RAS 5853 72-22-ISFSI - Joint Exhibit 9-Recd 4/11/02

AFI 51-503 ACCIDENT INVESTIGATION REPORT

AUTHORITY: Under the provisions of Air Force Instruction (AFI) 51-503, the Twelfth Air Force Commander Lieutenant General James F. Record appointed Colonel Dwayne A. Alons on 7 Jul 96 to conduct an aircraft accident investigation of the F-16C(85-1545) accident that occurred on 7 Jun 96 near Sioux Falls, South Dakota. The accident resulted in a successful ejection of Colonel Gilbert R. Dardis and the destruction of F-16C aircraft SN 85-1545. Damage to private property was limited to crop damage and soil contamination by JP-8 fuel (Tab P-2). The investigation was conducted from 8-27 Jul 96. Technical advisors were Captain Steven B. Barnett (Maintenance), Captain Daniel J. Higgins (Legal), and Captain Aaron C. Pohl (Flight Surgeon)(Tab Y).

PURPOSE: An aircraft accident investigation was convened under AFI 51-503. This investigation is separate and apart from the safety investigation conducted under AFI 91-204. The purpose of this investigation is to find and preserve evidence to use in claims, litigation, disciplinary actions, adverse administrative proceedings, and all other purposes. The report is available for public dissemination under the Freedom of Information Act(5 U.S.C. 522) and AFI 37-131.

SUMMARY OF FACTS

1. History of Flight: On 7 Jun 96, Colonel Gilbert Dardis was scheduled as number two in a two-ship Air Combat Training (ACBT) mission to the Fechter Military Operating Area (MOA) over Northwest Iowa. The flight was planned as a two-ship continuation training Basic Fighter Maneuver (BFM) flight. The flight was filed as call sign Bat 51 led by Lt Colonel Tom Considine with Colonel Dardis as the wingman (Bat 52) (Tabs K-2,3). Bat 51 flight departed runway 03, Sioux Falls, South Dakota (FSD) at 1050 CDT. Bat 51 flight was cleared on course to the southeast for the Fechter MOA and to expect a level-off at 10,000 feet Mean Sea Level (MSL) due to delays with the hand-off from Departure Control to Minneapolis Center (Tab N-3). On the southeasterly heading above the clouds, Bat 51 cleared Bat 52 to perform the weapon systems check. Bat 52 reduced power and maneuvered toward Bat 51's 5 o'clock position to begin the check of his aircraft's radar and captive AIM-9 missile. As Bat 52 increased engine power to stabilize for the weapon

systems check, the mishap pilot (MP) heard a loud bang. He instinctively turned back towards FSD and began the engine airstart procedures while observing the RPM rapidly decay to zero. Realizing that he did not have enough altitude to glide to FSD with the engine seized, the MP elected not to eject from the mishap aircraft(MA) until it dropped below the clouds. He visually cleared his flight path away from inhabited farm sites, correcting slightly to the right towards a clear field area. The MP ejected at approximately 1,600 feet above ground level(AGL) two minutes after first noticing the engine problem (Tabs N-4, V-2, V-7). The MA impacted the ground in a cornfield near the small town of Valley Springs, SD approximately 12 statute miles east of Sioux Falls (R-5). The MP was rescued by the Lifeguard helicopter from McKennan Hospital in Sioux Falls within twenty minutes of his parachute landing in a pasture (Tab N-10). Initial questions from the local news media concerning the accident were answered by South Dakota ANG public affairs personnel from the 114 Fighter Wing (FW). Media involvement included personnel from several local television stations and newspapers(Tab AA-2).

2. Mission: The mission was scheduled and planned as a two aircraft ACBT flight. Bat 51 and Bat 52 would alternately practice an AIM-9 missile attack converting to a gun-tracking solution (heat to gun exercise) followed by offensive and defensive 9,000 feet perch BFM set-ups. The flight planned to recover via an instrument landing system (ILS) approach for Bat 52 and to remain in visual contact with the tower for landing (Tabs V-2, V-7).

3. Briefing and Preflight: Crew rest was adequate. Colonel Dardis left his office at the 185FW in Sioux City at 1730 CDT the day prior to the mishap and received slightly more than 7 hours of uninterrupted rest before beginning his drive to FSD at 0700 on 7 Jun. Due to runway closure at Sioux City Gateway Airport, the 185 FW was conducting flight operations from FSD, located approximately 100 miles to the north. He arrived at FSD at approximately 0830 CDT. The flight briefing began at 0920 CDT (Tab V-2). Lt Colonel Considine and Colonel Dardis had adequate time to prepare for the briefing and flight that morning. Lt Colonel Considine used the 185FW Flight Briefing Guide to cover threat of the day, emergency procedure of the day, Special Interest Items, and normal operations for a BFM mission

(Tabs V-2, V-7). Because of the broken to overcast weather conditions, extra attention was given to the 2,000 foot tall television towers to the east of FSD since the flight was departing in that direction (Tab V-2). The flight briefing was adequate and covered all pertinent and required items (Tabs V-2, V-7). Aircraft preflight inspections and start were normal for Bat 52 (Tabs V-2, V-42).

