UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT



F-16C, T/N 85-01546 and F-16C, T/N 85-01549

457TH FIGHTER SQUADRON 301ST FIGHTER WING Naval Air Station Fort Worth Joint Reserve Base, Texas



LOCATION: RUNWAY AT NELLIS AFB, NV DATE OF ACCIDENT: 15 AUGUST 2015 BOARD PRESIDENT: COLONEL PETER S. FORD Conducted IAW Air Force Instruction 51-503



OFFICE OF THE COMMANDER 205 DODD BOULEVARD SUITE 200 JOINT BASE LANGLEY-EUSTIS VA 23665-2788

1 8 DEC 2015

ACTION OF THE CONVENING AUTHORITY

The Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 15 August 2015 mishap, at Nellis Air Force Base, Nevada, involving two F-16Cs, T/N 85-01546 and 85-01549, assigned to the 457th Fighter Squadron, 301st Fighter Wing, Naval Air Station Fort Worth Joint Reserve Base, Texas, complies with applicable regulatory and statutory guidance; on that basis it is approved.

HERBERT/J. CARLISLE General,/USAF Commander

*On 14 March 2016 the Board President approved non-material, administrative changes to the report. Such changes included the addition of tab citations within the Summary of Facts and non-discretionary redactions of Privacy Act materials within the Tabs.

Agile Combat Power

EXECUTIVE SUMMARY UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION

F-16C, T/N 85-01546 and F-16C, T/N 85-01549 NELLIS AFB, NV 15 AUGUST 2015

On 15 August 2015 at 1102 hours local time two F-16Cs collided on a runway at Nellis Air Force Base, Nevada. Mishap Aircraft 2 (MA2) impacted the back portion of Mishap Aircraft 1 (MA1) conjoining them. Mishap Pilot 1 (MP1) suffered no injuries and Mishap Pilot 2 (MP2) suffered life-threatening injuries. MA1, tail number 85-01546 and MA2, tail number 85-01549, are assigned to the 457th Fighter Squadron, 301st Fighter Wing, Naval Air Station Fort Worth Joint Reserve Base, Texas. The estimated repair cost of MA1 is \$5,412,111. MA2, valued at \$64,036,628, was destroyed. Total government loss is valued at \$69,501,839.

The mishap occurred as part of a local area orientation sortie for Red Flag 15-4, a large force training exercise. The mission was uneventful until landing when MA2 impacted MA1 slightly left of centerline with 2512 feet remaining on Runway 21 Right. MP1's landing, aerobrake, and initial landing rollout were uneventful. However, during deceleration after rollout, he did not clear to the cold (exit) side of the runway. MP2 configured for landing without opening his speedbrakes (flight control surfaces that slow the aircraft). While MP2 landed with proper spacing, he landed too fast, touched down long, and had the engine above idle power. Additionally, MP2 did not aerobrake within prescribed limits. Combined, these actions created a substantial closing velocity between the aircraft. MP2 did not immediately perceive this closure.

As MP2 recognized this closure, he saw MA1 still on the hot (landing) side of the runway. MP2 then applied heavy braking pressure and directed MP1 to "clear to the right" (runway exit/cold side). MP1 let his aircraft continue drifting left as he mentally processed this directive radio call. On hearing MP2's second directive radio call, MP1 braked and maneuvered hard right toward the cold side. Simultaneously, MP2 applied maximum braking (minus extended speedbrakes) and abandoned normal runway deconfliction with a hard right maneuver in an attempt to pass MA1 on the right. MP1's hard right maneuver coincided with MP2's right maneuver resulting in ground collision. The force of this collision conjoined the aircraft, pinned MP2 under MA1's right wing, fired MP2's ejection seat, and drove them off the runway. When the conjoined aircraft came to a stop, MP1 ground egressed. MP2 sustained life-threatening injuries and was lodged in his aircraft, which promptly caught on fire engulfing MA2 in flames. Nellis AFB first responders were on scene fighting this fire in 68 seconds, and subsequently removed MP2 from the wreckage. MP2 was transported to the Nellis AFB Hospital where medical personnel initiated critical life-saving measures.

The Accident Investigation Board President found by a preponderance of evidence the causes of the mishap were MP2's landing, lack of comprehensive braking and flight path deconfliction, combined with MP1's delayed transition to the cold side of the runway.

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-16C, T/N 85-01546 and F-16C, T/N 85-01549 15 AUGUST 2015

