samples taken from the Fuel oil cooler and the nozzle actuator both checked good (TAB O-7 thru O-8)

m. Airframe and Aircraft Systems. Flight control systems, hydraulic, electrical, avionics, and fuel systems do not appear to be a factor in this accident. The power plant and egress systems were the major area for analysis.

(1) The engine was examined by Patrick Borgerding and Michael O'Donnell, both aerospace engineers from OC-ALC/LPARA (TAB J-49). Primary metallurgical consultation was provided by Larry Coulter, OO-ALC/TIELM (TAB J-49).

(2) The engine was recovered from the impact crater by means of a backhoe, with no physical inspection of the crater possible due to safety concerns (TAB J-49). The physical description of the engine following impact revealed damage and discrepancies in several critical areas.

(a) **Front Frame and #1 Bearing.** Starting from the front of the engine, the outer structure of the frame and all its struts and Inlet Guide Vane (IGVs) flaps were broken off. One of the IGV flaps found in lodged in the # 1 Fan blade, and of the two other IGVs that were found; one was broken in half axially (TAB J-49). Only three IGV flaps total and about 50% of the circumference of the front frame structure were recovered (TAB J-49). According to expert testimony, the most likely reason for the IGV flap to be found lodged in the fan blade was as a result of the impact (TAB V-86). The # 1 bearing had no signs of pre-impact failure (TAB J-50). No metallurgical analysis was performed on the IGV flap that was broken in half axially (TAB V-90). No metallurgical analysis was performed on any piece of the recovered front frame (TAB V-90).

(b) **Fan Rotor, Fan Stator, Fan Frame, and #2 and #3 Bearings.** The stator case rubstrips were gouged out, and the metal beneath them exhibited minor rotational scoring (TAB J-50).

(1) Fourteen stage 1 fan blades were broken off at approximately 1/4 to 1/2 span, with all of the blades exhibiting moderate to very deep nicks and gouges (TAB J-50). Four of the blades were bent over severely at 1/2 span TAB J-50). Three had metallurgical analysis performed on them, one for base material analysis, and two for fracture analysis (TAB J-17, TAB J-77, TAB V-90). The base material for the blades was titanium, of an unspecified alloy (TAB J-17). Titanium is a relatively low-temperature alloy, so to increase its resistance to heat stresses, thermal spray coatings are often applied (TAB V-86). On these particular blades, a platform thermal spray coating of Copper/Nickel (Cu/Ni) was identified, with a mid-span thermal spay coating of Silicon, Cobalt and Tungsten (TAB J-17). Visual and macroscopic examination of the two broken fan blades showed only overstress, with no evidence of prior cracking (TAB J-77). Overstress is synonymous with damage caused by impact forces. Expert testimony identified that since only four of the blades were bent over severely, a condition of low core speed was inferred at time of impact (TAB J-57). Expert testimony also identified that the nicking and gouging could come either as a result of impact forces, or from damage caused by impact with either an object foreign to the engine (FOD, or foreign object damage), or an object found inside the engine (DOD, or domestic object damage). Some types of analysis that you would perform to identify what the precise cause of the damage was would be examination of the component for signs of metallic residue that you could then match up with a broken part, or evaluation of rotational damage markings, again in the effort to positively identify a component that had impacted an area (all from TAB V-86). No testing was performed on these blades to identify what struck them (TAB J-50).

(2) All of the stage two and three fan blades were found full length , with slight bending in the degree of rotation and moderate to very deep nicks and gouges observed (TAB J-50). The low rotational damage is again reflective of low RPMs at time of impact (TAB J-57). Again, the nicking and gouging could come as a result of either crash impact, or a FOD/DOD strike prior to impact (TAB V-86). No testing was performed on these components to identify what the cause might have been TAB J-50).

(3) All of the number one stage fan stator vanes were missing, with 44 eventually recovered (TAB J-50). Moderate nicking and gouging was the only discrepancy observed on these components (TAB J-50). All of the number two fan stator vanes were present, again with moderate nicking and gouging observed (TAB J-50). The number three fan stator vane airfoils were crushed axially (TAB J-50), a sign of impact damage (TAB V-90). Testing was performed on 5 first stage fan vanes, with titanium of an unspecified alloy found in a dent on one of the vanes, and molten titanium splattered on two of the vanes (TAB J-35). No detectable levels of tungsten or cobalt was identified in these two areas (TAB J-35).

