



AIRCRAFT ACCIDENT INVESTIGATION

2003 JAN 21 PM 3: 38

OFFICE OF THE SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

AUTHORITY: Under the provisions of Air Force Instruction (AFI) 51-503, the Ninth Air Force Commander, Lieutenant General John P. Jumper, appointed Lt Col Joseph H. Long to conduct an aircraft accident investigation where an F-16 CG (89-2058) landed at Moody AFB GA on 18 Oct 94 with the nose landing gear (NLG) in the up position. The investigation was conducted at Moody AFB GA on 28 Oct and 2 Dec 94. The investigation was continued at Shaw AFB, SC between these dates and 15 Feb 95.

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 and administration needs. In addition to setting forth factual information concerning the accident, the investigating officer 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 investigating officer substantially contributed to the accident. The report is available for public dissemination under the Freedom of Information Act (5 U.S.C. 552) and AFI 37-131

SUMMARY OF FACTS:

a. **History of Flight:** On 18 Oct 94, Lt Col Tom Ardern, the mishap pilot (MP), was scheduled as Number 3 of a Surface Attack Tactics (SAT) mission as the evaluator giving Number 2 (Capt Pete Parsons) a mission check ride. Capt Earle Thompson led the mission. (V-1) The flight departed Moody AFB GA at 1457 hours eastern standard time (EST) and proceeded to VR-1001 Point B. (K-1) From Point B, the flight conducted low level operations along VR-1001 to Moody Military Operating Area (MOA) 2. Shortly after the flight entered MOA 2 the mishap aircraft's (MA) hydraulic B-system failed. The MP declared an emergency and maneuvered for landing at Moody AFB, GA. Following checklist procedures Lt Col Ardern was unable to extend the nose landing gear (NLG) and subsequently made a gear up landing. The mishap site was runway 18L, Moody AFB GA. (V-1)

b. **Mission:** The flight was scheduled and planned as a four-ship SAT mission with Number 2 being evaluated by the MP Number 3. The planned profile included single ship takeoffs, medium altitude cruise to VR-1001 Point B, low level navigation on VR-1001, a simulated bomb attack in MOA-2, practice gunnery on Grand Bay Range and return to base via vectors to initial for overhead patterns. (V-6)

c. **Briefing and Preflight:** Lt Col Ardern reported for duty at approximately 0900 hours EST. (V-1) The briefing and preflight were standard and unremarkable. After engine start the lead aircraft was delayed and taxied late. (V-6)

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 Docket No. _____

_____ Staff _____
 _____ Applicant _____
 _____ Intervention _____
 _____ Cont'g Off'r _____
 _____ Contractor _____
 _____ Other _____
 _____ Witness _____
 _____ Reporter _____

DATE 7/11/02

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d. Flight: The flight, callsign Snake 01, took off at 1457 hours EST on a VAD-38 stereo flight plan.(K-1) The takeoffs were single-ship using afterburner (AB) power. The flight to VR-1001 and the low level portion of VR-1001 were uneventful. (V-6) After entering Moody MOA-2, while maneuvering for a simulated bomb attack the MP received an aural warning, a hydraulic/oil pressure light and noted zero pressure on the B-system hydraulic pressure gauge. The MP called knock-it-off for Number 3 and Number 4 and climbed to 5,000 feet. The MP then contacted RAPCON, declared an emergency, and requested the single frequency approach to coordinate with the wing's supervisor of flying (SOF). The MP followed the checklist and when the gear handle was lowered the landing gear stayed up with no B-system hydraulic pressure. The MP then pulled the alternate gear extension handle and the main gear fell into position, however, the nose gear door remained closed and the NLG up. The MP's wingman Number 4 confirmed that condition. The MP climbed to 12,000 feet and asked the SOF to call the aircraft manufacturer, Lockheed, for any additional ideas. The MP then tried using G forces to pull the gear down. He accelerated to 320 knots and pulled approximately 3.9 Gs. The doors remained closed. The MP climbed back to 12,000 feet, accelerated to 360 knots and pulled 4.8 Gs. This still had no effect. With fuel becoming a factor (Number 4 with 1,700 pounds fuel remaining), the MP directed Number 4 to land in front of him since he would close the runway. (V-1) After Number 4 had been cleared off, Lockheed recommended to try using negative G then positive G to snap the gear down. (V-2) The MP then accelerated to 280 knots and went from -1.1G to 3.7Gs. The NLG remained up. The MP's fuel was now at 1,500 pounds so he completed the checklist by turning on the emergency power unit (EPU) and maneuvered for landing. The MP flew a shallow approach and touched down approximately 500 feet down the runway. Shortly after touchdown the MP shutoff the throttle and held the nose off the runway using aerodynamic braking. At approximately 100 knots the MP lowered the nose to the runway and used back-up accumulator brakes to stop the aircraft. (V-1) After the aircraft came to rest the MP safely egressed as the fire department sprayed foam around the aircraft. (V-5).

