RAS 5406 72-22-ISFSI — Applicant Exhibit 185 — Rec'd 7/1/02

AIRCRAFT ACCIDENT INVESTIGATION

1. AUTHORITY: Under the provisions of Air Force Instruction (AFI) 51-503, on 19 Aug 96, the Twelfth Air Force Commander, Lieutenant General James F. Record, appointed Lieutenant Colonel (Lt Col) Donald L. Oukrop to conduct an aircraft accident investigation after F-16CG, aircraft number 89-2101, crashed near Dhahran Air Base, Kingdom of Saudi Arabia (SA) (Y-2). No damage was caused to private property (P-2). The investigation was conducted at Dhahran Air Base, SA, from 28 Aug through 4 Sep 96, and Hill AFB, UT from 7 Sep through 25 Sep 96. The technical advisors were Lt Col Christopher R. Kleinsmith (medical), Captain (Capt) Thomas L. Wall (maintenance), Capt Douglas M. Whitehead and Capt Michelle Zellers (legal), and Mr. Caesar Sabatelli (technical advisor) (Y-3-7).

2. PURPOSE: An aircraft accident investigation is convened under AFI 51-503. The investigation is intended primarily to gather and preserve evidence for claims, litigation, disciplinary actions, adverse administrative proceedings and all other purposes other than safety. In addition to setting forth factual information concerning the accident, the investigating officer (IO) is also required to state his opinion concerning the cause or causes of the accident (if there is clear and convincing evidence to support that opinion), or to describe those factors, if any, that in the opinion of the IO substantially contributed to the accident. This investigation is separate and apart from the safety investigation conducted under AFI 91-204. The report is available for public dissemination under the Freedom of Information Act (5 U.S.C. 552) and AFI 37-131.

3. SUMMARY OF FACTS:

a. History of Flight: On 3 Aug 96, Capt Charles A. Durfee, the mishap pilot (MP), was piloting the second of four aircraft, call sign Pointer 12, on an air interdiction training mission supporting OPERATION SOUTHERN WATCH (OSW). The MP had 336.9 hours in the F-16C/D and was soon to enter the flight lead upgrade program (G-2, V-7.1). Capt Michael D. Hays briefed and led the four-ship mission (V-9.1). The flight used rolling afterburner (AB) take-offs with 20-second spacing between aircraft for its on time, 1420 local (L), takeoff from Dhahran Air Base, SA. The MP accelerated to the briefed 400 knots and turned to intercept the 310° radial during his climb out. Shortly thereafter he heard popping noises from behind and noticed white smoke in the cockpit as the engine appeared to lose power. The MP began to turn the aircraft back towards Dhahran Air Base when he heard another pop and series of bangs. The cockpit lighting then went out and all he saw was an engine warning light (V-7). At about 1425L the MP ejected from the aircraft. He was between 5,400 and 6,000 feet above sea level (MSL) and about 10 nautical miles from Dhahran Air Base (O-40, 42). His parachute deployed and he landed at 26°22.1'N and 49°59.7'E without injuries other than the minor abrasions he received when he was dragged by his parachute (N-2, DD-6.2, DD-8). A Royal Saudi Air Force (RSAF) search and rescue (SAR) helicopter crew took the MP back to the Air Base. U.S. personnel accompanied the Saudi ambulance which took the MP to the Ministry of Defense and Aviation (MODA)

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NUCLEAR REGULATORY COMMISSION

Docket No _____ Official Exh. No. 185

In the matter of _____

Staff _____ IDENTIFIED ✓

Applicant ✓ RECEIVED ✓

Intervenor _____ REJECTED _____

Contractor _____ DATE 7/11/02

Other _____ Witness _____

Reporter CK

hospital for treatment and observation (V-7.4). The aircraft crashed nearby in the desert and was completely destroyed upon impact. There was little news media interest in Saudi Arabia and in Utah the local media gave limited coverage (AA-2 and -3).

b. Mission: The flight was scheduled and planned as a four-ship interdiction mission as directed by the Joint Task Force (JTF) Southwest Asia (SWA) Air Tasking Order (ATO) in support of OSW (V-9.1).