(4) The fan frame was severely crushed and buckled in the axial direction, and the #3 bearing housing showed moderate rotational rub damage (TAB J-50, J51). This most likely occurred during impact with the ground (TAB V-90). There were no signs of pre-impact failure of #2 or 3 bearings (TAB J-51).

(c).**Compressor Rotor and Stator.** The High Pressure Compressor rotor showed moderate rotational damage from contact with the #3 bearing housing (TAB J-51). According to expert testimony, this most likely happened during the impact sequence (TAB V-90).

(1) All compressor blades were present and full length, with moderate to severe tearing and gouging exhibited in stage one blades, and slight tears and gouges found on the stage nine blades (TAB J-51). Titanium metal residue was found on all airfoil surfaces (TAB J-51), and the metallurgical report of this analysis goes on the specify that on the only stage one blade tested, an unspecified titanium alloy was found in splats along the surface, along with transferred concentrations of Copper/Nickel and an unspecified titanium alloy (TAB J-17). Metallurgical analysis of stage four compressor blades identified a base material of nickel-based super-alloy, with a single splat of an unspecified titanium alloy (TAB J-18). There was also an impact area on the blade that showed evidence of transferred titanium of an unspecified alloy, with copper and nickel (TAB J-18). An auger analysis was also performed on a stage four compressor blade (TAB J-41). It revealed that an impact area on the blade had the presence of an unspecified titanium alloy fragments (TAB J-42). It also showed a plume of an unspecified titanium alloy, nickel, copper and carbon (TAB J-42). The carbon was embedded much deeper into the surface of the material than the other elements (TAB J-42). A stage nine compressor blade was also tested, with similar results of splatterings of an unspecified titanium alloy, and transfer of an unspecified alloy of titanium and copper/nickel (TAB J-18). The relative ratio of the copper/nickel in the transferred area is very similar to the thermal spray coating used on the Stage 1 fan blades (TAB J-18).

(2) All Variable Stator Vanes (VSVs) were present and correctly installed, with moderate gouging and tearing found (TAB J-52). Stages four through eight compressor stator vanes also exhibited similar gouging and tearing (TAB J-52).Metallurgical analysis was performed on 6 Compressor IGV blades, with the presence of an unspecified molten titanium alloy found splattered on the blades (TAB J-17). In addition, areas where on object had impacted the blades contained traces of copper and nickel (TAB J-17).

(d) **Combustor, Combustor Diffusor Nozzle Case, and Main Fuel Nozzles.** The combustor was found in good shape, with an unspecified titanium alloy splatter identified on the inner cowl (TAB J-8).

(1) The honeycomb material on the five-step compressor discharge pressure seal was not attached to its backing over a six inch arc beginning at the six o'clock position (TAB J-54). A poor brazing operation at the time of manufacture was cited as the reason this piece of material delaminated from its backing (TAB J-11). A spot of metal splatter was evident every three inches around the outer diameter of the seal; future analysis identified this splatter as an unspecified titanium alloy (TAB J-12). According to expert testimony, the effect of this honeycomb seal coming loose during

normal engine operation would most likely be negligible, both from a structural and operational viewpoint (TAB V-87).

(2) One attach bolt for the number fifteen fuel nozzle was found with zero torque on it (TAB J-54). Two of the main fuel nozzles, number five and number seventeen, had broken loose from their mount pads; the number seventeen nozzle was found hanging by its B-nut and one mount bolt, the number five nozzle was later found in the clay washed out of the engine during initial cleaning (TAB J-54). A hole was found in the outer fan duct that corresponds to the dimensions of the number five fuel nozzle, and impact markings were identified that were consistent with the B-nut from this nozzle (TAB J-55). Metallurgical analysis on the screws and the boss assembly where the nozzle was previously attached identified characteristics of overstress in the materiel, with no conclusive evidence of prior cracking or materiel defects (TAB J-27). Analysis of one/half of a screw still attached to the nozzle showed only characteristics of overstress (TAB J-77). Metallurgical and chemical analysis of the bolt holes show molybdenum anti-seize compounds on the threads, instead of the Technical Order (T.O.)-dictated lube you would expect to find (TAB J-54). According to expert testimony, it is unlikely that the use of this anti-seize compound contributed to either the one loose bolt found on the number fifteen fuel nozzle, or had any effect on the separating of the number five and seventeen nozzles (TAB V-87). The expert identified that the most likely cause for the separation of the fuel nozzles was that they were sheared off in impact (TAB V-87). The expert further stated that had the number five nozzle come off in flight, you would expect to see signs of severe melting on the engine, characteristics that were not identified in the report on this engine (TAB V-87, TAB J-54 and J-55).