4. Flight Activity: Bat 51 flight was filed on a Fechter One stereo flight plan from Sioux Falls (Tab K-2). The flight departed in formation from Sioux Falls via radar vectors from Sioux Falls Departure Control (Tab V-17). Bat 51 was given a right turn to 090 degrees (east) with a subsequent right turn on course (Tab N-3). Bat 51 flight stayed in fingertip formation until above the overcast deck with the cloud tops reported at 4300 feet MSL (Tabs B-4, V-2, V-7). On a southeasterly heading approaching an intermediate level-off at 10,000 feet MSL, Colonel Dardis began his weapon systems check. Bat 52 reduced power and maneuvered to get behind Bat 51 by approximately one mile. As Colonel Dardis increased thrust to stabilize for the weapons check, he heard a loud bang accompanied by a deceleration of the aircraft. Simultaneously, dust particles floated up inside the cockpit into his field of view. Having recently attended a conference where failures of the canopy were covered, the MP instinctively looked up to check whether or not the canopy had cracked above his head. Seeing no canopy damage, he began cross-checking his engine indications. The MP began an immediate right hand turn to return to FSD (Tab V-2). Bat 51 immediately gave the lead of the flight to Bat 52 following the MP's radio call that he had a problem. Bat 51 followed the MA in the right hand turn to the northwest and kept control of radio communications with Departure Control. Bat 51 declared the emergency with Departure and instructed Departure to vector a Seneca away from the MA flight path (Tabs N-3, N-4, V-7). The MP initiated airstart procedures in the secondary fuel control (SEC) position (Tab V-2). Bat 51 visually followed the MA into the cloud deck but had to initiate lost wingman procedures when he lost sight of the MA in the clouds (Tab V-7). The MP realized that an airstart was the only possibility for a return to the airfield with or without his centerline fuel tank. He therefore decided to retain the centerline fuel tank due to his position above the clouds and his inability to determine a safe impact point. The MP

determined that the engine had seized with RPM stuck at zero. He elected not to engage the jet fuel starter (JFS), which could have caused further problems. The MP was able to lock his shoulder harness in preparation for an ejection after the engine failed to respond to two airstart attempts. The MP ejected from the MA while in a descent at approximately 1,600 feet AGL and an airspeed of 160 knots (Tab V-2). The MA continued to glide to the northwest and impacted the ground in a slightly nose high attitude with a small left bank and was destroyed (Tab J-2). Bat 51 requested Departure Control to inform the 185 FW Supervisor of Flying (SOF) of the ejection and to initiate the Crash Rescue checklist which included a Lifeguard helicopter. After delaying his descent through the clouds to preclude over-running the MP's parachute descent, Bat 51 orbited below the clouds east of the MA's last known position (Tab V-7). While orbiting, Bat 51 saw a fireball in the middle of a field and the MP's parachute about one and one-half miles to the southeast of the crash site (Tabs V-7, N-7).

5. Impact: The MA impacted the ground near Valley Springs, South Dakota, in a cornfield located at 43° 33' 45.4'' North, 96° 29' 53.3'' West at 1056 hours CDT, 7 Jun 96. The MA struck the ground with the left wing slightly low, and a nose high attitude. The MA bounced twice, receiving major impact damage, and came to rest with the empennage and engine separated from the remains of the fuselage, approximately 330 feet from the initial impact site (Tab J-2) . The remains were further damaged by a post impact fire, which burned for approximately 45 minutes until extinguished by 114 FW crash response units.

6. Egress System: As a result of complete engine failure and impending crash, the mishap pilot initiated the ejection sequence at approximately 1600 feet AGL, with an airspeed of 160-170 knots. The aircraft was in a rapid but controlled descent, and had a nearly level attitude (Tab V-2). Due to the fact that Lt Colonel Considine stayed above the clouds, he was not able to see the ejection or parachute descent (Tab V-7). After initiating ejection, the mishap pilot recalled seeing smoke rise from below his seat, his initial ride up the rail, and then feeling tossed around violently upon exiting the aircraft. He did not report feeling any impact during or after the ejection, and did not remember

separation from his seat. The canopy jettisoned automatically and without incident. The MP's next memory was of looking up, seeing a fully opened and untangled parachute, and a quiet, smooth descent. He did not feel any pain or mental confusion initially or throughout the descent. His spectacles were blown from his face during the initial wind blast of ejection. There was insufficient time for him to remove his mask completely or deploy the 4-line release on his parachute due to his low altitude ejection. Of note, the 4-line release tacking separated only on the left parachute risers, which is not uncommon in a low altitude ejection. The seat kit deployed properly and did not cause any oscillations or problems with controllability on descent. He was able to adequately control his descent direction by pulling on the right risers, but was unable to avoid an awkward and hard landing into the face of a sloped hill. This caused immediate and severe lower back pain, but he denied any other problems. His parachute and mask were removed without problem once on the ground (Tabs V-2, V-47).

7. Personal Survival Equipment: All personal life support equipment worked without problems. Life support equipment records indicated current inspections on all equipment (Tab AA-23). The pilot did not use any of his survival equipment due to the promptness of rescue.