c. Briefing and Preflight: The MP departed the squadron at approximately 1700L on the day prior to the mishap. On 3 Aug 96, he awoke at 0930L following about 8½ to 9 hours of sleep and reported for duty at the squadron at approximately 1030L (V-7.1). The flight lead, Capt Hays, had developed his own flight brief for the mission (O-49, V-9.1, CC-8). It was a normal OSW brief and covered all standard requirements for accomplishment of an OSW mission (V-4.1, V-7.1, V-9.1, V-10.1). The only other than normal briefed procedure was to accelerate to and initiate climb at 400 knots versus approximately 380 knots (V-7.1). The MP's preflight of his primary aircraft was unremarkable. However, after engine start, problems with the inertial navigation system (INS) batteries and flight control system (FLCS) required maintenance actions (V-7.2). Due to time requirements, the Top 3 (squadron supervisor) directed the MP to go to a spare aircraft. As the MP was reviewing aircraft 89-2101's forms, Capt Clapp (the Top 3) and Capt Rodgers arrived at the aircraft. As was the squadron's standard practice, Capt Clapp said that he and Capt Rodgers would perform the exterior preflight (V-5, V-7.1, V-11). The MP performed the cockpit preflight and strapped in for start (V-7.1). After engine start there was enough time to accomplish an 8 minute INS alignment and to bleed an over-serviced hydraulic system to technical order specifications (V-7.1, V-13). The MP did not feel rushed as he called for taxi to join his flight. He was the last flight member to complete end-of-runway checks (V-7.1).

d. Flight: The flight, call sign Pointer 11, took off at 1420L on a standard OSW departure (CC-2.2). The takeoffs were rolling single ship with 20 second delays between aircraft using full AB. According to the SOF (supervisor of flying), who was positioned next to the departure end of the runway, all four jets sounded the same and took about the same distance to lift off. The winds were 20 knots from 340° gusting to 28 knots (V-8). The MP did not feel hurried as he taxied to his assigned position to execute the takeoff as briefed by Capt Hays (V-7.1).

(1) The MP released brakes and paused in full military power (full throttle short of AB) to check engine instruments prior to selecting AB. All engine instruments were in normal operating limits (V-7.1-7.2). He took off and started a gradual climb, coming out of AB between 320 and 340 knots. He kept accelerating in military power until he reached about 400 to 410 knots then increased his climb rate and started to turn to intercept the 310° radial (V-7.2). The last time the MP specifically remembers checking his altitude, he was passing between 1,800 and 2,000 feet. He acquired a radar lock on his leader and began to follow in trail with the leader. Soon thereafter he heard a pop in his engine, experienced deceleration, and noticed smoke in his cockpit (V-7.2). The MP called on VHF (radio used for inter-flight communication): "Pointer 11,

Pointer 12 has a problem" (V-7.2, V-10.1). Pointer 11, Capt Hays, acknowledged the MP's call and directed Pointer 13 to maneuver forward and support the MP (V-9.2).

(2) Pointer 13, Capt John Montgomery, in trail behind the MP, noticed on his radar the mishap aircraft (MA) was to the right of the flight path. Though the flight plan called for a 2-3 mile spacing, Pointer 13 was gaining on the MA when he picked up visual contact and noted its deceleration (V-10.2). When the MP felt the initial pop in his engine, he selected AB from military power, thinking his engine had experienced an AB blowout. He realized he was not in AB and pulled the throttle back to military power. These actions took a matter of seconds. Whitish gray smoke had entered the cockpit and the MP observed it right in front of him as he looked towards the heads up display (HUD). He did not remember any fumes associated with the smoke and his vision was not obscured (V-7.2). The MP monitored his engine instruments and remembered the RPM (revolutions per minute) was somewhere in the low 90s and his nozzle was between zero and five percent (normal reading). He also remembered checking his oil and FTIT (fan turbine intake temperature), but did not remember the exact readings. It seemed to him that they were in the normal range (V-7.2). At that point Pointer 13 told the MP to continue his climb (V-9.2). The MP called that he was starting to turn back towards Dhahran Air Base (V-7.2).