(e) **High Pressure Turbine (HPT) Rotor and Stator**. The HPT rotor was in good condition except for the HPT blades, which exhibited severe overtemperature damage to the tips and trailing edges (TAB J-52). Metalization from these blades was deposited radially outward on the HPT shroud, and downstream on the Low Pressure Turbine (LPT) section (TAB J-52).

(1) The HPT inner nozzle support had metal residue later identified by metallurgical testing as an unspecified titanium alloy on it.

(2) Expert testimony identified that the most likely reason for the overtemperature condition observed on the blades is the engine scheduling increased and unnecessary fuel flow to compensate for a inefficiency inside the core section (TAB V-87). As something causes the first stages of the motor to slow down, the Main Engine Control (MEC) perceives this as an inability to meet scheduled demand, and attempts to compensate by dumping more fuel into the combustor section. The expert went on the further state that the result is the turbine blades, already operating at high temperatures, are subject to temperatures beyond their wear limits, and an a breakdown in base materiel begins (TAB V-88).

(f) **Low Pressure Turbine (LPT) Rotor, Stator, #4 and #5 Bearing.** The LPT blades all had signs of overtemperature exhibited on them, and metalization from the HPT blades (TAB J-53). Twenty-two turbine first stage blades were found full length, with the rest being broken off at about 1/2 to 2/3 span (TAB J-53). Thirty turbine second stage blades were found full length, with the rest broken off at about 2/3 span (TAB J-53). The number one LPT nozzle airfoils were heavily metalized from the HPT section (TAB J-53). The number two LPT nozzle airfoils were all broken at about 2/3 span, with overtemperature discoloration also observed at this location (TAB J-53).

(1) The number four and number five bearing exhibited no signs of pre-impact failure (TAB J-53).

(2) Metallurgical analysis was performed on a stage one LPT blade. The base materiel was identified as a nickel-based super alloy identified (TAB J-8); the splat of material on this blade was also identified as a nickel-based super alloy (TAB J-8).

(3) Metallurgical analysis was performed on a stage two LPT for examination of a fracture surface typical of other blades in that area (TAB J-17). No evidence of prior cracking was found, with the fracture pattern being typical for overstress of the material (TAB J-17).

(g) **Exhaust Nozzle.** The exhaust nozzle had separated from its liner and duct, but no evidence was found of pre-impact burn-through was identified (TAB J-56).

(1) Overtemperature discoloration and sooting were identified on the exhaust nozzle outer flap, primary flaps, divergent seals, and primary seals (TAB J-56). Expert testimony confirmed that all of these signs are consistent with the engine scheduling increased fuel flow to compensate for a core inefficiency (TAB V-87).

(2) Three exhaust nozzle actuators were found in a position inconsistent with reported engine operating condition at the time of impact; three actuators were found in various states of extension, instead of the expected fully retracted position that corresponds to the engine operating in secondary mode (TAB J-56). No reason for this could be identified, however, discrepancies in exhaust nozzle positioning are not linked to the severe internal damage observed in this engine (TAB V-88, TAB J-50 thru TAB J-55).

(h) **Accessories.** The anti-ice valve was found in the open, or operating condition. A Materiel Deficiency Report (MDR) was submitted on the MEC (TAB I-9

(3) Expert testimony relayed that the titanium splattering observed throughout the engine is indicative of melting titanium parts inside the engine; precise

analysis of where the splattering came from is difficult without identifying which titanium alloy was present in the splatterings (TAB V-86). The expert went on to further explain that there are different types of titanium used throughout the engine, and again, further analysis is required to positively identify where the source of the splattering is from (TAB V-86, TAB V-89). The first area of the engine where metallurgical analysis confirmed the presence of the splattering was on the five first stage fan stator vanes (TAB J-35).