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ACRONYMS AND ABBREVIATIONS

AB	Afterburner	D	Drive
ABU	Airmen Battle Uniform	DD	Designated Driver
ACBT	Air Combat Training	DED	Data Entry Display
ACC	Air Combat Command	Det	Detachment
ACM	Air Combat Maneuvering	DN	Down
ADC	Area Defense Counsel	DO	Director of Operations
ADVON	Advanced Echelon	DoD	Department of Defense
AF	Air Force	DVR	Digital Video Recorder
AFB	Air Force Base	Ea	Each
AFE	Aircrew Flight Equipment	ECM	Electronic Counter-Measure
AFI	Air Force Instruction	EKG	Electrocardiogram
AFIP	Air Force Institute of Pathology	EMR	Emergency Medical Response
AFMES	Armed Forces Medical Examiner System	EMT	Emergency Medical Technician
AFPAM	Air Force Pamphlet	EOR	End of Runway
AFRC	Air Force Reserve Command	EP	Emergency Procedure
AFTO	Air Force Technical Order	EPU	Emergency Power Unit
AGI	Above Ground Level	FR	Emergency Room
AIR	Accident Investigation Board	FTA	Estimated Time of Arrival
	Air Intercent Missile	ETT	Estimated Time of Antivar
	Aeromedical Information Management		Energency Trauma recimician Federal Aviation Administration
	Weiver Tracking System	FAM	Femiliarization
	Acceleration Monitoring Davice	FAST	Focused Assessment Sonography of Trauma
	Acceleration Monitoring Device	ECIE	Flight Crow Information File
AOA	Angle of Attach	FCIF	Flight Equipment Pacerds Management
ADE	Airfield Responsibility	TERMS	Fight Equipment Records Management
	Aircraft Bassus and Fire Fighting	FLUC	Elight Load Upgrada
	Alicial Rescue and File Fighting	FLUG	Fight Lead Opgrade
ASD	Average Sortie Duration	F.U.	Foreign Object
ATC	All Traffic Controllers	FOD ED 1	Foreign Object Damage
ATAUS	Automatic Terminal Information Service		First Responder 1
A115 A	Automatic Terminal Information Service	FKZ	First Responder 2
Aux	Auxiliary Durathing Air	FK3 ED4	First Responder 5
BA D.C.	Breatning Air	FK4	First Responder 4
B-Course	Basic Course	FS	Fighter Squadron
BD	Battle Damage		Fighter Training Unit
BFM	Basic Fighter Maneuver	FW	Fighter wing
BP	Board President	G	Gravity
BRAA	Bearing Range Altitude Attitude	GS	Ground Speed
CAF	Combat Air Force	G Suit	Anti-Gravity Suit
CAPS	Critical Action Procedures	HFACS	Human Factors Analysis and Classification
Capt	Captain		System
CATM	Captive Air Training Missile	HMIT	Helmet Mounted Integrated Targeting
CC	Commander	HOTAS	Hands on Throttle and Stick
CCAT	Critical Care Air Transport Team	HUD	Head-Up Display
CDU	Center Display Unit	IAW	In Accordance With
Chanl	Channell	ICNS	Integrated Chin and Nape Strap
CBI	China-India-Burma	ICU	Intensive Care Unit
Col	Colonel	IFF	Introduction to Flight fundamentals
Comm	Communication	ILS	Instrument Landing System
CPR	Cardio Pulmonary Resuscitation	IMDS	Integrated Maintenance Data System
CSFDR	Crash Survivable Flight Recorder	IO	Investigating Officer
CSMU	Crash Survivable Memory Unit	IP	Instructor Pilot
СТ	Continuation Training	ISB	Interim Safety Board

JAG	Judge Advocate General	R	Reverse
JRB	Joint Reserve Base	R/H	Right Hand
Κ	Thousand	RTB	Return to Base
L	Local Time	RWY	Runway
LA	Legal Advisor	SA	Situational Awareness
LAO	Local Area Orientation	SAC	Strategic Air Command
LAU	Launcher Assembly Unit	SADL	Situational Awareness Data Link
LEF	Leading Edge Flap	SAU	Signal Acquisition Unit
L/H	Left Hand	SCBA	Self Contained Breathing Apparatus
LM Aero	Lockheed Martin Aeronautics Company	SCU	Software Capabilities Update
Lt Col	Lieutenant Colonel	SDR	Seat Data Recorder
MA1	Mishap Aircraft 1	SEPT	Simulator Emergency Procedure Training
MA2	Mishap Aircraft 2	SIB	Safety Investigation Board
Maj	Major	SMART	Sustainment of Medical and Readiness
MAJCOM	Major Command		Training
Mbr	Member	SME	Subject Matter Expert
MF	Mishap Flight	SMS	Stores Management System
MFC	Maintenance Fault Code	SMSgt	Senior Master Sergeant
MLG	Main Landing Gear	SOF	Supervisor of Flying
MMC	Modular Mission Computer	SrA	Senior Airman
MOA	Military Operating Area	SSgt	Staff Sergeant
MP1	Mishap Pilot 1	STAPAC	Stabilization Pack
MP2	Mishap Pilot 2	TAD	Tactical Awareness Display
MOT	Mission Qualification Training	TCTO	Time Compliance Technical Orders
MSgt	Master Sergeant	TDY	Temporary Duty
MTT	Mission Task Trainer	TH	Thru-Flight Inspection
NAS	Naval Air Station	TLAR	That Looks About Right
NM	Nautical Miles	ТО	Technical Order
NOTAMs	Notices to Airmen	TV	Television
NTTR	Nevada Test and Training Range	UFC	Up Front Control
NV	Nevada	UMC	University Medical Center
O2	Oxygen	UPT	Undergraduate Pilot Training
O Club	Officer's Club	US	United States
OIC	Officer in Charge	UTA	Unit Training Assembly
OJT	On the Job Training	VA	Veterans Affairs
OPS O	Operations Officer	VFR	Visual Flight Rules
OR	Operating Room	VMC	Visual Meteorological Conditions
PA	Public Announcement	VSD	Vertical Situation Display
PFT	Physical Fitness Test	WAI	Walk-Around Inspection
PHA	Preventative Health Assessment	WIC	Weapons Instructor Course
PLI	Pre-Launch Inspection	WOW	Weight on Wheels
PPE	Personal Protective Equipment	Xmit	Transmit
PR	Pre-Flight Inspection	YDS	Yards
Qual	Qualification	Z	Zulu

The above list was compiled from the Summary of Facts, the Statement of Opinion, the Index of Tabs, and Witness Testimony (Tabs R, V).

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 30 September 2015, General Herbert J. Carlisle, Commander, Air Combat Command (ACC), appointed Colonel Peter S. Ford to conduct an aircraft accident investigation board (AIB) of a 15 August 2015 mishap involving two F-16C Fighting Falcon aircraft, tail numbers 85-01546 and 85-01549, which occurred on a runway at Nellis Air Force Base (AFB), Nevada (NV) (Tab Y-2). The F-16C accident investigation was conducted in accordance with Air Force Instruction (AFI) 51-503, *Aerospace and Ground Accident Investigations* at Nellis AFB, NV from 5 October 2015 through 4 November 2015. Board members were Legal Advisor (Major), Pilot Member (Captain), Medical Member (Captain), Maintenance Member (Senior Master Sergeant), and Recorder (Staff Sergeant) (Tab Y-2 to Y-4). A civilian F-16 Test Pilot was appointed as a Subject Matter Expert (Tab Y-2 to Y-4).

b. Purpose

In accordance with AFI 51-503, *Aerospace and Ground Accident Investigations*, this accident investigation board conducted a legal investigation to inquire into all the facts and circumstances surrounding this Air Force aerospace accident, prepare a publicly releasable report, and obtain and preserve all available evidence for use in litigation, claims, disciplinary action, and adverse administrative action.