8. Rescue: The MA crashed at 1056 hours CDT, near Valley Springs, South Dakota, at coordinates 43° 33' 45.4'' North, 96° 29' 53.3'' West. Bat 51 immediately notified Departure Control that Bat 52 was down and then circled above the cloud layer until he was certain Colonel Dardis' parachute had reached the ground. He then dropped below the clouds and first sighted the impact area, and then the parachute (Tab V-7). The squadron operations duty desk, although involved with a separate in-flight emergency, was able to monitor conversations between Bat 51 and Departure Control (Tabs V-12, V-28). The SOF then began proper accident checklist procedures, including notification of local crash response personnel and the 114th FW (South Dakota Air National Guard) Command Post (Tab V-12). At 1058L crash response units were dispatched by both the 114 FW and the Valley Springs Volunteer Fire Department (VSVFD). By the time the VSVFD arrived on the scene at 1102L, two civilians who witnessed the mishap were already with Colonel Dardis

(Tabs V-2, V-47). Mr. Dave Wessels arrived at the scene within a minute of Colonel Dardis reaching the ground (Tab V-47). This immediate attention precluded Colonel Dardis' use of his emergency radio and explains why Bat 51 could not establish contact with the MP (Tabs V-2, V-7). Colonel Dardis complained of lower back pain, but was otherwise uninjured (Tabs V-2, V-47). The Lifeguard helicopter arrived at the site at 1113L (Tab N-10) and left with Colonel Dardis approximately ten minutes later (Tab N-12). Colonel Dardis was transported to McKennan Hospital in Sioux Falls, South Dakota, where he was examined. Bat 51 continued to orbit the mishap site, returning to Sioux Falls only after Colonel Dardis had been airlifted to the hospital (Tab V-7).

9. Crash Response: 114 FW personnel monitored the conversation between Bat 51 and Departure Control from the squadron operations duty desk and immediately notified their Command Post, which in turn activated its Disaster Response Team (Tabs V-12, V-28). Because the majority of 185 FW crash response assets were located nearly a hundred miles to the south at Sioux City, Iowa, the 114 FW initially took control of the accident sight. The 114 FW crash response consisted of a mobile command post, hydrazine response team, and Bio-Environmental Engineering personnel. Additionally, a Resource Protection Team consisting of a six passenger pickup truck, two other pickups, two one and a half ton trucks with light-alls, and a 28 passenger bus were also sent to the scene (Tab AA-5). 185 FW personnel were also on the scene initially and took over formal on-scene command shortly after the accident.

10. Maintenance Documentation: A complete review of the MA's active forms, document file, and Core Automated Maintenance System (CAMS) records back to Jun 95 was performed. In addition, applicable CAMS records were examined for aircraft 85-1548, which had the mishap engine installed in it from 1 Sep 93 to 23 Feb 94, and aircraft 85-1566 in which it was installed from 2 Mar 94 to 17 Nov 94. The board also reviewed Comprehensive Engine Management System (CEMS) records, and engine historical records available for the life of the engine. This review revealed a single incidence of blade blending performed on 9 Aug 94. The CAMS documentation of this event was not very specific, consisting of a request from flightline personnel to the Jet

Engine Intermediate Maintenance (JEIM) section to, ''repair nicks,'' and a job completion statement from JEIM personnel of, ''blended blade IAW 70FI-00-11'' (Tab U-3). Subsequent examination of JEIM records revealed a Fan Blending Record (Tab U-2) from 9 Aug 94 that depicted a blend performed on the leading edge of first stage fan blade number 9 approximately halfway between the blade base and the blade mid-span shroud. The AIB identified this as the blade that eventually failed. The mismarking of the Fan Blend Record, identifying blade 9 instead of blade 8, was attributed by the board to the fact that identifying the proper blade number without removing the entire fan rotor is extremely problematic. Further examination of all available records yielded the following relevant information:

DATE	WRITE-UP
9 Aug 94	Blade Blended
28 Sep 94	#1 Phase Fan Inspection -- No Defects Noted
28 Sep 94	Engine Removed for Cracked High Pressure Turbine Nozzle
13 Oct 94	Fan Blades Removed and Reinstalled to Facilitate Other Maintenance (FOM)
7 Jan 95	Engine installed in MA
22 Aug 95	HQ Directed One Time Inspection (OTI) of Fan Blades -- No Defects Noted
25 Oct 95	#2 Aircraft Phase Fan Inspection -- No Defects Noted

Basic post-flight, and basic pre-flight inspections were properly annotated on 781H aircraft forms on 6 and 7 Jun, respectively (Tab H). The AIB did not find any relevant discrepancies or trend items in records of scheduled aircraft or engine inspections, time changes, or Time Compliance Technical Orders (TCTO). Pre-accident oil samples were taken and analyzed, revealing no trend or indications of impending bearing or engine failure. (Tab AA-6). Generally perfunctory CAMS maintenance documentation entries hampered the board's investigative efforts, but was not considered a factor in the accident.