(3) The MP started a turn back towards Dhahran Air Base thinking something was wrong with the engine (V-7.2, V-10.1). With only 5 miles visibility due to haze, he was unable to see the airfield. His thoughts were to return to Dhahran Air Base and strive for either a high key or a low key position required to execute a potential flame-out landing. As he went to select SEC (secondary engine control), he noticed another couple of bangs from behind (V-7.2). He did not recall whether he actually switched to SEC. At that point the radio and all the instrument lights in the cockpit went out. The only light that was on was the engine light (V-7.2).

(4) The MP then made the decision to eject. This decision was based upon his perceived position and the engine's condition. After the lights went out the MP did not remember his airspeed, though the last time he checked he was decelerating between 330 or 320 knots. He estimated his altitude was between 4,000 and 6,000 feet and about eight to ten miles from Dhahran Air Base (V-7.3). He also realized he did not have the required 1 to 1 ratio (1 mile horizontal distance for every 1,000 feet of altitude) to return to Dhahran Air Base with an inoperable engine. He knew the engine had failed and did not believe he had the time to restart the engine and did not remember if the emergency power unit (EPU) had come on. The MP made no attempt to jettison his fuel tanks and GBU-12 (guided bomb unit) (V-7.3, V-9.1, V-10.2). Pointer 13 observed the MA starting a slight left-hand turn and the MP ejecting at approximately 1423L (N-16, V-10.1).

(5) Much of the data from the Crash Survivable Flight Data Recorder (CSFDR) was irretrievable due to damage sustained at impact (O-7-8). According to the seat mounted Flight Data Recorder (FDR), the MP ejected at the 2 minutes and 5 seconds point (which equates to 2 minutes and 12 seconds into the flight) at an uncorrected altitude of 5,963 feet with an air speed of 285 knots (O-42). Based upon the local altimeter setting of 29.41, the corrected altimeter

reading would have been 5,487 (plus or minus 100) feet mean sea level (MSL) or about 5,400 feet above ground level (O-40, O-42, K-7, R-2). The ejection took place 11.8 miles from Dhahran Air Base and 11.3 miles from the non-operational King Fahd International Airport, based upon the trajectory and final position of the ejection seat (R-2, BB-2.1).

e. Impact: According to the CSFDR, the MA impacted the ground at about 2 minutes and 33 seconds into the flight (1425L) with an air speed of 352 knots at an angle of attack (AOA) of 4.2 (O-15). The MA crashed on 3 Aug 96, in an uninhabited desert terrain 10.5 miles northwest of Dhahran Air Base at 26°24.95'N and 49°57.81'E and was destroyed on impact (B-2, S-2).

f. Egress System: The MP initiated ejection seat sequence after he determined his engine was not operable and his altitude, approximately 5487 feet MSL, was too low to glide to a suitable airfield (K-7, O-40 and -42, R-2, V-7.3). The ejection was witnessed by Pointer 13, who maintained a visual on the MP (V-10.1-10.2). The MP noted nothing unusual about the ejection (V-7.3). However, the seat drogue chute did not function properly (S-4). Given the MP's altitude and air speed, the drogue chute was within the parameters to deploy according to T.O. 1F-16CG-1, Change 1, p. 1-95, Figure 1-47. Subsequent inspection of the seat drogue chute revealed scorching (S-4-5). Though not overdue, TCTO (time change technical order) 14D1-3-567 Inspection and Rework of Aces II Drogue Parachute Assemblies had not been implemented (U-3). Following ejection the MP noted his seat kit had deployed and his raft was spinning below him. He wrapped the line around his leg and pulled it up until the raft stopped spinning. The four-line jettison cord had been pulled up into the pockets of the risers, so the MP used his hook blade knife to cut the cords loose. Having completed the four-line jettison, he was better able to maneuver away from power lines and traffic. The MP landed hard in a field and was dragged by his parachute approximately five feet across the ground (V-7.3, DD-6.1, DD-8). He used his harness releases to collapse the parachute (V-7.3). According to the Aces II Seat Inspection Checklist for seat serial number 65U152, the last scheduled 36-month maintenance was performed 14-16 Feb 96 (U-12.8).