(4) Expert testimony identified that the overtemperature condition in the turbine blades is most likely the result of decreasing core speed (TAB-86). The expert identified possible sources for the decreasing core speed include failure of a bearing inside the core section of the engine, impact strike on an internal component from either DOD or FOD that propagates damage throughout the core, or failure of the tower shaft that leads to the accessory drive. Evidence from the engine identified that all the bearings functioned as advertised (TAB J-50, TAB J-51, TAB J-53, TAB J-5). Expert testimony identified that the tower shaft was most likely intact at the time of engine failure (TAB V-87). There are signs of impact damage on blades beginning with the first stage fan blades (TAB J-50, TAB J-17). No identification of what caused this damage is provided (TAB J-50). Signs of transferred titanium of an unspecified alloy and nickel/copper were identified on blades beginning with the first stage of the compressor section, and continuing aft (TAB J-51). Titanium splattering of an unspecified alloy was identified on the first stage fan stator vane, and continued aft (TAB J-35). Expert analysis showed that the composition of the first stage fan blades roughly matches that of the transferred material, however analysis of this transfer is inconclusive due to thermal effects complications (TAB J-17, TAB V-84). No signs of pre-existing cracks were found in the first stage fan blades (TAB J-77). Without precise identification of the titanium alloy, precise identification of the location of the transferred materiel is impossible (TAB V-86). No components submitted for metallurgical analysis were identified to have pre-existing cracks on them; a condition that would identify them as being likely to initiate a DOD scenario inside the engine (TAB V-90, TAB J-17, TAB J-77). No testing for organic residue was accomplished; a test consistent with FOD scenario identification (TAB V-89). In the expert's opinion, precise determination of what started the engine failure sequence is impossible at this stage (TAB V-89). Neither FOD or DOD related scenarios can be ruled out at this time.

(5) In the expert's opinion, with the amount of damage that was caused inside the HPC, it is unlikely that the engine could have been started in the air (TAB V-88).

(6) The egress system did not perform in accordance with the system operational configuration that was testified as being selected.

(a) **Ejection sequencing.** Capt Synder testified that the aft mode was selected for seat operation (TAB V-30). In this mode, the aft ejection seat leaves the aircraft after a .33 second, delay, followed by the forward seat .40 seconds later (TAB J-58). In this case, propellant residue from the ejection system was found on the clothing of Capt Snyder, the back seater (TAB J-2). This is indicative of the forward seat departing

the aircraft first, a situation directly the opposite of the normal egress sequence. Analysis of recovered egress components was inconclusive as to the cause of the sequencing problem, with only speculation as to the cause (TAB J-60). Gas pressure from an initiator that was activated never made it to the ejection mode select valve (TAB J-60).

(b) **Aft Seat Inertia Reels.** An arbor and screw assembly was found to be outside of specified dimensions (TAB J-66). This prevented a piston from performing as required, and through a series of failed interactions with other mechanical components inside the interia reel, eventually resulted in the failure of the strap locking mechanism (TAB J-66).

n. **Operations Personnel and Supervision:** The flight was authorized by Major Brill, acting 466FS/DO on 4 February 1997 (TAB K-3). Major Goggins used the standard 466FS briefing guide, and flight members testified all portions were thorough and briefed IAW AFI 11-F16 VIII. There were no squadron supervisors at the briefing (TAB V-63).

o. **Crew Qualifications:**

(1) Examination of individual flight records indicated that both Major Goggins and Captain Snyder were qualified for this mission. Major Goggins had 2033.2 hours in the F-16 and 3209.6 total flying hours. Captain Snyder had 269.5 hours in the F-16 and a total of 400.2 flying hours (TAB G-4, G-12,13).

(2) Review of the training records indicate no discrepancies or weaknesses and the 30/60/90 day flying experience look back is as follows (TAB G-3, G-11):

	Major Goggins			Captain Snyder		
	30	60	90	30	60	90
Flying Hours	9.8	24.8	31.8	6.0	6.0	7.0
Sorties	9	19	25	5	5	6

(3) Crew training was current with one exception. The flight surgeon's egress and hanging harness training was not current IAW Air Combat Command Instruction (ACCI) 11-301. The squadron was using a 180 day period for training currency. ACCI 11-301 directs flight surgeons to receive egress and hanging harness training every 60 days and may be extended to 180 days after demonstrating proficiency and submitting a waiver to the Major Command (MAJCOM). Although Capt Snyder had demonstrated proficiency, no waiver was submitted to the MAJCOM (TAB T, V-96, CC-4).

p. **Medical:**

(1) Major Goggins and Captain Snyder were both medically qualified for flight duty at the time of the mishap (TAB CC-2).

(2) Major Goggins' last physical examination was on 7 December 96. No medical defects or diseases were noted. There is no history of chronic illness or the use of any medications. No medical waivers are present. No recent or chronic dental problems were noted in his dental records (TAB CC-2).