11. Maintenance Personnel and Supervision: All maintenance personnel had been authorized to perform the jobs that they accomplished on the MA, as indicated by Special Certification Roster, Training Forecast, and Air Force (AF) Form 623 training records. However, some of the AF Form 623s of personnel involved had been transcribed due to age. This made it difficult for the AIB to determine personnel qualifications at the time maintenance actions were actually performed. This is because the dates entered in the qualification column of the Career Field Education and Training Plan were the dates that the information was transcribed, and not the original date of qualification. The board was also not able to determine personnel qualifications to perform engine blade blending operations. This training was performed mostly through on-the-job training, and was not documented on the AF Form 797, Job Qualification Standard Continuation sheet (Tab V-40). Interviews with JEIM personnel did not reveal any systematic training on techniques to assess or reliably repair fan blade damage. While JEIM personnel were motivated and evidenced a strong desire to perform blade blending operations within the guidelines of the applicable T.O., several indicated that they felt that they did not have the measurement tools available to assess blade damage to the levels of accuracy required (Tabs V-25, V-30, V-34, V-40). Several opportunities did exist for JEIM and Crew Chief personnel to detect the fault that eventually led to the accident. Several fan inspections were documented by JEIM personnel in the CAMS maintenance records in 1994, as outlined in paragraph 10. All of these efforts pre-date the requirement (levied Jan 96) to perform inspections of the stage one fan blade leading edge with an inspection mirror to ensure adequate visibility of the back, or concave side of the blade. In Sep 95 the Air National Guard Resource Center LG section directed a OTI of the first stage fan blades on F110-GE-100 engines. This OTI was generated in response to the detection of cracks emanating from incompletely blended fan blade leading edges of F110-GE-100 engines in a different command (Tab AA-7). This OTI also pre-dates the inspection mirror requirement. An Oklahoma City Air Logistics Center message, dated 141856Z Sep 95 (Tab AA-9), provided detail on the problems that lead to the generation of this OTI. This message identified incomplete blends and the presence of transverse file marks, (similar to those on the mishap fan blade) as a potential problem to

look for, but this information was not included in the OTI. The last inspection documented that presented JEIM personnel an opportunity to identify the problem fan blade was the fan inspection performed during the Oct 95 #2 aircraft phase inspection. This inspection also failed to detect the tiny damaged area in the blended portion on the fan blade, and also pre-dates the inspection mirror requirement. Crew Chief personnel performed literally hundreds of intake and first stage fan blade checks during pre-flight, through-flight and post-flight inspections required each time the MA flew. The Crew Chief personnel utilize the 1F-16C-6WC-1-11 work cards as guidance to perform these inspections. The work cards use numerous full T.O.s as the source of the information contained on each card, and reference the T.O. that should be consulted if any inspection problems are discovered. The T.O. referenced in the work cards for the fan (card 1-066, Tab AA-13) is the 1F-16C-2-70FI-00-11. This work card requires the individual performing the inspection to inspect the, "fan rotor for nicks, dents, or missing fan blades; midspan damper for cracks, nicks, dents, or missing pieces." When change 15, dated 31 Jan 96 (Tab AA-14) to the referenced 1F-16C-6FI-00-11 T.O. was incorporated, it included a caution requiring the use of a bright light and inspection mirror to inspect the concave side of the leading edge of the first stage fan blades. No note or indication of this change was included in the work cards. The unit did have Maintenance Squadron Operating Instruction 36-2203 (Tab AA-19), dated 18 Jul 95, which requires workcenter supervisors to advise assigned personnel of changes, and to ensure that technicians understand the changes. This did not occur in the section where the crew chiefs performing fan inspections are assigned (Tabs V-19, V-21). This was influenced by the fact that the unit was on Temporary Duty at Incirlick Air Base, Turkey during Mar 96 when the change arrived on base at Sioux City (Tabs V-19, V-21). Additionally, no one in the direct supervision of the crew chiefs had seen or was aware of the message traffic alerting personnel to possible first stage fan problems (Tabs V-19, V-21). As a result, the crew chiefs were not aware of the T.O. change, or fan blade concerns, and continued to perform their fan inspections without the use of an inspection mirror (Tabs V-19, V-21, V-36, V-42). This technique was not likely to discover the small fault on the fan blade that failed, due to the fault's location on the concave side of the leading edge (Tab V-30, V-36).

12. Engine, Fuel, Hydraulic and Oil Inspection Analysis: Oil analyses records for the mishap engine were reviewed, and determined to have no abnormal trend indications (Tab AA-6). Fluid samples were taken from the fuel truck and oil cart last used to service the MA. Analyses of these samples did not reveal any abnormal indications (Tabs AA-20, AA-21). Post impact hydraulic samples were taken from the engine nozzle actuator, and the A-system hydraulic pump. Analyses of these samples also did not reveal any abnormal indications (Tab AA-21). Post impact oil samples were taken from the generator constant speed drive, and the engine oil lube and scavenge pump. The constant speed drive sample indicated elevated levels of iron (FE) and copper (CU). These indications are consistent with aircraft impact damage, and were determined by the board to be the result of the mishap, rather than causal (Tab AA-21). The lube and scavenge pump sample indicated slightly elevated iron levels, but was within acceptable limits (Tab AA-21).

