

UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT



F-16CM, T/N 92-3907

55th FIGHTER SQUADRON

20th FIGHTER WING

SHAW AIR FORCE BASE, SOUTH CAROLINA



LOCATION: OSAN AIR BASE, REPUBLIC OF KOREA

DATE OF ACCIDENT: 16 JULY 2013

BOARD PRESIDENT: LIEUTENANT COLONEL WILLIAM R. JONES

Conducted IAW Air Force Instruction 51-503

Volume One of Two

**EXECUTIVE SUMMARY
AIRCRAFT ACCIDENT INVESTIGATION**

**F-16CM T/N 92-3907
Osan Air Base, Republic of Korea
16 July 2013**

On 16 July 2013, at approximately 18:07 hours local time (L), the mishap aircraft (MA), an F-16CM, tail number 92-3907 assigned to the 55th Fighter Squadron, 20th Fighter Wing, Shaw Air Force Base, South Carolina, after a routine training mission at Osan Air Base, Republic of Korea, skidded off the runway and crashed after a normal approach and landing. At 0.75 seconds after touchdown, the right main landing gear (RMLG) collapsed. As a result, the MA's right station 6 external fuel tank contacted the runway surface along with the MA's station 8 air intercept missile (AIM) -9. The MA drifted right on its nose landing gear (NLG), left main landing gear (LMLG), station 6 external fuel tank and station 8 AIM-9 until it skidded off the runway 5 seconds later, approximately 9 seconds after touchdown, 2,000 feet from its touchdown point. Two seconds after the MA skidded off the runway, the NLG collapsed and the MA's nose dug into the ground, and the MA flipped and rolled. The MA came to rest in the grass to the right of the runway 16 seconds after touchdown and 3,000 feet from the touchdown point. The MA was destroyed. The mishap pilot (MP) incurred a minor back injury during the mishap. The MP egressed the aircraft and fire recovery personnel recovered him for medical care. There was no damage to private property. Estimated government loss is \$33,483,954.56.

The Accident Investigation Board (AIB) President found, by clear and convincing evidence, the cause of this mishap was the collapse of the right main landing gear by the unlocking of the toggle and link assembly in the right main landing gear drag brace assembly.

Additionally, the AIB president found, by a preponderance of evidence that each of the following factors substantially contributed to the mishap: (1) the installation of an incorrect pivot pin that connected the upper drag brace assembly to the main drag brace assembly and (2) natural resonant vibrations of the drag brace assembly, when combined with the vibrations created by wheel spin up and spring back phenomena unlocked the toggle and link drag brace assembly, thereby unlocking the RMLG. The RMLG collapsed as the weight of the aircraft settled onto it. Specifically, during normal operations, the toggle and link assembly may move towards an unlocked position. The probability of achieving an unlocked condition increases under certain conditions. Several of these conditions existed during the mishap: an incorrect drag brace assembly pin (connects the upper drag brace with the drag brace assembly) was installed, high vertical velocity during touchdown, normal wheel spin up and spring back of the landing gear, and compression loads on the landing gear. Each of these conditions had a cumulative effect on moving the RMLG toggle and link assembly far enough to reach an unlocked condition. As the weight of the aircraft settled onto the RMLG, the unlocked drag brace assembly collapsed, which in turn allowed the entire RMLG to collapse.

Under 10 U.S.C. § 2254(d) the opinion of the accident investigator as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report, if any, may not be considered as evidence in any civil or criminal proceeding arising from the accident, nor may such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.