g. Personal and survival equipment: Personal and survival equipment inspections were up to date (U-12). The MP drank some water from his survival kit while waiting for the SAR helicopter. His survival radio functioned normally and the only signaling device used was his parachute, which he spread on the ground (V-7.3).

h. Rescue: When the MP ejected at 1423L, Pointer 13 radioed on Director's (Saudi Military Air Traffic Control) frequency "Mayday, Mayday, Mayday. Director, Pointer 12 has just ejected from his aircraft. Mayday, Mayday, Mayday." and gave the location (N-16). Pointer 11 then contacted the SOF and advised him of the ejection (V-9.2). All members of Pointer flight maintained their common VHF frequency to coordinate the SAR effort (V-4.1, V-9.2). Pointer 13 instructed Pointer 14 to climb above 9,000 feet to stay clear of the MP's chute. He also told Pointer 14 to monitor Director's frequency and requested Director keep the area clear of other aircraft. Pointer 13 then turned his HUD camera on and observed the MP's descent and landing (V-4.1, V-10.1). After the MP landed, he spread his parachute on the ground to aid the SAR effort. Both Pointer

13 and Pointer 11 unsuccessfully attempted to radio the MP on SAR nets A and B (V-9.2). The MP made a call on Guard frequency and Pointer 13 directed him to the SAR A frequency (V-7.3, V-10.1). Shortly thereafter the SOF directed Pointer 13 to switch to 282.8, the peace time SAR frequency. Upon hearing the mayday call, the SOF coordinated with the U.S. Air Force liaison in the air traffic control tower to scramble an RSAF helicopter (V-3, V-8). An RSAF search and rescue helicopter was deployed to the crash site and retrieved the pilot at 1452L (N-13).

i. Crash Response: Lt Col Jimmy C. Mann, 4404 Support Group Deputy Commander, was the crash site on-scene commander (V-2.1). When he arrived at the RSAF ramp, the SAR helicopter that retrieved the pilot was just returning. He and some USAF security policemen departed on another RSAF helicopter and arrived at the scene about 45 minutes later at 1600 hours. Although the helicopter had to travel only about 13 miles from the airfield, finding the crash site was difficult because it blended in with the desert topography. When Lt Col Mann arrived, two Saudi military police and four Saudi civilian police were 50 or 60 yards from the site. The Saudi police told him that no one had been on the site or had taken anything. Since there were no footprints in the sand, he concluded it was unlikely that anyone had tampered with the wreckage. Ten minutes later a fire truck and other vehicles arrived carrying the fire chief, disaster preparedness personnel, and additional security policemen. Lt Col Mann cordoned off the crash site. A local resident told Lt Col Mann, through an interpreter, that when the jet crashed he heard four or five loud explosions and two separate sets of rapid fire. Explosive ordnance (EOD) personnel found the four missile carcasses, the remains of the aircraft's 20mm gun, and several rounds of high explosive incendiary (HEI). The GBU-12 did not explode and was recovered by EOD (V-2.2).

j. Maintenance Documentation: The Maintenance Board Member reviewed the MA's active forms and found no indication of any pending mechanical, electrical, or jet engine failure (H-2). A review of 180 days of Core Automated Maintenance System history divulged no negative trends or open discrepancies in maintenance actions, scheduled inspections, and time change items contributing to this accident (U-2.1). Inspection of the MA's F110-GE-100 engine (s/n 545169) maintenance documents did not disclose any abnormalities (U-2.1). All required time compliance technical orders (TCTO) on both the airframe and engine were accomplished and properly documented (U-2.1). No TCTO discrepancies were noted which may have related to the accident. No maintenance procedures, practice, or performance was found to be related to the accident. The Joint Oil Analysis Program at the deployed location was mature and operated within command standards. Pre-accident oil analyses were taken and no discrepancies were noted (O-57, U-5.2). A combined Basic Post-Flight and Pre-Flight inspection was accomplished on 2 Aug 96, at 1900 hours (U-9.1-9.2). No defects were noted on the Walk Around Inspection accomplished on 3 Aug 96, at 1000 hours (U-8.1-8.2).