13. Airframe and Aircraft Systems: Data recovered from the ejection seat flight data recorder (Tab O-2), AIB interview with the mishap pilot (Tab V-2), and technical and engineering evaluations of material (Tabs J-2 through J-21) indicate that all aircraft systems other than the engine operated normally throughout the mishap. Data from the above sources indicates that the engine experienced a catastrophic failure approximately 2.5 minutes into the mishap sortie brought about by the separation of the number eight first stage fan blade 2.3 inches from the base of the blade. The liberated portion of the fan blade caused immediate and dramatic domestic object damage to the engine, leading to rapid engine shut-down and seizure. The cause of the fan blade failure was determined to be a fatigue crack originating from a .015 of an inch deep dent in the concave side of the leading edge of the blade (Tab J-21). The dent was in a portion of the leading edge that had been previously blended (Tabs J-21, J-11). At the time that this blend was accomplished (Aug 94), the approximate depth of the blend, .037 of an inch from the original leading edge (Tab J-21) indicates the removed damage was within serviceable limits in accordance with T.O.1F-16C-2-70FI-00-11. The additional .015 of an inch dent in the blend may have been from an impact after the blend was accomplished, but the statistical likelihood of this is very low (Tab AA-22). The

higher probability is that this dent was damage that was not completely removed when the original blend was accomplished in Aug 94. Since the damage to the blade, even including the .015 of an inch depth of the unblended dent was not greater than serviceable limits (as those limits were set at the time), no blending or repair action was required. Interviews with JEIM personnel indicate that it is standard practice for them to blend out this type of serviceable damage, even though it is not required by the T.O. (Tab V-30). In Jan 96, the serviceable damage limit on the leading edge of the first stage fan blades was reduced by 50 percent. Thus, the depth of the damaged area, considering the blended .037 of an inch area plus the .015 of an inch deep remaining damage, was beyond the serviceable limit in accordance with T.O. 1F-16C-2-70FI-00-11 (Tab AA-14). The blend was not reassessed in light of this T.O. change, however, so the blade remained in service and continued to accumulate stress until fatigue cracks formed. Expert testimony before the board indicated that at least eight flights occurred between the time the fatigue crack formed, and the blade failed (Tab V-44). Additional testimony suggested that the forming crack was probably not visible to the naked eye, but it is not possible to determine this for certain.

15. Pilot Qualifications: Colonel Dardis was current and qualified to perform the mission. Prior to the flight he had not completed the May Situational Emergency Procedures Training(SEPT) which should have been completed prior to his first flight in June (Tabs V-2, V-7, V-12); however, the AIB members determined that this was not a factor in the mishap. He was in the two-ship flight lead up-grade program with 3626.7 total hours, and 359.4 hours in the F-16 (Tab G-2). Colonel Dardis' pilot skills were considered average to excellent by 185 FW pilots (Tabs V-7, V-12, V-17). In the month of May, Colonel Dardis flew 5 sorties which is normal for Mission Capable status (Tab T-9-A). The flight on 7 Jun was his first sortie for the month. Colonel Dardis' most recent checkride was an Instrument Evaluation accomplished on 15 Mar 96; however, the documentation of this checkride was not totally completed with all required signatures and dates (Tab T-40).

30/60/90 Day Flying Summary (Tab G-4):

30 Day	4.7 hours/	2 sorties
60 Day	16.3 hours/	10 sorties
90 Day	27.7 hours/	17 sorties

16. Medical: The mishap pilot was medically qualified at the time of the accident. There were no disqualifying medical, psychological or physiological discrepancies in his medical record, and he had a valid AF Form 1042 (Tab T-25). He suffered a painful lower back injury in the mishap and subsequent medical evaluation revealed a small anterior compression fracture of the second lumbar vertebrae. Initial treatment was with back immobilization and analgesics, and he remains disqualified from flying until fully recovered (Tab X-6). Toxicologic studies immediately post-mishap showed detectable levels of salicylates and caffeine, but were otherwise unremarkable (Tab X-3). Human factors pertaining to the incident include the following categories:

a. Personal relationships: Peers describe the mishap pilot as a professional, and an average to excellent pilot. He is perceived as friendly and easy-going, but also mature, self-disciplined and a consistent follower of all rules and regulations. He had a reputation of being a careful, non-risk taking pilot and pleasure to fly with. Recent work performance was good with no adverse trends. All witnesses to his mental and physical condition immediately prior to the mishap described him as appearing and acting completely normal (Tabs V-7, V-12, V-17).

b. Lifestyle patterns: The mishap pilot does not smoke, rarely drinks alcohol, and followed a routine exercise program prior to his injury. He normally gets 7 hours of restful sleep per night, and the night before the mishap was no exception. His dietary habits are healthy, consistent and unremarkable (Tab V-2).

c. Physical characteristics: The mishap pilot appears healthy, well nourished, and physically fit. He is 71 1/2 inches in height and weighed 190 pounds on his last physical dated 3 Jun 95.

d. Pathologic factors: There were no predisposing illnesses or injuries.

e. Physiologic factors: There were no physiologic factors involved with this mishap. This includes G-loading, spatial disorientation, fatigue, circadian rhythm, hypoxia and hyperventilation.

f. Environmental factors: There were no significant environmental factors with the incident including temperature, light, noise, and pre-ejection decompression.

g. Psychological factors: All evidence indicates the mishap pilot to generally be a calm, rational, and level-headed person. He was under no stressful or distracting life situations at the time of the mishap. He was able to maintain clear thought processes, good judgment, and good situational awareness throughout the mishap (Tab V-2).