SUMMARY OF FACTS AND STATEMENT OF OPINION
F-16CM, T/N 92-3907
16 July 2013

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ACRONYMS AND ABBREVIATIONS

1v1	One Versus One	HFACS	Human Factors Analysis and Classification System
20 FW	20th Fighter Wing	HMCS	Helmet Mounted Cueing System
55 FS	55 th Fighter Squadron	HTS	HARM Targeting System
9 AF	9 th Air Force	HUD	Heads-Up Display
AB	Air Base	Hz	Hertz
ACC	Air Combat Command	IAW	In Accordance With
AF	Air Force	IMDS	Integrated Maintenance Data System
AFB	Air Force Base	IMIS	Integrated Maintenance Information System
AFE	Aircrew Flight Equipment	IPB	Illustrated Parts Breakdown
AFI	Air Force Instruction	IVSC	Integrated Vehicle Subsystem Controller
AFPAM	Air Force Pamphlet	JBER	Joint Base Elmendorf-Richardson
AFTO	Air Force Technical Order	JDAM	Joint Direct Attack Munitions
AGL	Above Ground Level	JHMCS	Joint Helmet Mounted Cueing System
AIB	Accident Investigation Board	K	Thousand
AIM	Air Intercept Missile	KCAS	Knots Calibrated Airspeed
AMU	Aircraft Maintenance Unit	KGS	Knots Ground Speed
AMXS	Aircraft Maintenance Squadron	KTAS	Knots True Airspeed
AOA	Angle of Attack	kts	Knots
AR	Aero Repair	L	Local Time
ATO	Air Tasking Order	LG	Landing Gear
ATP	Advanced Targeting Pod	LMLG	Left Main Landing Gear
Aux	Auxiliary	Lt Col	Lieutenant Colonel
BFM	Basic Fighter Maneuvers	LWD	Left Wing Down
BPO	Basic Post Flight	MA	Mishap Aircraft
Capt	Captain	Main Gen	Main Generator
CATM	Captive Air Training Missile	MARSA	Military Assumes Responsibility for Separation of Aircraft
CCIP	Common Configuration Implementation Program	MF	Mishap Flight
CIP	Core Integrated Processor	MFL	Maintenance Fault List
CMR	Combat Mission Ready	MIC	Micrometer
CMS	Component Maintenance Squadron	MLG	Main Landing Gear
Col	Colonel	MM1	Maintenance Member 1
Comms	Communications	MM2	Maintenance Member 2
CSFDR	Crash Survivable Flight Data Recorder	MM3	Maintenance Member 3
CSMU	Crash Survivable Memory Unit	MM4	Maintenance Member 4
CT	Continuation Training	MOA	Military Operating Area
CTK	Composite Toolkit	MP	Mishap Pilot
DoD	Department of Defense	MQT	Mission Qualification Training
DU	Display Unit	MS	Mishap Sortie
DVR	Digital Video Recorder	MSL	Mean Sea Level
ECM	Electronic Counter Measure	MXO	Maintenance Operations
ECS	Environmental Control System	MXS	Maintenance Squadron
EMS	Equipment Maintenance Squadron	NLG	Nose Landing Gear
EPS	Emergency Power System	NOTAM	Notice to Airman
EPU	Emergency Power Unit	NWS	Nose Wheel Steering
FL	Flight Lead	Ops Sup	Operations Supervisor
FLCS	Flight Control System	Ops Tempo	Operations Tempo
FPM	Feet Per Minute	ORM	Operational Risk Management
fps	Feet Per Second	PACAF	Pacific Air Forces
FS	Fighter Squadron	PEX	Patriot Excalibur
ft	Feet	PHA	Physical Health Assessment
g	Gravitational Force	PMG	Permanent Magnet Generator
HARM	High Speed Anti-Radiation Missile	Pres	Board President
HAS	Hardened Aircraft Shelter	PSI	Pounds Per Square Inch

QA	Quality Assurance	SOF	Supervisor of Flying
QAI	Quality Assurance Inspector	SSgt	Staff Sergeant
QVI	Quality Verification Inspection	T.O.	Technical Order
RADOME	Radar Dome	T/N	Tail Number
RAP	Ready Aircrew Program	TCTO	Time Compliance Technical Order
RMLG	Right Main Landing Gear	TI	Tactical Intercepts
ROK	Republic of Korea	TOD	Technical Order Data
ROKAF	Republic of Korea Air Force	TSP	Theater Security Package
RTB	Return To Base	USAF	United States Air Force
RWD	Right Wing Down	VFR	Visual Flight Rules
SAR	Search and Rescue	VVI	Vertical Velocity Indicator
SAT	Surface Attack Tactics	WOW	Weight on Wheels
SEAD	Suppression of Enemy Air Defenses	Z	Zulu
SII	Special Interest Item		
SIM	Simulator		
SMSgt	Senior Master Sergeant		

The above list is derived from the Summary of Facts, the Statement of Opinion, the Index of Tabs, and Witness Testimony (Tab V).