e. Impact: N/A

f. Ejection Seat: N/A

g. Personal and survival equipment: N/A

h. Rescue: N/A

i. Crash Response: The crash net was activated at 1547 hours EST. At 1620 hours EST the aircraft touched down with the NLG in the up position. When the nose was lowered to the runway surface flames immediately began to trail behind the aircraft. The fuel trucks were on the scene immediately and discharged 30-60 gallons of foam to extinguish the fire. The pilot ground egressed the aircraft and exited the area via the aircraft's right forward quadrant. The MA was checked for possible hydrazine leaks and none was detected. (V-5-1, V-5-2)

j. Maintenance Documentation: A thorough review of the maintenance records for aircraft 89-2058 revealed no discrepancies that caused or contributed to the accident. (U-1)

k. Maintenance personnel and supervision: Aircraft 89-5028 was properly serviced, inspected and prepared for flight by qualified maintenance personnel. Training records were reviewed and all personnel involved in the preflight and launch of the aircraft were qualified. (DD-1) There is no evidence of maintenance malpractice associated with this mishap. (V-3,V-4)

l. Engine, fuel, oil and hydraulic inspection analysis: Hydraulic samples were tested from the aircraft's hydraulic system A and system B, three hydraulic servicing carts and a hydraulic test stand. Tests on system A, the hydraulic carts and the test stand were normal. (CC-1, CC-3-1-2-3,CC-4,CC-5) Tests on system B detected a high level of contamination by steel, copper, aluminum, teflon, acrylic polymer, daillyl phthalate resin and iron. Much of the contamination is consistent with pump failures, however, the aluminum, teflon, acrylic polymer and daillyl phthalate resin contaminants could be considered failure initiators. This could not be determined due to the catastrophic destruction of the pump. (CC-2,AA-1-4,AA-1-5)

m. Airframe and aircraft systems: Technical data pertaining to operation, inspection, and maintenance of the hydraulic and landing gear system was reviewed. In addition, historical data on hydraulic and landing gear mishaps was provided by Department of Defense employees located at HQ AFSA/SECD, Kirtland AFB, NM. HQ Ogden Air Logistics Center (AFMC), OO-ALC/LAAM, Hill AFB, UT provide the technical break down analysis and historical data on the gear actuators and HQ Oklahoma City Air Logistics Center(AFMC), OC-ALC/LIIR, Tinker AFB, OK provided the same information on the MA's hydraulic pump.

1. The mishap data provided by Hq AFSA listed all F-16 mishaps related to hydraulic and/or landing gear problems from 1985 to 1994. The study of this data over the last ten years revealed there have been thirteen mishaps reported due to hydraulic failures in the F-16. One was system A failure, two were on the ground and one was in the air with the gear already down. These four were not considered since they did not affect the lowering of the landing gear. Of the nine remaining four were able to lower the gear by the alternate method and one was able to use G forces to fully extend the nose gear when it remained partially up after alternate gear extension. Four resulted in partial gear up landings for the following failures:

- (a) Two NLG door actuators.
- (b) One left main gear (LMG) door actuator.
- (c) One NLG extend/retract actuator.

There were four other gear up landing not associated with hydraulic problems and all were due to the actuator failures listed below:

(a) Three NLG extend/retract actuators.