17. Navaids and Facilities: There were no NOTAMS pertaining to navigational aids or facilities on 7 Jun 96 that affected this BFM mission. All relevant navigational aids and facilities were functional (Tab V-12). The NOTAM board at the 114 FW is updated daily at the beginning of the duty day utilizing the CONUS Meteorological Data System(COMEDS) print-out. In addition, electronic updates can be obtained as required.

18. Weather: (Tab W)

SYNOPTIC WEATHER DEPICTION FOR 7 JUNE 1996 FOR SOUTH DAKOTA AND IOWA

The entire Midwest region was under the influence of a low pressure system over eastern Iowa producing broken to overcast conditions at 2,500 to 6,000 feet. Upper level winds were from the northwest at 30 to 40 knots. Alternate airfields to the south and east had light rain showers to thunderstorms in the vicinity. Military Weather Advisory (MWA number 07B) was valid for the area from 0900 - 1300 CDT with isolated thunderstorms having forecast tops to 45 thousand feet. No advisories were issued for turbulence, icing, or general precipitation.

SIOUX FALLS (FSD) OBSERVATIONS AND FORECAST

Observations from FSD showed the base of the clouds to be broken at 2,900 feet and overcast at 3,500 feet. Tops were reported at 4,300 feet. Visibility below the clouds was greater than 10 miles. The temperature was steady at 61 degrees with the dew point at 49 degrees. Winds were from the northeast at 16 knots gusting to 22. A peak wind of 26 knots from 030 degrees was observed at 1056 CDT. The forecast for FSD, valid until 1300 CDT, was for conditions to remain at 2,000 feet broken, 6,000 feet broken, 7 miles visibility, winds shifting more northerly gusting to 20 knots with the barometric pressure slowly dropping to 29.95.

FECHTER MILITARY OPERATING AREA PLANNING FORECAST

Weather forecast issued at 0630 CDT by Offutt AFB Weather Station, valid until 1300 CDT, showed weather conditions of a scattered to broken cloud layer from 1500 feet to 4000 feet. A mid-level broken layer of clouds was also forecast at 10,000 to 14,000 feet. Winds were forecast from the north at 12 gusting to 20 knots, minimum altimeter setting 29.90, and no thunderstorms, turbulence, or icing.

19. Governing Directives and Publications: Primary directives and publications relevent to this investigation are:

AFI 11-206, General Flight Rules
AFI 11-206, ACC Sup 1, General Flight Rules
AFI 11-401/ANG Sup 1, Flight Management
AFI 11-408, Aircrew Standardization/Evaluation Program Organization and Administration
AFI 11-408 , ACC Supp 1/185 FW Supp 1, Aircrew Standardization/ Evaluation Program
AFI 13-201, Airspace Management
MCH 11-F16 Vol 5, Flying Operations - Combat Aircraft Fundamentals - F-16
MCI (ANG) 11-F16 Vol 1, Pilot Training - F-16
MCI (ANG) 11-F16 Vol 3, F-16 Aircraft Pilot Procedures
MCI (ANG) 11-F16 Vol 3/185FW Supp, Chapter 8 - Local Operating Procedures
MCI 11-463, Operations Supervision
T.O. 1F-16C-1, F-16C/D Flight Manual
T.O. 1F-16C-1CL-1, F-16C/D Pilot Checklist

185 FW Briefing Guide
185 FW "Bat Book" - Inflight Guide
T.O. 1F-16C-2-70FI-00-11
1F-16C-6WC-1-11, F-16C Pre-Flight/Post-Flight Work Cards

The provisions of change 15 to T.O. 1F-16C-2-70FI-00-11 were not complied with.

Dated this 27th day of July 1996.

Dwayne A. Alons

DWAYNE A. ALONS, COLONEL, USAF
Accident Investigation Officer

Statement of Opinion

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to cause or causes of, or the factors contributing to, the accident set forth in an 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.

The opinion of this board is that the crash of aircraft 85-1545 was caused by a fatigue failure of the number 8 first stage fan blade, leading to catastrophic engine failure. Engine indications in the air were that of total engine failure and seizure, with no response to airstart attempts. The MP analyzed the situation correctly, took proper actions, and ejected from the MA causing no loss of life, and minimal property damage. All aircraft systems, other than the engine, operated normally throughout the flight.

