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USNR

AFR 110-14 USAF AIRCRAFT ACCIDENT INVESTIGATION REPORT

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OFFICE OF THE SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

19 FEBRUARY 93
YANKEE RANGE, TX

F-16A
AIRCRAFT
S/N
83-1102

149 FG
182 FS

INVESTIGATION OFFICER
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HQ
147th FIGHTER GROUP

PFS Exh. 147

57596

COPY NUMBER _____ OF _____

2. SUMMARY OF FACTS

a. History of Flight: The mishap aircraft, F-16A Serial Number 83-1102, Callsign "Rolex 21" was number four in a flight of four on a surface attack training sortie. The flight of four departed Kelly AFB, Texas, at 0940 local, 19 February 1993. The flight was a routine training mission throughout the initial phases of the mission until the 5th bombing pass. On turn to down, the Mishap Pilot experienced a loud bang or compressor stall. The situation degraded rapidly into an out-of-control condition below 10,000 feet AGL. The Mishap Pilot ejected in IMC conditions. During the ejection process, the Mishap Pilot experienced difficulty obtaining a fully deployed parachute canopy. The condition was not corrected in sufficient time for the Mishap Pilot to make a safe landing.

b. Mission: The mission was scheduled as a routine Basic Surface Attack training mission. Ceiling and visibility were adequate for the mission. The sky condition was overcast with a ceiling of 2,000' in the Yankee Range in R-6312. Cloud tops were approximately 5,500'. The flight of four executed a standard departure of two two-ships and proceeded to the weapon area in a box formation below the cloud bases.

c. Briefing and Preflight:

Standard Briefing and preflight were normal and in accordance with squadron standards. The mission was briefed by the flight lead, Rolex 21, and all squadron

standards were complied with. Briefing elements included takeoff, departure, range operations, alternate missions, and recovery procedures.

(2) Preflight was normal. The mishap aircraft was fully fueled and configured with a centerline 300-gallon external fuel tank on Station 5, TERs (Triple Ejection Racks) on stations 3 and 7, with 3 BDU-33 practice bombs on each, and a captive AIM-9M practice missiles on station 9.

d. Flight Activity:

(1) Rolex 21 flight departed Kelly AFB at 0940L in two elements of two aircraft. The Mishap Pilot was the wingman in the second element. The four ship performed a standard departure and proceeded to the Yankee Range in a standard box formation. Departure from Kelly through ingress into the range were done below the cloud bases which were at least 2,000 feet AGL throughout the flight profile.

(2) Range entry, setup, communications with the Range Control Officer, and initial passes were uneventful. Each aircraft completed five passes prior to the incident. The Mishap Pilot, Rolex 24, had just completed his fifth pass and his turn to downwind, at 400-450 KCAS, when he heard and felt a loud "bang" or "thump." The Mishap Pilot had experienced compressor stalls in the past and was familiar with the symptoms. He described the noise as very similar. The Mishap Pilot immediately initiated a climb to achieve maximum altitude available below the cloud deck. The Mishap Pilot simultaneously retarded the throttle to the minimum practical setting and checked his engine instruments in accordance with CAPs. His initial inspection showed no abnormal indications. No Warning or Caution lights were illuminated immediately after the noise. The Voice Warning system had not activated.

(3) Concurrent with his initiation of the climb, the Mishap Pilot called "knock it off" and transmitted that he had "a problem." (See Tab N for a transcript of the air-to-air communication). For reference, the "knock it off" radio call is used as the beginning of the time sequence in "minutes:seconds", (0:00) of subsequent events. The flight lead responded and asked the nature of the problem. Transmissions by the Mishap Pilot indicate that when he responded to the query at 0:07, after he called the knock-it-off, he did not have a specific indication of the cause or effect of the problem. The Mishap Pilot's element lead, Rolex 23, directed the Mishap Pilot to continue on the downwind track. Rolex 23 was two or three-thousand feet ahead of the Mishap Aircraft and initiated a hard right turn to achieve visual contact with the Mishap Aircraft.