(b) One NLG door actuator. (BB-1 through BB-2-16)

It should be noted that although these actuators operate different components they are of the same design and that the design problem is in the locking pawls which have a tendency to jam. (EE-1-1,EE-2-1)

2. After the mishap, the hydraulic pump was removed and sent to Oklahoma City for analysis. Sampled hydraulic fluid revealed a high degree of contamination consistent with pump failure and also many contaminants that were not. These contaminants may have been initiators of the failure, however, due to the catastrophic failure of the pump the cause could not be determined. A number of questions have arisen from this mishap and other hydraulic pump failures in the last few years, Presently, AFMC is reviewing the possibility of shortening Time Change Interval (TCI) of the F-16 hydraulic pumps. (AA-1-3,AA-1-4,AA-1-5)

3. After the mishap the NLG door actuator was removed and tested by a technician from Ogden doing a slow pressure rise check designed to identify faulty actuators. This actuator failed the test on five of eight attempts and when the tear down analysis was accomplished there was no noted significant wear or failure. (J-2-1,J-2-2) This finding is consistent with the known actuator design problem identified in the 1970s and 1980s. (EE-1-1) Compounding the actuator design deficiency is that when hydraulic system B is lost there is a very high probability that the landing gear actuator locking pawls will jam. Currently, a newly designed actuator has been manufactured and is being tested for a possible retrofit into the F-16 fleet. (EE-2-1)

n. Operations personnel and supervision: The mission was accomplished under authority of the 347 Fighter Wing (FW) and 69 Fighter Squadron (FS). Captain Thompson gave the pre-mission brief in accordance with MCR 55-116 and MCR 55-116, Moody AFB Supplement 1. All supervisor briefings and actions were accomplished. (V-6)

o. Pilot Qualifications: Lt Col Ardern was current and fully qualified to perform the scheduled mission. (T-1) His flying experience is as follows: (G-2,G-3)

T-38	1134.7
AT-38	23.3
F-16A/B	103.4
F-16C/D	1364.0
F-4	<u>376.6</u>
TOTAL	3001.3

HOURS/SORTIES 30 days/60 days/90 days

30 Days
9.2/7

60 Days
21.6/16

90 Days
32.7/25

p. **Medical:** Lt Col Adern was medically qualified to fly. (X-1) Toxicology specimens contained no alcohol, elevated carbon monoxide levels, or illegal substances. (X-2)

q. **Nav aids and facilities:** All applicable NAVAIDS were in operation. Runway 18R/36L was closed, however, this had no impact on the accident.. (O-2-4)


r. **Weather:** The latest weather observation was taken at 1555 hours EST. The weather was estimated 3,000 scattered, 10,000 scattered, 20,000 scattered, visibility 7 miles, temperature 78/dew point 46, winds 0900/02, altimeter 30.11 inches. (W-1)

s. **Directives and publications:**

MCR 55-116, F-16 Pilot Operational Procedures
MCR 55-116, MAFB Sup 1 Local Operating Procedures
T.O. 1F-16CJ-1, Flight Manual
T.O. 1F-16CJ-1CL-1, Flight Manual Checklist

There are no indications of deviation from directives. (V-1,V-2,V-6)

OPINION AS TO THE CAUSE OF THE ACCIDENT: 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 proceedings arising from an aircraft accident, nor may such information be considered an admission of liability by the United States or by any person referred to in those conclusions or statements. Based upon the evidence which I found to be clear and convincing was that the primary cause of the accident was the failure of the NLG door actuator pawls to unlock, thus not allowing the NLG door to open and the NLG to come down. In addition to the actuator failure, the single significant contributing factor to the jammed actuator pawls was failure of the B-system hydraulic pump. Over the ten year period 1985 to 1994, there have been eight partial gear up F-16 landings. All were caused by actuator failures with four being associated with B-system hydraulic failure.