k. Maintenance Personnel and Supervision: The Maintenance Board Member reviewed the crew chiefs' and specialists' AF Forms 623 (On The Job Training Records) and AF Forms 797 (Job Qualification Standard Continuation/Command JQS) and verified individuals assigned to work the MA were properly trained and held the skill level required to perform assigned duties. The 34 FS (deployed) Maintenance Supervision provided adequate oversight and was effectively

organized in the manner specified in ACCI 21-166 (Objective Wing Aircraft Maintenance). No maintenance practice or procedure was deemed a factor in the accident (GG-2).

l. Engine, Fuel, Hydraulic, and Oil Inspection Analysis: Fluid samples taken from the fuel truck, oil servicing cart, and hydraulic servicing cart used to service the MA passed testing for purity, composition, and quality (U-6.1-6.2, U-7). The last 30 oil samples showed no signs of negative trending (an increase in wear metals) or indicating a potential for engine failure (O-57, U-5.2). Post impact oil samples taken from the ADG filter and engine bowl indicated extremely high levels of iron, aluminum, chromium, copper, magnesium, silicon, tin, and zinc.

m. Airframe and Aircraft, Missile, or Space Vehicle Systems:

(1) The MP did not report any abnormality in the hydraulic, electrical, mechanical, or avionics systems during pre-flight and takeoff (V-7).

(2) The last major maintenance completed on the engine occurred in the 388 Maintenance Squadron, Jet Engine Intermediate Maintenance shop and passed the Test Cell run 4 Aug 95 (U-11.4). The major maintenance included replacing the augmentor, exhaust nozzle, high pressure turbine (HPT) rotor, HPT nozzle, HPT shroud, combustor, and low presser turbine rotating air seal (U-11). The HPT rotor assembly was a serviceable asset from depot with the aft blade retainer made with the supersolvus process (U-10.13).

(3) An engineering analysis revealed that the damage sustained by the fan, compressor and combustor related components resulted from impact and did not contribute to the cause of the mishap (HH-2.1). From the HPT nozzle aft, all of the engine flow path surfaces exhibited severe breakage, tears, denting, rubbing, and bending that were attributed to both foreign object damage (FOD) and ground impact. Damage to the main engine bearings, external structures, accessories mounted both externally and on the gear box, all tubing, and all wiring was attributed to secondary failure events (HH-2.1).

(4) Analysis revealed the presence of a contour anomaly within the filet radius of the HPT disk aft rim rabbets. This contour anomaly departs from drawing specified contour requirements and plunges deeper into the disk with a profile that is irregular although very uniform over the circumference of the disk (Z-2.1-2.3, HH-2.3). By design specifications, the forward and aft filets should be mirror images of each other (Z-2.3, HH-2.3, note 5). The HPT disk had nine consecutive posts that were fractured at the aft rabbet (Z-2.1, HH-2.1). The five center posts showed fatigue crack origins within the aft rim rabbet contour anomaly (J-7, HH-2.2-2.4). The HPT aft rabbets serve to position and provide radial restraint and support for the HPT aft blade retainer. Without this restraint and support, the retainer would succumb to excessive centrifugal loading and hoop stresses (HH-2.2, note 2). An eight inch section of the aft disk retainer corresponding to the location of the nine damaged posts with separated rabbets liberated (J-8, Z-2.1-2.2, HH-2.2,). The trajectory of all or part of the broken section of retainer was marked by a path of damage that was tangent to and in the same plane as the hoop of the HPT aft blade

retainer (HH-2.2). With the eight inch section broken loose, the HPT rotor became grossly imbalanced and caused subsequent damage that rendered the engine incapable of producing thrust (HH-2.3).

(5) General Electric, manufacturer of the F-110-GE-100 engine, analyzed the HPT disk (P/N 1385M23P03-110, S/N MPOV5685), the HPT aft blade retainer (P/N 1476M95P03, S/N LPA930253C), HPT blades 4-7, HPT blade interface seals, and HPT retainer nuts and bolts (J-7-8).