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 6 August 2013, Lieutenant General Lori J. Robinson, Vice Commander, Air Combat Command (ACC), United States Air Force (USAF), appointed Lieutenant Colonel William R. Jones as the Accident Investigation Board (AIB) President to conduct an aircraft accident investigation of a mishap that occurred on 16 July 2013 involving an F-16CM, Fighting Falcon aircraft at Osan Air Base (AB), Republic of Korea (ROK) (Tab Y-8). The aircraft accident investigation was conducted in accordance with Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, at Osan AB, ROK, from 26 August 2013 through 13 September 2013. Board members included a Pilot Member, Flight Doctor, Legal Advisor, Maintenance Member, and Recorder (Tab Y-3).

b. Purpose

This is a legal investigation convened to inquire into the facts surrounding the aircraft or aerospace accident, to prepare a publicly releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes.

2. ACCIDENT SUMMARY

On 16 July 2013, at approximately 18:07 hours local time (L), an F-16CM, tail number 92-3907, the mishap aircraft (MA), assigned to the 55th Fighter Squadron, 20th Fighter Wing, Shaw Air Force Base, South Carolina, departed runway 27 after a normal approach and landing (Tab J-2, Tab Q-7, Tab CC-10). At 0.75 seconds after touchdown, the right main landing gear (RMLG) collapsed (Tab J-2). As a result, the MA's right station 6 external fuel tank contacted the runway surface along with the MA's station 8 air intercept missile (AIM) -9 (Tab J-2). The MA drifted right on its nose landing gear (NLG), left main landing gear (LMLG), station 6 external fuel tank and station 8 AIM-9 until it departed the runway five seconds later, approximately nine seconds after touchdown, 2,000 feet from its touchdown point (Tab J-2). Two seconds after the MA departed the runway, the NLG collapsed and the MA's nose dug into the ground, after which, the MA flipped and rolled (Tab J-2). The MA came to rest in the grass to the right of the runway 16 seconds after touchdown and 3,000 feet from the touchdown point (Tab J-2). The MA was destroyed (Tab P-3). The mishap pilot (MP) incurred a minor back injury during the mishap (Tab J-2). The MP egressed the aircraft and fire recovery personnel recovered him for medical care (Tab J-2, Tab V-1.21). There was no damage to private property (Tab P-3). Estimated government loss is \$33,483,954.56 (Tab P-3).

3. BACKGROUND

The MA belonged to the 55 FS, 20 FW, 9th Air Force (9 AF), Air Combat Command (ACC) stationed at Shaw AFB, South Carolina (Tab CC-3 through Tab CC-4, Tab K-7, Tab Q-8).

a. Air Combat Command (ACC)

ACC is the primary force provider of combat airpower to America's warfighting commands. Supporting the global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management, and electronic-combat aircraft. It also provides command, control, communications and intelligence systems, and conducts global information operations. ACC numbered air forces provide the air component to U.S. Central, Southern, and Northern Commands. ACC also augments forces in U.S. European, Pacific, and Strategic Command (Tab CC-3).



b. 9th Air Force (9 AF)

The 9th AF organizes, trains, and equips Air Combat Command air component forces based throughout the Southeastern United States. Ninth Air Force comprises eight active-duty wings and two direct reporting units with more than 480 aircraft and 28,000 active-duty and civilian personnel. Ninth Air Force is also responsible for the operational readiness of 14 Air Reserve Component Wings (Tab CC-5).



c. 20th Fighter Wing (20 FW)

The 20 FW provides combat ready airpower and Airman, to meet any challenge, anytime, anywhere. The wing is capable of meeting all operational requirements worldwide, maintains a state of combat readiness and operates as the host unit at Shaw AFB by providing facilities, personnel, and material (Tab CC-8).



d. 55th Fighter Squadron (55 FS)