JOSEPH H. LONG, Lt Col, USAF
AFI 51-503 Aircraft Accident Investigating Officer

GLOSSARY

AB	AFTERBURNER
ACC	AIR COMBAT COMMAND
AFB	AIR FORCE BASE
AFE	AIR FORCES EUROPE
AFI	AIR FORCE INSTRUCTION
AFMC	AIR FORCE MATERIAL COMMAND
AFSA	AIR FORCE SAFETY AGENCY
AFTO	AIR FORCE TECHNICAL ORDER
ALC	AIR LOGISTICS CENTER
ANG	AIR NATIONAL GUARD
AVBL	AVAILABLE
AYS	WAYCROSS TACAN IDENTIFIER
BFM	BASIC FIGHTER MANEUVERS
BKN	BROKEN
C/L	CENTERLINE
C/W	COMPLIED WITH
CC	COMMANDER
DME	DISTANCE MEASURING EQUIPMENT
DRAIR	DEFICIENCY REPORT ANALYSIS INFORMATION REPORT MALFUNCTIONS
DSN	AUTOVON TELEPHONE NUMBER
EPU	EMERGENCY POWER UNIT
EQD	EQUIPMENT DESIGNATOR
EST	EASTERN STANDARD TIME
ETD	ESTIMATED TIME OF DEPARTURE
ETE	ESTIMATED TIME ENROUTE

EXP	EXPERIENCE
EXT	EXTERNAL
FCST	FORECAST
FLT	FLIGHT
FOUR SHIP	FLIGHT LEAD STATUS (TO LEAD NUMEROUS AIRCRAFT)
FS	FIGHTER SQUADRON
FW	FIGHTER WING
G	FORCE OF GRAVITY
GCC	GRADUATED COMBAT CAPABILITY
HQ	HEADQUARTERS
HYD	HYDRAULIC
ILS	INSTRUMENT LANDING SYSTEM
INT	INTERNAL
IP	INSTRUCTOR PILOT
LANT	LANTIRN
LANTIRN	LOW ALTITUDE NAVIGATIONAL TARGETING INFRARED FOR NIGHT
LMG	LEFT MAIN GEAR
LOC	LOCALIZER
LTC	LIEUTENANT COLONEL
MA	FS MAINTENANCE CHIEF
MA	MISHAP AIRCRAFT
MALS	MALFUNCTIONS
MAV	MAVERICK AIR TO GROUND MISSILE
MCR	MULTICOMMAND REGULATION
MDS	MISSION DESIGN CODE
MICAP	MISSION IMPACT CAPABILITY
MOA	MILITARY OPERATING AREA

MP	MISHAP PILOT
MSN CC	MISSION COMMANDER
MTBD	MEAN TIME BETWEEN DEMAND
MTBM	MEAN TIME BETWEEN MAINTENANCE
N/A	NOT APPLICABLE
NAV	NAVIGATION
NAVAID	NAVIGATION AID
NLG	NOSE LANDING GEAR
NSTF	NONSTANDARD FORMATION
OG/CC	OPERATIONS GROUP COMMANDER
RAPCON	RADAR APPROACH CONTROL
REMIS	RELIABILITY, MAINTAINABILITY INFORMATION SYSTEM
REQ	REQUIRED
RPI	RATED PROFICIENCY INDEX
RQ	REQUEST
RT	RIGHT
RWY	RUNWAY
SAFE	SUPPORTABILITY ANALYSIS FORECASTING EVALUATION
SAN NR	SOCIAL SECURITY NUMBER
SAT	SURFACE ATTACK TACTICS
SCT	SCATTERED
SE	SAFETY
SEFE	STANDARDIZATION/EVALUATION FLIGHT EXAMINER
SOF	SUPERVISOR OF FLYING
SR	SENIOR
SYS	SYSTEM
TAC	TACTICAL AIR COMMAND

TACAN	TACTICAL AIR NAVIGATION
TAR	TARGETING
TCI	TIME CHANGE INTERVAL
TNG	TRAINING
TO	TECHNICAL ORDER
TOT	TIME OVER TARGET
TWO SHIP	FLIGHT LEAD STATUS (LIMITED TO TWO AIRCRAFT ONLY)
UFN	UNTIL FURTHER NOTICE
VAD	LOCATION IDENTIFIER FOR MOODY AFB
VFR	VISUAL FLIGHT RULES
VR	VFR MILITARY TRAINING ROUTE
VERFY	VERIFY
WG	WING
WIE	WHEN IN EFFECT
WT	WEIGHT
WUC	WORK UTILIZATION CODE
WX	WEATHER
Z	GREENWICH MEAN TIME ZULU