(4) At 0:16, the Mishap Pilot reported a fire light. Two seconds later (0:18), Rolex 23, who had obtained visual contact with the MA, reported that the Mishap Aircraft was trailing smoke. During his transmission that the Mishap Aircraft was trailing smoke, Rolex 23 observed that the Mishap Aircraft also began to trail flames from the aircraft. Rolex 23 then reported to the Mishap Pilot that he was "big-time burning."

(5) The Mishap Pilot does not remember hearing the "big-time burning" transmission, nor could he state with certainty whether his aircraft had experienced any electrical problems at that moment. The Mishap Pilot indicated that throughout the initial

moments of the event, he was attempting to ascertain the nature and extent of the problem, including ensuring that the Fire warning light was valid. Though it seems unlikely that the Mishap Pilot would not remember hearing confirmation that he had a fire, insufficient data exists to establish whether the Mishap Aircraft radio was working at that moment.

(6) Immediately after Rolex 23's confirmation of the fire, the Mishap Aircraft began an uncommanded but relatively mild climb (0:26), which the Mishap Pilot could not counteract with flight control inputs. This is consistent with predicted performance of the F-16A when the flight controls "streamline" after loss of computer inputs to control their position. Initiation of the climb was interpreted as an intentional pre-ejection "zoom" maneuver by Rolex 23.

(7) The Mishap Pilot reported that the uncommanded pitch-up of the aircraft, though mild at first, rapidly increased in intensity to a five-to-six G pull-up. The Mishap Pilot did not specifically observe the "G" reading or the flight instruments. His conclusion is based on experience and reinforced by his later observation that his G-suit was fully and strongly inflated. G-suit inflation is influenced by the magnitude of the forces as well as the rate of onset. The Mishap Pilot's observation of his G-suit is consistent with his conclusion of the G loads achieved. The Mishap Pilot became aware that ejection would be necessary when the aircraft began the uncontrolled climb, but because the aircraft was climbing, the Mishap Pilot elected to take advantage of the increasing altitude to improve his margin in the ejection envelope.

(8) The Mishap Aircraft entered the clouds almost immediately after the uncommanded climb was initiated. The Mishap Pilot does not have a clear memory of aircraft attitude or airspeed at any point from entry into the clouds until he ejected. The Mishap Pilot reported that he experienced a rolling motion, but he could distinguish whether the motion was induced by aileron inputs alone or whether it may have been a "yaw roll." Therefore, it cannot be determined if the aircraft was in coordinated or uncoordinated flight at the time of ejection.

e. Ejection:

(1) When the aircraft began the rolling motion, the pilot initiated the ejection sequence (elapsed time was estimated to be at 0:30 to 0:35) with a good body position but with his visor in the "up" position. The pilot is not aware of his ejection altitude. The pilot heard the initiator fire and observed the canopy depart the aircraft. The pilot does not remember the "ride up the rails" but he did recall hearing and "feeling" some small "explosions" which apparently were part of the ACES-II seat initiator sequence. The Mishap Pilot recalled side-to-side forces on his body by which he apparently meant left-to-right, then right-to-left twisting forces prior to initial canopy opening. When the forces on his body diminished, the Mishap Pilot noted that he was hanging in the chute. The pilot was in IMC at the time.

(2) The Mishap Pilot began performing his post-ejection checklist and noted that his parachute canopy was much smaller than it should have been. The pilot had made two civilian parachute jumps previously but had never ejected. The Mishap Pilot

estimated that the canopy was only four or five feet in diameter. The Mishap Pilot noted that the canopy shroud lines were twisted beginning several feet above his head. See photos at Tab Z-1, Z-2. The Mishap Pilot attempted to perform the "bicycle" maneuver, which involved pulling the risers down and apart with his arms and making a bicycle-like maneuver with his legs in an attempt to untwist the risers. The attempt was unsuccessful. The Mishap Pilot noted that the twist in the lines was too far above his head for the bicycle maneuver to be effective. The maneuver is primarily designed to remove twists in the risers near the pilot.