2. ACCIDENT SUMMARY

On 15 August 2015, at 1102 hours local time (L), two F-16Cs, tail numbers 85-01546 and 85-01549 (Mishap Aircraft 1 (MA1) and Mishap Aircraft 2 (MA2) respectively), assigned to the 457th Fighter Squadron (FS), 301st Fighter Wing (FW), Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Texas (TX), collided on the runway following a local area orientation (LAO) mission at Nellis AFB, NV (Tabs N-4, Q-5 to Q-6, and R-4). Mishap Aircraft 2 (MA2) impacted the back portion of Mishap Aircraft 1 (MA1) conjoining both aircraft and causing a fire (Tabs R-5, Q-5, and Z-18). Mishap Pilot 1 (MP1) suffered no injuries (Tab X-6). Mishap Pilot 2 (MP2) suffered life-threatening injuries (Tab X-6). The estimated repair cost of MA1 is \$5,412,111 (Tab P-4). MA2, valued at \$64,036,628, was destroyed (Tab P-4). Total government loss is valued at \$69,501,839 (Tab P-4). There was no damage to private property. Environmental clean-up cost was estimated at \$11,000 (Tab P-2).

3. BACKGROUND

2 x F-16C, 85-01546, 85-01549, Class A, 15 August 2015

a. Air Force Reserve Command (AFRC)

The mission of the Air Force Reserve Command is to provide combat ready forces to fly, fight and win (Tab CC-2 to CC-3). Reservists support nuclear deterrence operations, air, space and cyberspace superiority, command and control, global mobility and personnel recovery (Tab CC-2 to CC-3). They

also perform space operations, aircraft flight testing, aerial port operations, civil engineering, security forces, military training, communications, mobility support, transportation and services missions (Tab CC-2 to CC-3).

b. Tenth Air Force (10 AF)

Tenth Air Force (10 AF) activated for air operations in the China-India-Burma (CIB) Theater; commanded tactical units from March 1942 to December 1943, then served as a strategic bombardment headquarters in the CIB (Tab CC-4 to CC-5). Following World War II, 10 AF initially

conducted air defense operations and training beginning in the late 1940s (Tab CC-4 to CC-5). 10 AF was responsible for air defense and early warning forces based in the northern central and later southern central United States (U.S.) from 1966 to 1969 (Tab CC-4 to CC-5). From 1976, 10 AF exercised intermediate command over reserve component flying training, fighter, bomber, air refueling, rescue, space and special operations forces (Tab CC-4 to CC-5). 10 AF and its units are currently responsible for "power/vigilance with intelligence, surveillance, reconnaissance, network operations, space, and special operations forces" (Tab CC-3). These forces include fighters, bombers, remotely piloted aircraft, cyber, space operations, and special operations flying and training (Tab CC-3).

c. 301st Fighter Wing (301 FW)

The 301 FW is based at NAS Fort Worth JRB, TX and is equipped with the F-16C+ Fighting Falcon (Tab CC-6 to CC-7). The 301 FW mission is to provide Airmen to fly, fight and win in air, space and cyberspace (Tab CC-6 to CC-7). The wing has a rich history in the Reserve component of the Air Force dating back to the mid-1940s (Tab CC-6 to CC-7). The 301 FW is the

largest tenant unit on NAS Fort Worth JRB (Tab CC-6 to CC-7). With approximately 2,200 reservists and civilians, the wing has an economic impact of more than \$152 million in the local community (Tab CC-6 to CC-7). During peacetime, the 301st Fighter Wing reports to Tenth Air Force (Tab CC-6).

d. 457th Fighter Squadron (457 FS)

The 457 FS is assigned to the 301st Operations Group, 301 FW, NAS Fort Worth JRB, TX (Tab CC-6). The 457 FS trained in the continental U.S., from October 1944 to February 1945 then moved to the western Pacific Ocean in the spring of 1945 (Tab CC-9 to CC-10). Between 1953 and









1959, and again since July 1972, they have trained for a variety of tactical air missions and are frequently deployed for training exercises (Tab CC-9 to CC-10). 457 FS took part in Operation Deny Flight, enforcing a no-fly zone over Bosnia in the mid 1990s (Tab CC-9 to CC-10). The 457 FS provided resources for Operations Northern Watch, Southern Watch, Noble Eagle, and Iraqi Freedom (Tab CC-9 to CC-10).

e. F-16C – Fighting Falcon

The F-16 Fighting Falcon is a compact, multi-role fighter aircraft (Tab CC-11 to CC-12). It is highly maneuverable and is proven in air-to-air combat and air-to-surface attack (Tab CC-11 to CC-12). It provides a relatively low-cost, high-performance weapon system for the U.S. and allied nations (Tab CC-11 to CC-12). Since September 11, 2001, the F-16 has been a major component of the combat forces committed to the war on terrorism flying thousands of sorties in support of operation Noble Eagle, Enduring Freedom in Afghanistan and Iraqi Freedom (Tab CC-11).



f. Red Flag

Operation Red Flag's mission is to maximize the combat readiness, capability, and survivability of participating units by providing realistic training in a combined air, ground, and electronic threat environment while providing a free exchange of ideas among forces (Tab CC-19). Red Flag exercises have provided training for over 400,000 military personnel including more than 132,000 aircrew members flying over 350,000 sorties and logging over 600,000 hours flying time (Tab CC-19).