T.O. 1F-16C-1 recommends ejection from a stricken aircraft in controlled flight at 2,000 feet AGL or above. Because of the cloud layer, Colonel Dardis delayed his ejection to approximately 1,600 feet AGL in his attempt to find an uninhabited spot for the impending crash. Colonel Dardis should be commended for this well thought out action; however, this slight delay may have contributed to his own back injury. Colonel Dardis followed the normal procedures after ejection by checking his canopy, checking his visor up, and then attempting to remove his oxygen mask. At this time he states that he noticed the rate of speed the wind was carrying him across the ground. In his attempt to steer toward an area free of trees and barbed wire fences, Colonel Dardis did not pull the 4-line release on the risers of the canopy which was appropriate for his closeness to the ground (Tab V-2). At the time of bailout a weather observer reported a peak gust of wind at FSD of 26 knots (Tab W). Colonel Dardis feels he made some corrections toward a clear area while descending, but the wind carried him into a sloped ravine which aggravated his parachute landing fall (PLF) (Tabs V-2 and V-47). The AIB members believe that the

wind conditions at the time coupled with the sloped terrain contributed significantly to Colonel Dardis' back injury. The AIB members cannot determine whether or not a normal canopy without the 4-line release activation was a contributing factor to Colonel Dardis' injury.

The board focused it's attention on the causes of the fan blade's failure. Examination of the failed blade under electron microscope identified a .015 of an inch deep dent in the leading edge of the concave side of the number 8 fan blade as the initiation point of the fatigue crack. This dent was in an area that had been previously repaired through blending (Tab J-21). A blend repair is the removal of a damaged area through filing, or grinding, and a subsequent polishing of the blended area to return it as closely as possible to the original finish and curvature of the blade. This process is prescribed in technical order (T.O.) 1F-16C-2-70FI-00-11.

An in-depth examination of all aircraft and engine historical records revealed evidence of a blend being performed in that area in Aug 94. This action was performed by personnel from the 185 FW Jet Engine Intermediate Maintenance (JEIM) section (Tab U-3). At the time that this blend action was performed, the serviceable limit for blade leading edge damage on this portion of the leading edge was .060 of an inch. Any damage less than this depth was considered serviceable, and did not require any action. Any damage .060 of an inch or greater required repair action, as long as the amount of blade leading edge removed to completely eliminate the damage was .150 of an inch or less. Any damage that required removal of over .150 of an inch of material was not repairable, and required blade replacement. The blend performed in Aug 94 appears to have been done to damage that was serviceable according to the T.O. limits at that time (less than .060 of an inch) (Tab J-21). That is, no action was required. Interviews with JEIM personnel indicate that they routinely blend this type of serviceable damage to preclude being called to evaluate the same damage repeatedly (Tab V-30). The evaluation of the remains of the number 8 fan blade showed that the .015 of an inch deep dent from which the fatigue crack initiated was probably damage not removed in the blending process in Aug 94. There is a small chance that this damage was caused after the blending was accomplished, but the probability of this is less than

one percent (Tab AA-22). The T.O. requires that any blending performed remove all of the damage completely. The blending was not completed in accordance with the T.O., leaving this small .015 of an inch dent on the concave, or back side of the fan blade. While this did not make the damage worse than it already was, it did act to mask the fact that there was still damage present on the blade in this area. Since the damage was within T.O. limits as set at the time, this damage should have been able to remain indefinitely without causing further problem. However, it was discovered by the F110-GE-100 engine management office at Oklahoma City Air Logistics Center (OC/ALC) that the first stage fan blades were less damage tolerant than was previously thought. After several F110-GE-100 engines from a different command were found with cracks in the leading edge of first stage fan blades, a one-time inspection of all F110-GE-100 engines was directed in Sep 95 to determine if existing blends on fan blades where done correctly (Tab AA-7). The inspection failed to identify this blade as a problem either because the damage involved was identified as still within the serviceable limits as prescribed in the T.O., or because the small remaining damage to the blade was in a difficult position to see, and was not detected. As a result of the analysis of damaged fan blades being found in the entire community of F110-GE-100 engine users, the OC/ALC made the determination that the fan blades were less damage tolerant than thought, and devised a change to T.O. 1F-16C-2-70FI-00-11. OC/ALC sent out a message warning units of the change in Dec 95 (Tab AA-9). None of the supervisors of the crew chiefs were aware of this message (Tabs V-19, V-21). The actual change to the T.O., dated 31 Jan 96, did not arrive on base at Sioux City until Mar 96. This change reduced the serviceable damage limits on first stage fan blades by 50 percent. It also created the requirement to use an inspection mirror and bright light to inspect the concave side of the leading edge in recognition that this area is very difficult to see (Tab AA-14). At this time, the unit had personnel deployed to Incirlik Air Base, Turkey. As a result, the engine mechanics assigned to the JEIM section were aware of the change, but the crew chiefs that perform the majority of fan inspections were not. The crew chiefs should have been aware of the change to the T.O., but the unit's system to inform them of the change failed to do so (Tab V-21). Additionally, the crew chiefs use work cards from T.O. 1F-16C-6WC-1-11 to perform