(3) The Mishap Pilot noted that the twist in the canopy lines was not untwisting on its own. He analyzed the situation and determined that he should attempt to induce an "untwisting" motion. He reached as far up on the risers as he could and then began attempting to rapidly twist his body in an attempt to induce an untwisting moment to the lines. The pilot made several unsuccessful attempts at this procedure, which he described as very strenuous. The Mishap Pilot had difficulty estimating the length of time he spent in his initial attempts at this maneuver or in the "bicycle" maneuver. The Mishap Pilot became sufficiently fatigued that he found it necessary to rest momentarily. The Mishap Pilot was not aware of his altitude above the ground, but he was still in IMC.

(4) After resting for a moment, the pilot made additional attempts to force the lines to begin untwisting. After his last attempt, he noted the parachute turning relative to him. The Mishap Pilot is not certain whether he was twisting (relative to the ground) or whether the canopy was twisting since he was in the clouds and had no reference. The canopy rapidly untwisted and fully deployed. The Mishap Pilot was nearing the cloud bases as the canopy fully deployed and was VMC almost immediately thereafter.

(5) At 0:40, Rolex 23 observed "pieces coming down" out of the cloud bases. The pilot could not identify the pieces with any certainty and could not determine whether he was observing the ejection seat or the canopy.

(6) At 0:49, nine seconds after seeing the pieces come through the clouds, Rolex 23 saw the aircraft come through the clouds. The aircraft was burning and appeared to be falling straight down or with little horizontal velocity. Crash site measurements and legend, Tab R, indicate that the aircraft impacted approximately 1,200 feet from the canopy and no components other than the ejection seat and aircraft canopy were found more than 300 to 400 feet from the wreckage itself.

(7) At 0:53 Rolex the Mishap Pilot in his parachute just below the cloud bases and noted that he had a ". . . good chute. . . ." The Mishap Pilot had gotten a full chute prior to being clearly below the cloud bases; therefore, it can be concluded that had the pilot's full parachute been delayed a few seconds longer, the pilot and the aircraft would have appeared through the clouds even closer together in time than the four seconds observed by Rolex 23.

(8) When the mishap pilot observed the wreckage of the aircraft, he noted that his drift was taking him toward the fire. He used standard parachute steering techniques to avoid the scene.

(9) Though the Mishap Pilot was not certain whether he was twisting or the parachute was twisting, the Mishap Pilot did not note any disorientation at cessation that might be associated with a spinning motion of his body in 1-G. This investigation cannot conclude if the actions of the pilot resolved the parachute problem or whether the complication resolved itself. Based on testimony of the pilot, it is concluded that the duration of the event, from initiation of ejection to resolution of the problem required at least 15 seconds and may have required as much as 20 seconds.

(10) Aircraft altitude, attitude, airspeed, pitch, roll and yaw rates at the time of ejection are not known, nor can any of these parameters be accurately estimated. Any calculations of any of these parameters require assumptions about several of the other parameters, as well as initial canopy inflation size and angle of egress of the seat. Small errors in any of the assumptions could result in large errors in the calculations. Some limits might be estimated based on terminal velocity of the man-chute system with and without parachute deployment factored against upper and lower limits on the length of time required for full chute deployment, but these limits would still be speculative and of questionable value.

(11) Based on ACES-II performance characteristics, see Tab BB, and the known flight parameters, the precise mode that the seat should have performed to cannot be determined with any certainty. Seat analysis indicates that the seat performed in Mode 2, which would require an ejection airspeed in excess of 220 KCAS at 4000 feet MSL. This is consistent with the pilot's sensory perception. However, the proximity of the crash site to the canopy and ejection seat are not inconsistent with a lower speed at the time of ejection. The time and distance proximity could also be explained by a rapidly decreasing airspeed as well as an unpredictable vertical flight path. Scenarios can be developed that would support either Mode 1 or Mode 2, depending on airspeed at the time of ejection. Based on the Mishap Pilot's statement, the system should have been in Mode 2 because Mode 1 requires an airspeed substantially lower than the airspeed estimated by the pilot based on the G-loads.