4. SEQUENCE OF EVENTS

a. Mission

The mishap flight (MF) included four F-16Cs call signs Bleed 1 (MP1), Bleed 2 (MP2), Bleed 3, and Bleed 4 (Tabs K-4 and R-3). The MF was an LAO mission authorized by the Officer In Charge (OIC) for Red Flag flying operations (Air Boss) (Tabs K-4 and R-3). The mission occurred on the Nevada Test and Training Range (NTTR) (Tabs CC-16, CC-19, V-1.3 and V-2.2). An LAO is a standard first mission for pilots at a new location to become familiar with the range, target sets, and airfield operations (Tabs R-3 and V-2.2). As scheduled, the MF departed at approximately 1000 hours L and returned at approximately 1100 hours L (Tab K-4).

b. Planning

The MF followed the planning process for an LAO mission (Tab R-11). Planning began on 14 August 2015 with development of mission materials (Tab R-11). On the morning of 15 August 2015, there was a mass brief at 0730 hours L which all four pilots of the MF attended (Tab R-3). The briefing was a standard Red Flag local area orientation brief (Tab V-1.3 to V-1.4, V-2.15 and V-4.2). Next, MP1 gave a brief using the 457 FS standard briefing guide that included 45 minutes on administrative orientation for Bleed 2 and Bleed 4 who had not flown at Nellis AFB (Tabs R-3, R-20, and V-1.4). No squadron supervisory personnel attended MP1's briefing (Tab V-1.4). The LAO mission included a low altitude attack on static targets at NTTR (Tab R-3).

c. Preflight

The MF received a standard briefing from the operations supervisor, often referred to as a "step brief" (Tab V-1.5). The step brief included updates to local airfield and airspace weather, additional divert instructions, and changes to Notices to Airman (NOTAMs) (Tab V-1.3). The step brief, filing of the flight plan, inspection and donning of flight gear, travel to the aircraft, preflight inspection of the aircraft, and engine start procedures were all uneventful (Tab V-1.6).

d. Summary of Accident

Stepping to the aircraft, taxi, take off, and travel out to airspace were all uneventful (Tabs R-17, V-1.6, V-2.2 and V-4.3). MA1 and MA2 took off at 1002 hours and 1003 hours L, respectively, followed by Bleed 3 and Bleed 4 who were not involved in the mishap sequence (Tabs EE-10 and K-2). Exiting the NTTR, the flight back to Nellis AFB, and the air traffic pattern were uneventful (Tabs R-3 to R-4, R-17 and V-4.3). As flight lead, MP1 made the first landing approach to Runway 21 Right (Tab R-4). MP1's configuration for landing was in accordance with Technical Order (TO) 1F-16C-1 landing gear down with speedbrakes (flight control surfaces that slow the aircraft) open (Tabs BB-34, EE-9 to EE-11 and Z-13). MP1's landing, aerobrake and initial landing rollout were unremarkable (Tab R-4). MP1 landed approximately 750 feet down the runway, aerobraked, and applied wheel brakes (Tab Z-39). In accordance with AFI 11-2F-16 Volume 3, F-16-Operations Procedures, each F-16 is required to land on the centerline, decelerate until at a safe speed, and then maneuver to the cold side of the runway (the side the aircraft will exit the runway) (Tab BB-17). MP1 landed on the centerline of the runway and continued decelerating through 60 knots airspeed (indicated by "000" on the left side of figure 1 (Tab Z-2 to Z-5). However, during deceleration, MA1 stayed on the hot (landing) side of the runway (Tabs BB-17, R-4, V-1.11 and Z-5). See figure 1, an image of the Head-Up Display



Figure 1: MA1 Perspective—MA1 on hot side of runway (Tab Z-5) 2 x F-16C, 85-01546, 85-01549, Class A, 15 August 2015

(HUD) from MA1 10 seconds before impact (Tab Z-5).

MP2's final approach to land was uneventful (Tab R-15). MP2 configured for landing without opening speedbrakes (not in accordance with TO 1F-16C-1) (Tab BB-34). The heat deformation on the speedbrakes, the position of the speedbrake switch, and Lockheed Martin Aerodynamics (LM Aero) advanced fluid dynamic modeling show MP2 configured for landing without opening speedbrakes (Tabs BB-34, EE-4, and FF-2 to FF-3). See figure 2 for LM Aero modeling.



Figure 2: LM Aero data graph modeling (Tab FF-5)

MP2 landed 15 seconds after MP1 and approximately 3052 feet behind MP1, which is standard practice for F-16 landings (Tabs EE-19 to EE-70, R-22, and Z-8). MP2's landing was approximately 1192 feet down the runway, compared to MP1's landing at approximately 750 feet down the runway (Tabs EE-19, EE-70, Z-2, Z-8, and Z-39). AFI 11-2F-16 Volume 3 requires landing between 150-1000 feet down the runway (Tab BB-12). MP2 landed at a speed of 181 knots ground speed (GS) versus MP1's landing speed of 163 knots GS (Tabs EE-19 and EE-70). MP2 pulled his throttle to the idle position at touchdown, whereas MP1 pulled his throttle to idle position two seconds before touchdown (Tab EE-18 to EE-23, and EE-70 to EE-73). Additionally, MP2 maintained an aerobrake of 10 degrees Angle of Attack (AOA) or less after landing (Tabs BB-35 and Z-9). Aerodynamic braking, also known as aerobraking, is a braking procedure required for F-16 landings (Tab BB-35). A proper aerobrake consists of maintaining a 13-degree AOA after touchdown, which increases drag (Tab BB-35). For F-16C



Figure 3: F-16C aerobrake (Tab Z-17) 2 x F-16C, 85-01546, 85-01549, Class A, 15 August 2015

aircraft configured like MA1 and MA2, an AOA of 13 degrees should be maintained until airspeed reaches approximately 100 knots (Tab V-4.5 and V-5.3). See figure 3, a picture of an F-16C aerobraking.

After MA2's weight settled on the main landing gear, MP2 maintained an AOA of less than 10 degrees (Tabs BB-35 and Z-9). MP2's AOA allowed less nose authority (aerodynamic lift) to maintain the aerobrake causing it to end prematurely at 116 knots GS (Tabs BB-35, EE-76 and Z-10). MP2 did not open his speedbrakes in accordance with TO 1F-16C-1, and according to the LM Aero report he did not apply his wheel brakes sufficiently, thus creating a substantial closing velocity between MA1 and MA2 (Tabs BB-34, EE-4, and EE-19 to EE-118).

MP2 recognized the excessive closure and saw MA1 still on the hot (left) side of the runway (Tabs N-4, V-1.10 and Z-12). MP2 applied heavy braking pressure and directed MP1 to "clear to the right (cold side of the runway)" (Tabs N-4 and EE-117). MP1 let his aircraft continue drifting left as he mentally processed this directive radio call (Tab V-1.11). See figure 4, an image from the MA2 HUD two seconds before impact.