The 55 FS can trace its roots back to 1917 when it first formed as the 55th Aero Squadron at Kelly Field, Texas. The "Fighting Fifty-fifth" saw combat during World War I, World War II, and Operations DESERT STORM, NORTHERN WATCH, and SOUTHERN WATCH. In its distinguished 96-year history, the 55 FS has flown 12 different types of aircraft (Tab CC-10).



e. F-16 Fighting Falcon

The F-16 Fighting Falcon is a compact, multi-role fighter aircraft. It is highly maneuverable and has proven itself in air-to-air combat and air-to-surface attack. It is a high performance weapon system used by the United States and allied nations. Since 1979, the F-16 has been a major component of the combat forces flying tens of thousands of sorties in support of various combat operations worldwide (Tab CC-12).



4. SEQUENCE OF EVENTS

a. Mission

The mishap sortie (MS) was scheduled and authorized by the Squadron Operations Supervisor (Tab K-7). The MA was the wingman in a two-ship flight of F-16s, designated Dice 21 flight (Tab V-1.7). The MS was part of a routine two-ship training mission flown on the afternoon of 16 July 2013 (Tab K-3, Tab K-11). The MS was planned and briefed as a surface attack tactics (SAT) mission in the central complex airspace in the Republic of Korea with a planned backup mission of tactical intercepts (TI) and basic fighter maneuvers (BFM) (Tab K-3, Tab K-4, Tab K-7, Tab K-11, Tab V-1.13). Dice 21 flight executed their planned backup mission of TI and BFM (Tab V-1.13). The MP's call sign was Dice 22 (Tab K-11).

b. Planning

Mission planning and briefing for the MS was conducted IAW standard procedures per AFI 11-2F-16, Volume 3, *F-16 Operations Procedures*, AFI 11-2F-16, Volume 3, Shaw AFB Supp, *F-16 Operations Procedures*, and the 20th Fighter Wing Standards (Tab DD-38). The day of the MS, all flight members involved in the MS attended a mass brief conducted by the fully qualified Squadron Operations Supervisor (Tab V-1.7, Tab K-19 through Tab K-35). The mass brief covered forecasted weather conditions, notices to airmen (NOTAMs), aircraft configuration, divert airfields, emergency procedures, and operational risk management (ORM) pertaining to each of the flights (Tab K-19 through Tab K-35). The coordination briefing and flight briefing were uneventful (Tab V-1.5).

c. Preflight

After donning their aircrew flight equipment, the mishap flight (MF) proceeded to the operations desk and received a step briefing from the Squadron Operations Supervisor (Tab V-1.8, Tab DD-38). The MF then proceeded to their assigned aircraft and performed preflight operations (Tab V-1.8). The MP stepped to the spare aircraft due to minor malfunctions with the originally assigned aircraft (Tab V-1.8). Preflight operations of the MA were uneventful (Tab V-1.9). The aircraft configuration was two external wing fuel tanks, two AIM-120 captive air training missiles (CATMs), one AIM-9 CATM, empty weapons pylons, a HARM targeting system (HTS) pod, a Sniper Advanced Targeting Pod, an AN/ALQ-184 electronic counter measures

pod, and a unarmed gun (Tab P-3, Tab P-4). There were no live weapons on the aircraft (Tab K-9).

d. Summary of Accident

Ground operations and aircraft taxi were normal (Tab V-1.8 through Tab V-1.9). There were no indications of any aircraft anomalies or malfunctions during pre-flight, ground operations, and aircraft taxi (Tab V-1.8 through Tab V-1.9). The MA took off at 17:02L (Tab DD-39). There was no evidence of anything abnormal about the takeoff, departure, or airspace entry. Furthermore, the MP testified that the landing gear retraction sequence and system B hydraulics were all normal during the takeoff phase (Tab V-1.6, Tab V1.11). Analysis of the crash survivable flight data record (CSFDR) data confirms the takeoff was normal (Tab J-7).