(12) Analysis indicated that the seat system operated in Mode 2. In this mode, the pilot should receive full parachute inflation 2.9 seconds after catapult initiation. In a Mode 1 ejection, full parachute inflation should come 1.8 seconds after catapult initiation. The time required for full parachute inflation in Mode 3 depends on how long it takes the seat to enter the Mode 2 envelope for airspeed and altitude. The Mishap Pilot did not receive full parachute inflation for at least 15 seconds after catapult initiation. The Mishap Pilot received minor abrasions on his face, and there was discoloration on his helmet, but the Mishap Pilot could not provide any definitive statements that would establish the existence or extent of seat-chute or seat-man involvement during the ejection process.

f. Impact The aircraft impacted in an inverted attitude with very low forward velocity. The impact caused very little physical damage to the private property where it

impacted. The area encompassed by the crash site is approximately 100 feet by 50 feet wide, in level, brushy terrain that is used for cattle grazing. An estimate of the cost of contamination clean-up of the site is contained in Tab P.

g. Personal and Survival Equipment: Once on the ground, the pilot used only the survival radio. The parachute release mechanism functioned normally. Surface winds were low and the pilot was not dragged. The raft deployed nominally.

h. Rescue: The pilot was rescued by ground vehicle responding to the crash approximately 20 minutes post-ejection.

i. Crash Response: Crash response was coordinated by the Range Control Officer. The training ammunition was detonating as the aircraft burned. This briefly delayed firefighters from approaching the wreckage.

j. Maintenance Documentation: AFTO Form 781 Series data indicates that no engine related write-ups were open in the 781A at the time of the incident. The 781K Calendar/Hourly Inspection records indicated that only the MSR tape was overdue. All other inspections were current. The open 781K write-ups did not include any engine performance related write-ups. Specific write-ups are listed in Tab H-1. The only open write-up on the aircraft that is noteworthy is that the video tape recorder was not useable, therefore, the Mishap Aircraft was not recording flight parameters during the mission.

k. Maintenance Personnel and Supervision: Review of relevant information indicates that all unit maintenance personnel performing service and inspections on the aircraft were fully qualified. Supervision appeared thorough and professional, and the Engine shop personnel exhibited an enthusiastic and "can-do" attitude.

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

(1) The Mishap Aircraft was fitted with a Pratt & Whitney F100-PW-200 engine, S/N PWOE703609. The Technical and Engineering Evaluation of Materiel Report is contained in Tab J. A brief summary of the significant facts is set forth below.

(2) Inspection of the wreckage indicated that the engine experienced an in-flight Fan failure. The Fan cases were buckled and torn open at the 12-to-4 o'clock position (aft looking forward). The 2-3 Spacer and the third stage fan disk were both fractured and were visible from the side of the Fan module. Pieces of the third stage disk were found outside of the Fan cases. Metal splatter on the aft face of the engine mount flange indicated there was an intense inflight fire which exceeded temperatures of 3000° F evidenced by the burnt titanium on the rear fan duct. The flame source was aft of the mount flange and external to the engine.

(3) Fan S/N PWOF003964 was received into the USAF inventory in February 1986. The Fan was installed on the mishap engine on 7 Dec 89 at 1601 CCy (Fan) and 2987.2 EOT and 4246 CCy for the engine. The Fan had accumulated 1025 CCy since

the last depot visit. The next schedule depot visit for the Fan was scheduled at 4601 CCy.

(4) Review of maintenance records showed that all engine-related TCTOs had been accomplished except TCTO 536 (220E configuration upgrade), TCTO 539 (compressor airseal modifications), and TCTO 540 (Re-op of 3rd Stage fan disk). All of these TCTOs are accomplished at Depot level only. In addition, TCTO 511 (rework of anti-rotation slots on the 2-3 Airseal) had been accomplished in September, 1985, at 1790.5 CCy (Computed Cycles); TCTO 518 (Sutton Barrel finishing) had been accomplished in September, 1989, at 3335.5 CCy. At that time, 3000 cycles were added to the life limit, bringing it to 6336 CCy. The 2-3 Spacer was installed on the Fan during its second depot visit in November, 1989. The 2-3 Spacer accumulated 4360 CCy immediately prior to the mishap sortie.