Figure 4: MA2 perspective: Far left side of runway (runway centerline not visible) (Tab Z-14)

After MP2's second directive radio call, MP1 braked and began a hard right maneuver toward the cold (exit) side of the runway (Tab V-1.11). Simultaneously, MP2 perceived MP1 staying on the left side of the runway and abandoned normal runway deconfliction (Tabs V-2.4). MP2 maneuvered hard right to pass MA1 on the right (Tabs V-2.4 and Z-15). It appears MP2 maneuvered right, believing MP1 was not moving right fast enough (Tab V-2.4) In accordance with AFI 11-2F-16 Volume 3, normal runway deconfliction requires landing on the centerline and maneuvering to the cold side of the runway when speed/conditions permit (Tab BB-17). See figure 5, an image from the MA2 HUD one second before impact as MA1 begins a maneuver right.



Figure 5: MA2 perspective: MA2 in a hard right turn to pass MA1 on right (runway centerline not visible) (Tab Z-15)

MP1's hard right maneuver coincided with MP2's maneuver to the right resulting in the collision (Tabs V-2.4 and Z-15 to Z-16). See figure 6, an image from the MA2 HUD at impact.



Figure 6: MA2 perspective: MA1 turns hard right, while MA2 attempts to pass on the right (Tab Z-16)

The force of this collision conjoined MA1 and MA2 and resulted in a left vector off the runway (Tab S-4). As the conjoined aircraft traveled to the infield, MP2 was pinned under the right wing of MA1 (Tab EE-3). The force of the impact broke the nose off of MA2 (Tab EE-4). During the

collision, the trailing edge of MA1's right wing: (1) forced MP2's panel against the ejection seat lever, (2) executed MP2's ejection seat sequence, and (3) pinned MP2 forcefully against the back of his ejection seat (Tab EE-3). During this ejection sequence, the canopy and drogue parachute departed, but the right wing jammed MP2 in the cockpit while the ejection seat fired (Tabs EE-3 and R-18).

e. Impact

MA2 (traveling at 60 knots GS) impacted MA1 (traveling at 30 knots GS) at 11:02:29 hours L time 37 feet to the left (hot) side of the runway centerline (Tabs EE-3 to EE-4, E-12, EE-43, EE-82, S-3, and Z-15). At the point of impact, there was 2500 feet of runway remaining (Tab EE-3). See figure 7: Picture of tire marks and debris showing point of impact (Tab S-3).



Figure 7: Point of impact left of centerline (Tab S-3)

MA2 struck the engine nozzle, right horizontal tail, and right wing of MA1, resulting in the forward cockpit section of MA2 resting beneath the right flaperon of MA1 (Tab EE-3). The MA2 radome separated during impact (Tab EE-3). The conjoined aircraft departed the east (left) side of the runway approximately 350 feet from the point of impact and a post-impact fire erupted below the aft (rear) section of MA2 (Tab EE-3 to EE-4). Debris was scattered along the runway from the impact point to the runway departure point (Tab S-3). Furthermore, debris was scattered in the infield from the runway departure point to the mishap aircraft stopping point (Tab S-4). The conjoined aircraft came to rest upright with MA2 rotated counter-clockwise from the orientation of MA1 (Tab EE-4).

Immediately after the conjoined aircraft came to a stop, the left fuel tank (station 4 of MA2) exploded (Tab EE-4). At this point, MA2 was engulfed in flames (Tab R-5). Subsequently, the right fuel tank (station 6 of MA2) burst as MA2 continued to burn (Tab R-5). The left side of the MA2 fuselage burned beyond repair and MA2 was a total loss (Tabs EE-4 and P-14).



Figure 8: Mishap site post-crash recovery (Tab Z-18)

f. Egress and Aircrew Flight Equipment (AFE)

MP1 was not injured (Tab R-5). After the conjoined aircraft came to rest, MP1 ground egressed from MA1 (Tabs EE-3 and R-5). At this same time, MA2 caught fire and MP2 could not egress because he was pinned in his seat by MA1's right wing (Tabs EE-3 and R-5). MP2 did not pull the ejection handle (Tabs EE-138 and V-2.22). Data from the Crash Survivable Flight Data Recorder (CSFDR) showed active control inputs (hand on stick and throttle) at the time of collision indicating MP2 could not have pulled the ejection handle (Tab EE-138). However, during initial impact MA1's right rear stabilizer dislodged the forward instrument panel of MA2 thereby initiating MA2's ejection sequence (Tab EE-3 and EE-138). The MA2 canopy jettisoned and all ejection sequence steps functioned (Tab EE-138). The seat traveled up the seat rails but did not leave the aircraft because the impact wedged the lower right leg guard behind a section of cockpit panel (Tab EE-138). After firing, the seat settled in a canted (angled) position (Tab EE-138). Before first responders extracted MP2, he sustained life threatening blunt force, burn, and crush-type injuries (Tab X-6).

Recorded data, impact marks on the front of the canopy, and marks on the aft transparency all indicate the canopy was in place at the time of collision (Tab EE-138). MP1's and MP2's aircrew flight equipment records show all inspections were current (Tab H-3).

g. Search and Rescue (SAR)

The crash occurred at 11:02:29 hours L (Tab Z-16). The Nellis AFB fire department Aircraft Rescue and Fire Fighting (ARFF) response was immediate as a fireman saw the crash and watched both aircraft come to rest in the infield (.47 miles from the Nellis AFB Fire Station) (Tabs DD-2 and V-8.15 to V-8.16).

The Supervisor of Flying (SOF) also saw the crash and initiated the crash recovery call to the fire station after impact (Tabs R-35 to R-36, and V-8.18). However, as the SOF made the crash recovery call, fire trucks were already en-route (Tabs R-35 to R-36 and V-8.18 to V-8.20).

The driver of Crash-7 (a P-23 eight-wheeled ARFF truck) witnessed the collision, immediately donned his Personal Protective Equipment (PPE), and got in the driver's seat (Tab V-8.3, V-8.5, V-8.15 to V-8.17). Less than 15 seconds later, the Crew Chief joined the driver and Crash-7 departed (Tabs V-8.19 and Z-25 to Z-30).