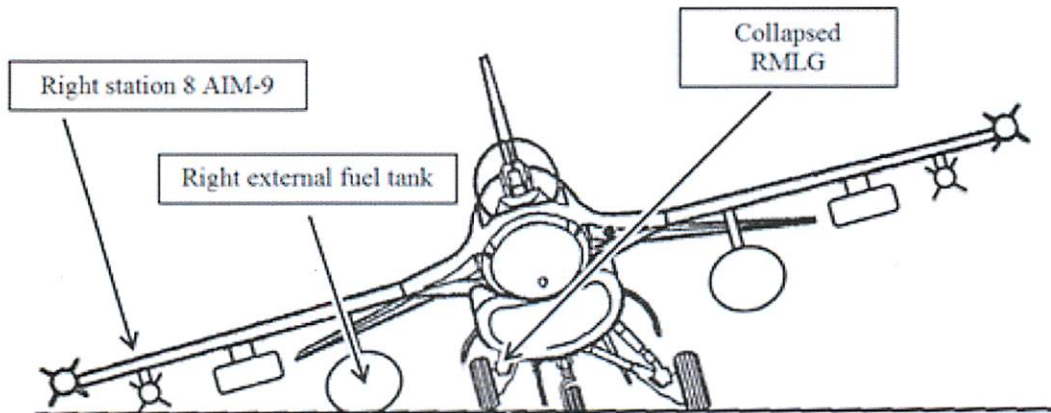
At 17:08L, the MF entered their designated training airspace (Tab J-7, Tab DD-39). The MF performed uneventful 1 versus 1 tactical intercepts and basic fighter maneuvers (3,000 ft setups) (Tab V-1.12). At 17:52L, upon training completion and while leaving the airspace, the MP turned off the aircraft's onboard video recording system (Tab DD-39, Tab V-1.17).

The return to base phase of the mission from airspace exit until landing was normal and the MP reported nothing out of the ordinary (Tab V-1.13). Although the crash survivable flight data recorder (CSFDR) overwrote stored data during this portion of the flight, it would have stored and saved any "special event" data if any anomalies or aircraft malfunctions had occurred (Tab J-16). The CSFDR recorded no "special event" data during this portion of the mission thus corroborating the MP's testimony that airspace exit and return to base were normal and uneventful up until the landing phase of the mission (Tab J-7, Tab V-1.13).

At approximately 18:06L the MP lowered the landing gear handle (Tab J-8, Tab DD-39). The landing gear extended normally and cockpit indications showed all three landing gear in the down and locked position (Tab V-1.14). This was confirmed by an analysis of the CSFDR data (Tab J-8). Furthermore, the Supervisor of Flying, located in the control tower, observed the MA's three extended landing gear (Tab R-3).

At 18:07L, the MA aircraft touched down (Tab J-8). The touchdown parameters were 8.0 feet per second (fps) (8 fps was recorded however the recorded precision is +/- 4 fps therefore actual vertical velocity range is between 4 fps and 12 fps), 12.7 degrees angle of attack (AOA), 1.5 times the force of gravity (g), throttle at idle, 156 knots calibrated airspeed (KCAS), 159 knots ground speed (KGS), and 600 ft down the runway (Tab J-2, Tab J-7). These parameters are all within the range of a normal landing (Tab J-39). Approximately 0.75 seconds later, the MA's right main landing gear collapsed (Tab J-36). Immediately, the MA's takeoff/landing configuration warning light illuminated, the pilot's heads up display flashed "WARN," and the voice message system stated "Warning Warning" (Tab J-8, Tab V-1.14). The MP quickly applied left roll control inputs and briefly kept the right wing off the runway (Tab J-2). Two seconds later, the MA's right external fuel tank contacted the runway (Tab J-2). One second later, at 147 KGS, the MA's station 8 AIM-9 missile contacted the runway (Tab J-2). With the increased drag on the right side of the MA, it skidded to the right side of the runway (Tab V-1.15). The aircraft continued moving forward and skidding right on its nose landing gear, left

main landing gear, and the right external fuel tank until it departed the runway nine seconds after touchdown and approximately 3,200 ft down the runway at 128 KGS (Tab J-2).