(5) Analysis of the mishap engine revealed that the fan case showed several exiting penetrations and punctures from internal debris. Impact marks on the engine stator generator, oil pump, and cuts in oil lines at the 6 o'clock (aft looking forward) evidence where fan blades exited the fan case. CIVV Control and Cylinder actuator piston positions were found in configurations consistent with a low power throttle setting as the final received command from the Engine Control. There was no evidence of bird ingestion.

(6) Fuel, hydraulic, and oil test data was normal. No information was discovered that would indicate that any of these items contributed to the mishap.

m. Aircraft and Aircraft Systems:

(1) Based on technical and engineering evaluations of material found, for an undetermined reason, the 2nd Stage Compressor Airseal (2-3 Spacer) failed catastrophically at high power.

(2) Failure of the Spacer led to immediate failure of the 2nd and 3rd Stages of the compressor, with subsequent penetration of the casing as fan blades were liberated at high power setting.

(3) Penetration of the casing caused a rapid and intense fire.

(4) System damage resulting from the liberated fan components and the resulting intense fire lead to loss of flight control command authority.

n. Operations Personnel and Supervision: The mission was authorized by [REDACTED] and approved by [REDACTED] on Form DD-175. [REDACTED] briefed the mission using Squadron Standard briefing guides. Supervisory personnel were in the building but not present for the briefing. All flight members were present. The briefing and preflight operations fully satisfied all squadron and ACC standards. The mission was thoroughly and adequately briefed.

o. Pilot qualification:

(1) Examination of pilot records indicated that the mishap pilot was fully qualified and current in accordance with current regulations and directives to fly the mission.

(2) The mishap pilot had accumulated 728.4 hours of flight time with 510.7 of those in the F-16. He had flown six sorties for 8.2 hours during the previous 30 days; seven sorties for 9.4 hours during the previous 60 days, and 10 sorties for 13.9 hours during the previous 90 days. He was proficient in the scheduled mission. His instrument and tactical qualifications were valid until the third quarter of CY 93.

(3) The flying experience for Lt White follows:

| TOTAL TIME | F-16 | AT-38 | STUDENT |
|------------|-------|-------|---------|
| 728.4 | 510.7 | 26.4 | 192.3 |

p. Medical: The mishap pilot received only minor abrasions during the ejection, landing and recovery. A small abrasion on his face, some minor neck strain and soreness resulted from the ejection process. His parachute landing fall was excellent and he received no injuries.

q. Nav aids and Facilities: All Nav aids and facilities necessary to mission were operational.

r. Weather:

(1) There was no significant weather that affected the mishap flight. Ceiling and visibility at the base of departure, Kelly AFB, was reported to be 2,000' overcast, 7 miles visibility, with surface winds less than 5 knots.

(2) Weather on the range was estimated by the flight members to be the same as observed at Kelly AFB. No information is available to identify the cloud tops or layers. The IMC conditions at the time of ejection contributed to disorientation of the pilot and prevented visual observation of the mishap aircraft's terminal flight profile by the flight members.

(3) There were no weather warnings for Kelly AFB, the route of flight, or the scheduled working areas.

s. Directives and Publications:

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

| | |
|---------------------------|--|
| AFM 50-46 | Weapons Ranges |
| AFM 60-1 | Flight Management |
| AFR 60-16 | General Flight Rules |
| AACM 3-3, Vol V | Mission Employment Tactics - F-16 |
| ACCR 51-50 | Flying Training - Tactical Fighter |
| ACCR 51-50, Vol 6 | F-16 Aircrew Training |
| ACCR 55-79 | Procedures for Air Operations |
| ACCR 55-116 | F-16 Aircrew Operational Standards |
| ACCR 60-2 | Aircrew Standardization/Evaluation Procedures |
| T.O. 1F-16A-1 | Flight Manual F-16A |
| T.O. 1F-16A-34-1-1 | F-16 Non-nuclear Weapons Delivery Manual |
| T.O. 1F-16A-6-WC-1 | Inspection requirements for the F-16A aircraft |
| T.O. 1F-16A-1-CL-1 | F-16A Flight Crew Checklist |
| 149 FG Squadron Standards | Flying training missions - Standard Procedures |

(2) There were no known or suspected deviations from the directives or publications by the pilot or others involved in this mission.


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4 JUN 93