Crash-7's driver took a direct route (2,460 feet from Fire Station 1) to the crash site (Tabs DD-2, V-8.20, and Z-30 to Z-38). This route took the crew south through the infield across Runway 21 Right onto the infield (Tabs DD-2 and Z-30 to Z-38). This route was significantly shorter than a route he could have taken to keep Crash-7 on paved surfaces (Tab DD-2). Had Crash-7 stayed on paved surfaces, the route would have been 3,168 feet (Tabs DD-2 and Z-38). Crash-7's direct route was 708 feet shorter than the paved-surface alternate route, which saved approximately 17 seconds (based on Crash-7's speed of 28 to 30 miles per hour) (Tabs DD-3 to DD-4 and Z-38). See figure 9.

When Crash-7 arrived at the MA, the fuel fire was severely burning (Tab V-2.5). Crash-7 driver's direct route cut 17 seconds from MP2's exposure to fire (Tabs DD-3 to DD-4 and Z-38). During the fire, MP2 experienced a temperature in excess of 1250 degrees Fahrenheit (Tabs BB-40, U-259, and Z-40). Thus, the critical heat transfer time-temperature threshold necessary to cause life-threatening heat injury was exceeded (Tab BB-42 to BB-51). Given the compounding nature of injury in sustained fire, each second was critical in saving MP2's life (Tabs BB-42 to BB-51, DD-3, V-2.5, and V-12.2).

Crash-7 reached the mishap site first and was suppressing the fire 68 seconds after the aircraft came to rest (Tab V-8.13). The Department of Defense response time requirement for an unannounced ARFF is 5 minutes (Tabs BB-27 to BB-32 and DD-6). Crash-7 began spraying foam fire suppressant while crossing Runway 21 Right just as the truck's water and foam cannons came within range of the fire and before the fire truck actually stopped (Tabs V-8.28 and Z-34 to Z-37).



Figure 9 – Crash-7's Response Route (Tab Z-38)

Shortly after Crash-7 arrived, two other ARFF

trucks with different specialized capabilities responded: a Striker and a P-19 (four wheeled ARFF truck) (Tabs R-6, V-8.5, V-8.23 to V-8.24 and V-8.28 to V-8.32). Fire crews from all three trucks attacked the fire with foam, water turrets on the trucks, and hand-lines pulled from the trucks (Tab V-8.28 to V-8.32).

Once the first responders extinguished the initial fire, they mounted MA2 on the off-rescue side (right side) to assess MP2's condition and begin extraction (Tabs V-8.36 to V-8.37 and Z-18). They used several methods of extraction; however, MP2 was trapped beneath the wing of MA1 (Tab V-1.12, V-2.28 to V-2.29, and V-8.40). Specifically, extraction methods were: air bladders to move the wing away from MP2, hydraulic rescue tools (Jaws of Life) to cut the wing, and a spreader to create space between the wing and MP2 (Tab V-2.5 V-2.28, V-8.38, and V-8.40). While working, the firefighters needed Self Contained Breathing Apparatus (SCBA) as protection from burning fuels, metal, and other fumes (Tab V-8.34). The work depleted the firefighter's SCBA oxygen bottles before they could extract MP2, but they continued to work without oxygen (Tab V-8.39). One first responder suffered heat exhaustion and required treatment (Tab V-8.41). One firefighter injured his back lifting MP2 from the cockpit (Tab V-8.38).

MP2 sustained life-threatening blunt force, burn and crash injuries (Tab X-6). Medical personnel at the Nellis AFB hospital immediately initiated critical life saving measures (Tab V-7.2 to V-7.7).

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

The Air Force Technical Order (AFTO) 781 series forms collectively document maintenance actions, inspections, servicing, configuration, status, and flight activities for the maintained aircraft (Tab BB-8). The Integrated Maintenance Data System (IMDS) is a comprehensive database used to track maintenance actions, flight activity, and to schedule future maintenance (Tab BB-7 and BB-10).

Review of the active 781 forms and IMDS revealed no overdue inspections or open Time Compliance Technical Orders (TCTOs) that would ground MA1 or MA2 from flight operations (Tab D-21 to D-24 and D-68 to D-71). Review of IMDS data for MA1 covering a 25-day period and MA2 covering a 59-day period prior to the mishap revealed maintenance documentation was properly accomplished under applicable maintenance directives (Tab U-2 to U-254). There is no evidence to suggest forms documentation was a factor in the mishap (Tabs D-21 to D-24, D-68 to D-71, and U-2 to U-254).

b. Inspections

The Pre-Flight Inspection (PR) includes visually examining the aerospace vehicle and operationally checking certain systems and components to ensure no serious defects or malfunctions exist (Tab BB-4). The Thru-Flight Inspection (TH) is conducted between flights and is accomplished after each flight when a turnaround sortie or a continuation flight is

scheduled (Tab BB-5). Phase inspections are a thorough inspection of the entire aerospace vehicle (Tab BB-6). Walk-Around Inspections (WAI) or Pre-Launch Inspections (PLI) are abbreviated Pre-Flight Inspections and are completed as required prior to launch in the applicable Technical Order (Tab BB-5).

The total airframe operating time of MA1 at takeoff of the mishap sortie was 5820.3 hours (Tab D-7). MA1 had flown 29.9 hours since the last phase inspection, which was completed on 31 July 2015 (Tab D-2). The last PR inspection occurred on 14 August 2015 at 1930 L, with no discrepancies noted (Tab D-7). A WAI occurred on 15 August 2015 at 0826 L, also with no discrepancies noted (Tab D-7).

The total airframe operating time of MA2 at takeoff of the mishap sortie was 6663.7 hours (Tab D-56). MA2 had flown 26.5 hours since the last phase inspection, which was completed on 17 June 2015 (Tab D-3). The last PR inspection occurred on 14 August 2015 at 2000 with no discrepancies noted (Tab D-56). A WAI inspection was completed on 15 August 2015 at 0830 L with no discrepancies noted (Tab D-56).