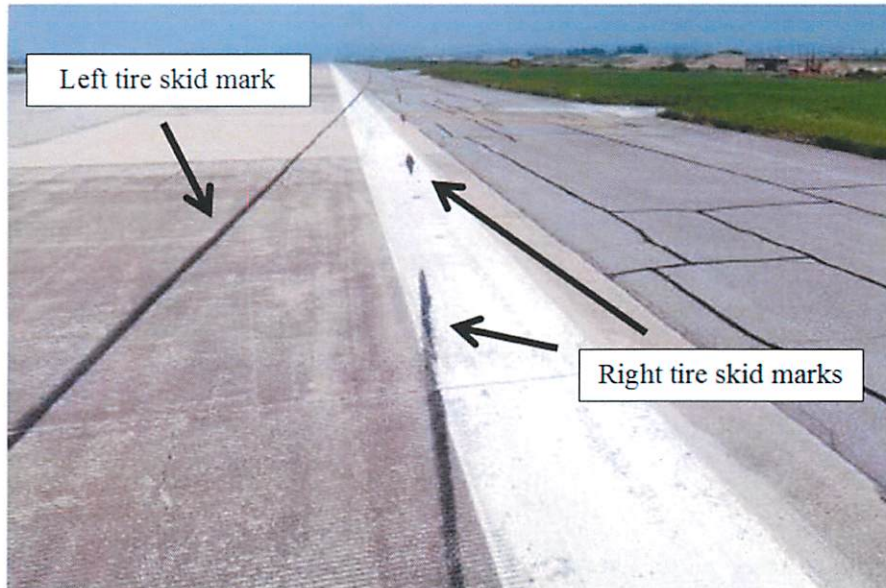


Tab Z-7

The MA's nose gear collapsed two seconds after departing the runway (Tab J-2). Three seconds later, the MA's nose dug into the ground at 70 KGS, followed by a flip and subsequent roll (Tab J-2). The MA came to rest in the grass, right of the runway, 16 seconds after touchdown and 3,600 ft from the end of the runway (Tab J-2). The aircraft was a total loss (Tab P-3). The MP egressed the MA and was driven to a medical facility for examination and treatment of a minor back injury (Tab J-2, Tab V-1.21 through V-1.22).

e. Impact

The MA skidded to a complete stop 3,000 ft from touchdown and 3,600 ft from the approach end of the runway (Tab J-2, Tab S-7). The initial touchdown point could not be confirmed visually due numerous touchdown skid marks on the runway and was therefore estimated using data from the CSFDR (Tab J-10). The first clear mishap-related marks on the runway were caused by the right external fuel tank and the station 8 AIM-9 missile fins scraping on the runway, starting at a point just past the first arrestment cable, approximately 1,400 feet from the approach end of the runway (Tab J-10). Starting approximately 1,700 feet from the approach end of the runway, there were skid marks of various lengths and shapes caused by the RMLG tire (Tab J-10). Because the RMLG collapsed, it was able to move up and down freely as it skipped along the surface of the runway, thus creating a series of short skid marks (Tab J-51). There was a continuous skid mark caused by the left main tire starting approximately 2,000 ft from the approach end of the runway and extending to the point where the MA departed the runway (Tab J-10). There was no damage to private property (Tab P-2).



Tab J-11

f. Egress and Aircrew Flight Equipment (AFE)

The MP did not eject (Tab H-2). After the MA departed the runway and came to a stop, the MP executed emergency ground egress procedures and evacuated the MA after disconnecting all aircrew flight equipment and seat connections (Tab H-2). No parts of the MP's uniform, restraint devices, or aircrew flight equipment created any egress problems (Tab H-2). The MP's aircrew flight equipment was fully functional, had a current inspection, and was in normal condition (DD-36).

g. Search and Rescue (SAR)

Not applicable.

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

The 20th Maintenance Group, 20th Aircraft Maintenance Squadron, 55th Aircraft Maintenance Unit maintained the aircraft forms for the MA. All maintenance was documented on Air Force Technical Order (AFTO) 781 forms and the Integrated Maintenance Data System (IMDS). The purpose of the AFTO 781 series forms is to document various maintenance actions (Tab U-16). They are maintained in a binder specifically assigned to each aircraft (Tab U-16). The IMDS is an automated database of aircraft discrepancies, maintenance repair actions and flying history (Tab U-16).