(3) Captain Snyder's last physical examination was on 4 May 96. No medical defects or diseases were noted. There is no history of chronic illness or the use of any medications. Captain Snyder does have a valid (indefinite) medical waiver for excessive visual refractive error as per AFI 48-123. No recent or chronic dental problems were noted in his dental records (TAB CC-2).

(4) Both Major Goggins and Captain Snyder were injured in this mishap. The injuries are summarized in Tab X, The Statement Of Injuries.

(5) The toxicology reports for both Major Goggins and Captain Snyder tested positive for the presence of morphine in the urine (Tab BB). A careful review of the medical records demonstrates that both of these men had received morphine for their injuries prior to the time that the toxicology specimens had been obtained (TAB CC-2,3).

q. Navaids and Facilities: All navaids and facilities relevant to this mission were operating and functional (TAB AA-4).

r. Weather: The UTTR northern range forecast at the time of the accident was FEW 030/100, OVC 040/220, visibility 9999 (7 miles) isolated 4800 (3 miles) -SHSN (light snow showers). Surface winds 17009 knots with light mixed icing 090/160. Sunset was 1748L. Moonrise was scheduled for 0445L the following morning with 16% illumination (TAB B-4, K-4).

s. Governing Directives and Publications:

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

ACCI 11-301	Aircrew Life Support Program
ACCR 55-2/419FW SUP	Life Support Program
AFI 11-206	General Flight Rules
AFI 11-214	Aircrew & Weapons Director Procedures for Air Operations
AFI 11-401	Flight Management
MCI 11-F-16VI	Pilot Training - F-16
MCI 11-F-16VIII	Pilot Operational Procedures - F16
T.O. 1F-16C-1	Flight Manual F-16C/D
T.O. 1-1C-1-30	Flight Manual / F-16 Flight Crew Air Refueling Procedures with KC-135 & KC-10
T.O. 2J-F110-6-11	Itermediate Level, Core Engine, GE F110

	Turbofan Engine, AFT Control/DEC
T.O. 1F-16C-6WC-1-11	Combined Flight Associated Inspection Workcards
T.O. 1F-16C-2-10G-00-1	Aircraft Safety
T.O. 1F-16C-2-12JG-00-1	Aircraft Safety

(2) Deviations:

(a) Major Goggins did not take any Airborne Videotape Recorder film IAW MCI 11-F-16VI, paragraph 1.9 (TAB V-16, AA-7).

(b) Major Goggins was not wearing aramed fiber long underwear IAW AFR 55-2/419FW Sup, paragraph 4-2b(1)(c) (TAB V-18, CC-3)

(c) Major Goggins was not wearing approved footwear IAW ACCI 11-301, paragraph 4.3.7.1 (TAB V-18, CC-3).

(d) Captain Snyder did not have a waiver on file extending his egress/hanging harness training currency IAW ACCI 11-301, paragraph 3.6.1.1 (TAB V-96, CC-4).

(e) Molybdenum Disulfide anti-seize compound residue was found on the threads of the mount bolts for the main fuel nozzles. The use of anti-seize compound in this area is not directed by T.O. 2J-F110-6-11. The T.O. requires only GP460 thread lubricant to be used on these screws (TAB J-54).

t. **Original Documents:** All of the documents in Tabs A through HH are originals except the following:

(1) Tab A-2 is not original because the original was misplaced and could not be located before this report was filed.

(2) Tab C-2 is not original because it is a computer generated form.

(3) Tab D-2 is not original because it is a computer generated form.

(4) Tab G-2 to G-16 are not original because they are computer generated, or the originals are maintained with the 466 Fighter Squadron.

(5) Tab H-2 to H-5 are not original because they are word processed computer documents prepared by the Safety Investigation Board.

(6) Tab I-2 to I-9 are not original because they are word processed computer documents prepared by the Safety Investigation Board.

(7) Tab J-2 to J-41 are not original because they are maintained by the OO-ALC/TIELC Metallurgical Shop.

(8) Tab K-2 is not original because the original is maintained by the 466 Fighter Squadron. Tab K-4 is not original because it is computer generated.

(9) Tab L-2 is not original because it is computer generated.

(10) Tab M-2 is not original because it was misplaced and could not be located before this report was filed.

(11) Tab O-2 to O16 are not originals because they are computer generated, or the location of the original was misplaced and could not be located before this report was filed.

(12) Tab Q-2 is not original because it is maintained at 12th Air Force.

(13) Tab T-2 to T-3 are not originals because the originals are maintained by the 466 Fighter Squadron.