There is no evidence to suggest that inspections were a factor in the mishap (Tab D-2 to D-3, D-7, and D-56).

c. Maintenance Procedures

A review of MA1's and MA2's AFTO 781 series forms and IMDS revealed all maintenance actions complied with standard approved maintenance procedures and TOs (Tab U-255). There is no evidence to suggest maintenance procedures were a factor in the mishap (Tab U-255).

d. Maintenance Personnel and Supervision

The 301st Aircraft Maintenance Squadron personnel performed all required inspections, documentation, and servicing for MA1 and MA2 prior to flight (Tab D-4 to D-94). A detailed review of maintenance activities and documentation revealed no major documentation errors. Personnel involved with MA1's and MA2's preparation for flight had adequate training, experience, expertise, and supervision to perform their assigned tasks (Tab T-51 to T-88). There is no evidence to suggest that maintenance personnel and supervision were a factor in this mishap (Tabs D-4 to D-94 and T-51 to T-58).

e. Fuel, Hydraulic, and Oil Inspection Analyses

Fuel samples were taken from the fuel trucks used to refuel the mishap aircraft prior to the mishap sortie on 15 August 2015 (Tab D-95 to D-97). The 99th Logistics Readiness Squadron Fuel Laboratory at Nellis AFB, NV analyzed the samples and reported no volatile contamination (Tab D-96 to D-97). There is no evidence to suggest fuel, hydraulic, or oil were factors in the mishap (Tab U-255).

f. Unscheduled Maintenance

The AIB conducted a review of unscheduled maintenance events for MA1 and MA2 for the previous 25 days and 59 days respectively (Tab U-2 to U-254). MA1 had one unscheduled,

unrelated discrepancy in the active forms (Tab D-16). MA2 also had one unscheduled, unrelated discrepancy in the active forms (Tab D-60). Exceptional Releases for both MA1 and MA2 were completed and the aircraft deemed airworthy (Tab D-9 and D-56). The Exceptional Release serves as a certification that the authorized individual who signs has reviewed the active forms to ensure the aerospace vehicle is safe for flight (Tab BB-9). There is no evidence to suggest that unscheduled maintenance was a factor in this mishap (Tab D-16 and D-60).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

(1) MA1 Condition

MA1 sustained impact damage to the tail section, both horizontal stabilizers, and the right wing (Tab P-5). Furthermore, MA1 sustained heat damage to the empennage and right wing, including the right wing stores (Tab P-5). In addition to impact damage and heat damage, the right wing was adversely loaded (pushed/forced in wrong directions)(Tab P-5). Heat damaged the right external fuel tank and pylon (Tab P-5). The Under-Wing Attachment, launcher, and Acceleration Monitoring Assembly pod were destroyed along with the AIM-120 inert missile and launcher (Tab P-5). The ensuing fire caused extensive heat damage to the lower aft fuselage and engine (Tab P-5). Fuselage damage included damage to the rudder, both horizontal stabilizers, both speedbrakes, the nozzle fairing, engine bay, ventral fins and panels, all aft engine access doors and panels, arresting hook, and the complete right box beam and aft strake area (Tab P-5). Parts not listed as destroyed but requiring inspection are: the right-hand carry-through bulkheads, right-hand lower strake skin Fuselage Station 373 to Fuselage Station 446, the aft most upper skin adjacent to the nozzle fairing, and the right-hand engine access door forward of ventral panels (Tab P-5).

(2) MA2 Condition

MA2 sustained substantial impact damage to the forward fuselage, cockpit area, and left wing (Tab P-14). Furthermore, MA2 sustained extensive fire and heat damage to approximately 90% of the aircraft (Tab P-14). The aircraft and all stores were deemed a total loss (Tab P-14 to P-15).

b. Evaluation and Analysis

Analysis conducted by LM Aero utilized data from both MA1's and MA2's CSFDR and Seat Data Recorder (Tab EE-2 to EE-16). The analysis revealed flight control surfaces, engine, electrical, and hydraulic systems were performing as expected prior to the mishap (Tab EE-8, EE-13 and EE-16). MA1 and MA2 had no relevant reportable maintenance issues prior to the mishap (Tabs D-4 to D-94 and U-2 to U-254). There is no evidence to suggest that aircraft maintenance documentation and aircraft maintenance were a factor in this mishap (Tabs D-4 to D-94 and U-2 to U-254).

7. WEATHER

a. Forecast Weather

The Nellis Weather Flight provided the mission execution forecast on 15 August 2015 (Tab F-2). The forecast included winds from the south at 9 knots, few clouds at 25,000 feet mean sea level, 37 degrees Celsius, and 7 statute miles of visibility (Tab F-5).

b. Observed Weather

The observed weather at Nellis AFB were winds out of the West at 4 knots, clear skies, 38 degrees Celsius, altimeter 29.96 pounds per square inch, and 10 statute miles visibility. (Tab F-7). The Nellis Weather Flight provided a special observation 11 minutes after the mishap (Tab F-7). The observation indicated winds light and variable from the Northeast, clear skies, 36 degrees Celsius, altimeter 29.97 pounds per square inch, and 10 statute miles of visibility (Tab F-7).

c. Space Environment

Not Applicable.

d. Operations

There is no evidence to suggest either of the mishap aircraft were operating outside their prescribed operational limitations.

8. CREW QUALIFICATIONS

a. Mishap Pilot 1

MP1 was a current and qualified F-16 Instructor Pilot (IP) (Tab G-38). He completed Air Force Undergraduate Pilot Training (UPT) at Sheppard Air Force Base, TX in 2000 where he flew the T-37 and T-38 (Tab T-49). Following UPT, MP1 stayed at Sheppard AFB for the Introduction to Fighter Fundamentals (IFF) course where he flew the T-38 and graduated successfully in March of 2001 (Tab T-89). MP1 earned his initial qualification in the F-16C from the 56th Fighter Wing, Luke AFB, Arizona (Tabs G-37 and T-48). Following completion of his initial F-16 qualification, MP1 was assigned to the 77th Fighter Squadron (77 FS) at Shaw AFB, South Carolina (Tabs G-37 and T-48). While flying with the 77 FS, MP1 completed his four-ship flight lead upgrade (skill based certification) followed by his IP upgrade in September 2004 (Tabs G-37 and T-50). MP1 attended the Weapons Instructor Course at Nellis AFB from January 2007 to June 2007 (Tab T-48). MP1's last active duty assignment was at Aviano Air Base, Italy (Tab T-48). MP1 entered the Air Force Reserves and was assigned to the 457 FS, AFRC, NAS Fort Worth JRB, TX where he flies as an F-16 IP (Tab G-7 to G-8). He had over 2200 hours in the F-16 (Tab G-4).