their fan inspections. These work cards reference the 1F-16C-2-70FI-00-11 as the source for the information on the card, but were not changed to reflect the last change in the source T.O. This led the crew chiefs to continue doing fan inspections without a mirror (Tabs V-19, V-21, V-36, V-42). While the JEIM section was aware that the serviceable damage limits in the T.O. had changed, and that the inspection mirror requirement was in place, they did not reassess blends or existing blade damage in light of that change (Tab V-25). The absence of another command directed one-time inspection or local action to inspect blades, and the failure to inform crew chief personnel of the T.O. change, combined to create a situation where this blade was never examined by 185 FW personnel with an inspection mirror, using the new damage criteria. If this inspection with a mirror had identified the unblended damage, then an analysis of the damage should have determined that approximately .037 of an inch of blade material had already been removed, and that an additional .015 of an inch dent was beyond serviceable limits as measured from the original leading edge, and required repair (Tab J-21). It is not certain, however, that the .015 of an inch dent would have been identified with the inspection mirror. The MA was deployed to Incirlik Air Base, Turkey, from Jan 96 through Apr 96. During this time period, possession of the aircraft rotated through several different units. Interviews with personnel from the 192 FW, Richmond, Virginia, indicate that they had possession of the MA from 8 Feb through 8 Mar while at Incirlik, and that they had been using inspection mirrors to do fan inspections at this time. There is no evidence to suggest that they were able to see the small .015 of an inch deep damaged section with the mirror.

The board also determined that two publications were factors in this mishap. The first was the 1F-16C-6WC-1-11 pre-flight/post-flight work cards. These work cards did not contain the same caution concerning use of a bright light and mirror that was added to the referenced source T.O. in Jan 96 (Tab AA-13). In the absence of a successful mechanism to pass on the information in the source T.O. change, personnel performing the majority of the first stage fan inspections continued to do so without a mirror after Jan 96. This greatly reduced the likelihood that the problem on the number eight first stage fan blade would be detected. Additionally, the work card, number 1-066, step

four only estimates 3 minutes for performing the fan inspection (Tab AA-13). While crew chief personnel interviewed by the board indicated that they took whatever time they felt necessary to do the inspection well (Tab V-36), the 3 minute criteria in the work card sends the wrong signal concerning the importance and care required. Additionally, the absence of the caution to use a mirror during the fan inspection in the work cards severely hampers the ability of transient alert personnel at non F-16 bases who frequently do not have access to a full T.O. library (Tab V-19).

The other publication the board considered a factor in this mishap is the 1F-16C-70FI-00-11. This T.O. covers the inspection criteria and blade blending technique for first stage fan blades. Interviews with maintenance supervisors and personnel revealed a significant amount of confusion regarding the information presented. For example, the T.O. gives serviceable and repairable limits for damage to the leading edge of the first stage fan blades. It also addresses the concave side of the leading edge of the fan blade, but does not provide any guidance to distinguish the leading edge from the airfoil section of the blades. Additionally, the blending guidance states that the leading edge contour of a blend should conform to the original contour of the blade. There are drastically enlarged drawings of a fan blade leading edge in the T.O. (Tab AA-14) that represent examples of acceptable and unacceptable leading edge contours after blending. The visual acuity of the unaided human eye would be severely challenged to distinguish the unacceptable contours from the acceptable one, especially on an installed blade. Throughout the T.O., there are requirements to make judgment calls and measurements to thousandths of an inch accuracy, without providing guidance on the measuring technique to be utilized. Interviews with JEIM personnel did not reveal any consistency on how to measure various kinds of blade anomalies (Tab V-25, V-30, V-34, V-38, V-40). This T.O. does not give the maintenance technician sufficient guidance to analyze or determine adequacy of repair on fan blade problems.

In conclusion, the fan blade that failed was blended improperly in Aug 94, but was still within serviceable limits until the 31 Jan 96 change to T.O. 1F-16C-2-70FI-00-11

was published. This change recognized that the blade was less damage tolerant than had been thought, and that the inability to properly see the concave side of the blade without a mirror was a problem. The 185 FW JEIM personnel were aware of the change, but the crew chiefs were not, and continued to perform fan inspections without the mirror. The damage to the fan blade went unnoticed, most likely masked by the incomplete blend repair, until the buildup of fatigue caused the initiation of a crack. This crack quickly progressed to total blade failure, and resulted in loss of the aircraft. Metallurgy experts determined the crack that initiated approximately eight flights prior to the mishap was probably not visible to the naked eye. From the testimony and evidence obtained in this investigation, the Board could not substantiate anything that would indicate any 185 FW personnel acted with intentional disregard for Air Force directives.

Dated this 27th day of July 1996.

Dwayne A. Alons

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Accident Investigation Officer

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RULEMAKINGS AND
ADJUDICATIONS STAFF

NUCLEAR REGULATORY COMMISSION

Docket No. _____ Official Exh. No. 9
In the matter of PFS

Staff	IDENTIFIED ✓
Applicant	RECEIVED ✓
Intervenor	REJECTED
Other Joint	WITHDRAWN
DATE 4-11-02	Witness
Clerk L. Shinderling	