(6) There were no base level repair stations involved in overhauling, repairing, benchchecking, or testing any component, accessory system, or unit suspected of failing.

n. Operations personnel and supervision: The mission was accomplished under the authority of the Joint Task Force South West Asia Air Tasking Order, through the 4404 Wing (Provisional) and 34 Fighter Squadron (FS). Capt Hays, 34th FS A-Flight commander, was the flight lead and developed his own mission briefing guide in accordance with MCR 55-116 and ACCR 55-116 (V-7.1, V-10.1). The squadron assistant operations officer was number 4 in the flight and stated all aspects of the flight were thoroughly briefed (V-4.1). All supervisor briefings and actions were accomplished (CC-2.2, CC-6.1-6.2, CC-7).

o. Pilot qualification: The MP was current and fully qualified to perform the scheduled mission (T-12). His flying experience is as follows (G-4, T-8):

Student Time	215.3
AT-38	20.7
F-16C/D	336.9
Total	572.9

HOURS/SORTIES

30 Days	60 Days	90 Days
28.6 hrs / 14 sorties	49.8 hrs / 25 sorties	57.2 hrs / 31 sorties

p. Medical: Capt Durfee was medically qualified to fly (T-4). Toxicology specimens contained no alcohol, elevated carbon monoxide, or illegal substances (DD-3.2).

q. NAVAIDS and facilities: There were no NOTAMs that affected the operation of the flight (FF-2.5).

r. Weather: Surface weather observations valid at 1430L on the date of the incident show clear skies, visibility of 5.63 miles with 20 knot winds from 340° and gusts to 28 knots. The temperature was 42°C with the dew point at 18°C and an altimeter setting of 29.41" (K-7). The

weather advisory log valid from 0640 through 1800 predicted northerly winds gusting between 25 and 34 knots (K-3).

s. Directives and publications: There were no known or suspected deviations from regulations, directives, or publications relevant to this accident.

Primary regulations relevant to this investigation are:

ACCI 21-166
ACCR 55-116
MCR 55-116
T.O. 1F-16CG-1

Donald L. Oukrop

DONALD L. OUKROP
Lt Col (Col Sel), USAF
Accident Investigating Officer

OPINION AS TO THE CAUSE OF THE ACCIDENT:

1. Under 10 U.S.C. 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 any such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.

2. The cause of this mishap, supported by clear and convincing evidence, was a contour anomaly within the filet radius of the aft rim rabbets of the high pressure turbine (HPT) disk (HH-2.3-2.4). The uniformity and precision of this anomaly is of a nature that could only be produced by a machining operation (HH-2.4). By design specification, both forward and aft contours of the rabbet filets are to be a mirror image of each other (Z-2.3, HH-2.3, note 5). The anomaly found on the aft rim rabbet filet radius of all 72 disk posts was an out-of-contour state (Z-2.3). This state consisted of a departure from the normal contour requirements and plunged deeper into the disk with an irregular profile which deviated from the drawing's specified requirements (HH-2.3-2.4). Five of the adjacent nine disk posts found to be fractured showed evidence of fatigue origins within the contour anomaly (J-7). Fundamental principles of stress analysis support the conclusion that the anomaly caused higher than normal operating stresses, which eventually resulted in the fatigue initiated failure of the HPT aft rim rabbets (HH-2.3). Once the aft rim rabbets broke off, an eight inch section of the HPT aft retainer broke free, causing foreign object damage, a severe out-of-balance rotation of the HPT rotor, and catastrophic failure of the engine (Z-2.1, HH-2.2). Due to this failure, the engine could not have been restarted (HH-2.3). As of 10 Sep 96 this anomaly was not identified by ACC as an F110-GE-100 major safety issue (II-2).

3. The MP accurately determined that the engine experienced a violent shutdown and would not restart (V-7.3). Though unable to later recall his specific distance and altitude, the MP correctly determined at the time that he could not successfully make a flameout landing and elected to eject (O-47, V-7.3, BB-2.2, EE-2).

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