(14) Tab U

(15) Tab V-11, V-14, V-20 are not originals because they were faxed to Hill AFB, from other locations and the originals were not received before this report was filed.

(16) Tab W-2 are not original because they are photo copies the originals are maintained by the 75th OSS Weather Squadron.

(17) Tab Y-2 to Y-5 are not original because the originals are maintained by 12th Air Force.

(18) Tab AA are not originals because they are computer generated.

(19) Tab BB-3, and BB-4 are not originals because the originals were maintained by the Air Force Institute of Pathology.

(20) Tab EE are not originals because they are computer generated, or photo copies maintained by the 419th Maintenance Squadron, and the 466th Fighter Squadron.

(21) Tab FF is not original because they are computer generated, and the originals are maintained by the Toole County Sheriff.

(22) Tab GG are not originals because they are photo copies from local newspapers.

(23) Tab HH-2 is not original because it is word processed and the original is maintained by the Disaster Response Group.

CHASE J. JOHNSON, Lt Col, USAF
Accident Investigation Officer

STATEMENT OF OPINION

1. Under U.S. Code 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.

2. Investigation of the 4 February 1997 aircraft accident involving F-16D (Block 30) S/N 87-0385 has resulted in the following opinions.

a. (CAUSE). F-16D S/N 87-0385 crashed due to catastrophic engine failure.

b. No definitive evidence points to a single cause that triggered the engine failure. However, some factors which contributed to the engine failure were identified. For an unknown reason, an engine component forward of the first stage fan stator vane failed. Titanium alloy is used forward of the first stage stator vane, specifically in the fan frame, fan inlet guide vanes, and the first stage fan blades. Signs of damage from titanium alloy and melting titanium were identified on multiple components aft of the first stage fan blades. Engine operation was indicated because melting titanium alloy was found deep within both core and bypass sections of the engine aft of the first stage fan blades. Possible reasons why an engine component came apart are that it failed due to either metal fatigue or impact from a foreign object. Testing failed to show any signs of fatigue in the first stage fan blades. No foreign material, other than aircraft aluminum, was found during engine examination (a fact that can easily be explained by ground impact forces). The damage aft of the first stage fan blades caused engine speed to decrease. When the engine sensed decreasing speed, it overcompensated by increasing fuel flow and as a result, an overtemperature condition occurred. Other components in the aft section of the engine began to melt as a result of this overtemperature. This damage cumulatively resulted in catastrophic failure of the engine.

c. Major Goggins was confronted with a catastrophic engine failure. He sequentially applied the correct procedures and properly prioritized his actions. After four unsuccessful airstart attempts and approaching minimum vectoring altitude, at night and in the weather, made the timely and correct decision to eject. The internal damage to the engine prevented usable thrust to sustain flight and the engine could never have been restarted. The actions of the crew of Cyborg 1, Cyborg 2, Clover control, Alta 1, the Army Blackhawk crew, the MC-130 crew, Air Med crew, Tooele County Sheriff's Department, and all agencies involved in the rescue and recovery were accurate, professional, and commendable.

d. The burns sustained by Captain Snyder were the result of an out-of-sequence ejection. No definitive evidence points to a single cause of the out-of-cycle sequence.

e. If Major Goggins had worn leather boots IAW Air Combat Command Instruction (ACCI) 11-301, the likelihood of suffering a broken ankle would be reduced.

3. Other deficiencies discovered during the investigation are determined to be inconsequential to the aircraft accident and injuries sustained by the crew.

a. The lack of airborne videotape recorder film.

b. The pilot was not wearing aramed long underwear.

c. There was no waiver to extend the currency for Captain Snyder's egress and hanging harness training from 60 days to 180 days IAW ACCI 11-301. Captain Snyder's actions were timely and accurate. The lack of waiver to his training currency did not contribute to his injuries.

d. Molybdenum disulfide residue was found on the threads of the fuel nozzle attach bolts.

e. A series of failed interactions starting with an incorrectly-sized arbor and screw assembly prevented the power spring inside the rear cockpit (RCP) ejection seat inertial reel from retracting and locking the straps during the ejection. This problem did not impact the function of the RCP ejection seat and successful ejection of Captain Snyder.

f. Analysis of the honeycomb air seal within the combustion section of the engine revealed improper manufacturing techniques. This problem did not cause nor contribute to the catastrophic engine failure.

CHASE J. JOHNSON, Lt Col, USAF
Accident Investigation Officer