MP1's recent flight time was as follows on the day of the mishap (Tab G-5):

MP1	Hours	Sorties
Last 30 Days	7.1	5
Last 60 Days	22.4	18

b. Mishap Pilot 2

MP2 was a current and qualified four-ship flight lead in the F-16 (Tab G-48). He completed Air Force UPT at Columbus AFB, Mississippi in 2012 where he flew the T-6 and the T-38 (Tab T-44 to T-47). Following UPT, MP2 stayed at Columbus AFB for the IFF course where he flew the T-38 and graduated successfully in December of 2012 (Tab G-20 and T-45). MP2 earned his initial qualification in the F-16C from the 162nd Fighter Wing, Tucson ANG base, Arizona (Tab T-43). Following completion of his initial qualification, MP2 was assigned to the 457 FS AFRC, NAS Fort Worth JRB, TX (G-24). While flying with the 457 FS, MP2 completed his four-ship flight lead upgrade in April 2015 (Tab T-5 to T-6). MP2 had 392.5 hours in the F-16 (Tab G-20).

MP2's recent flight time was as follows on the day of the mishap (Tab G-22):

MP2	Hours	Sorties
Last 30 Days	12.7	9
Last 60 Days	26.7	18
Last 90 Days	44.5	30

9. MEDICAL

a. Qualifications

MP1 was medically qualified for flight duties without restriction at the time of the mishap (Tab X-2). MP1 had a "medically cleared" Air Force Form 1042 on 2 November 2014, with an expiration of 30 January 2016 (Tab X-2). A review of his medical records revealed MP1 had no acute or chronic medical conditions requiring an aeromedical waiver (Tab X-6). Additionally, MP1 had no waivers in the Aeromedical Information Management Waiver Tracking System (AIMWTS) (Tab X-4).

MP2 was medically qualified for flight duties without restriction at the time of the mishap (Tab X-3). MP2 had a "medically cleared" Air Force form 1042 from his most recent PHA on 9 December 2014, with an expiration of 4 March 2016 (Tab X-3). A review of his medical records reveals MP2 had no acute or chronic medical conditions requiring aeromedical waiver (Tab X-6). Additionally, MP2 had no waivers in the AIMWTS (Tab X-5).

Review of medical records of on-duty Air Traffic Controllers (ATC) was unremarkable (Tab X-7). There is no evidence to suggest medical qualifications were a factor in this mishap (Tab X-6 to X-7).

b. Health

The medical records for MP1, as well as his 72-hour and 7-day histories and post-mishap physical exam were reviewed (Tabs V-1.5 and X-6). Medical records revealed he was in good

health and had no recent performance-limiting illnesses prior to the mishap (Tab X-6). MP1 had current physical health assessments as mentioned above (Tab X-2 and X-6). No relevant medical information was noted in the medical records (Tab X-6).

MP1 did not have any injuries resulting from this mishap (Tabs EE-3 and X-6).

The medical records for MP2 were reviewed (Tabs X-6). MP2 did not complete a 72-hour and 7day history due to significant injury (Tab X-6). Two months later, MP2 confirmed an unremarkable 72-hour and 7-day history prior to the mishap (Tab V-2.20). Medical records revealed he was in good health and had no recent performance-limiting illnesses prior to the mishap (Tabs V-2.20 and X-6). MP2 had current physical health assessments as mentioned above (Tab X-3). There is no evidence to suggest that health was a factor in this mishap (Tab X-6).

MP2 suffered a number of life threatening blunt force, burn, and crush-type injuries due to initial impact, ejection seat firing sequence, and the fuel fire (Tabs EE-3, V-2.4 to V-2.6, and X-6).

c. Pathology

The Armed Forces Medical Examiner System (AFMES) tested blood and urine samples in accordance with AFI 91-204, *Safety Investigations and Reports* (Tabs BB-20 to BB-21 and X-6). These tests identify carbon monoxide and ethanol levels in the blood and detect traces of drugs (amphetamine, barbiturates, benzodiazepines, cannabinoids, cocaine, opioids, phencyclidine, and sympathomimetic amines) in urine (Tab X-6).

The following members were tested: MP1, MP2, all MA maintenance crewmembers, and all mishap ATC members (Tab X-6 to X-7). All results were negative, with exception of MP2 (Tab X-6). However, MP2's positive result was consistent with medication administered during his rescue (Tab X-6).

d. Lifestyle

There is no evidence to suggest MP1, MP2, ATC, or maintenance member's lifestyle factors were a factor in this mishap (Tab X-6).

e. Crew Rest and Crew Duty Time

In accordance with AFI 11-202 Volume 3, *General Flight Rules*, aircrew members are required to receive a minimum of 12 non-duty hours of crew rest prior to performing flight duty (Tab BB-14 to BB-15). During this time, a crewmember may participate in meals, transportation, or rest. (Tab BB-14). This time must include an opportunity for at least 8 hours of uninterrupted sleep (Tab BB-14 to BB-15). Crew rest period cannot begin until after the completion of official duties (Tab BB-14 to BB-15).

A review of MP1's and MP2's duty cycles leading up to the mishap indicate they received the required crew rest time (Tabs R-29, V-2.20, and X-6). Both MP1 and MP2 were near the beginning of their 12-hour duty day when the mishap occurred (Tabs EE-10 and R-3).

There is no evidence to suggest crew rest or crew duty time were factors in the mishap (Tab X-6).

10. OPERATIONS AND SUPERVISION

a. Operations

The recent operations tempo of MP1 and MP2 were average with each getting five and nine sorties respectively which is within prescribed standards for a 30 day period (Tabs G-5, G-22 and Tab BB-15).

b. Supervision

The MF attended the LAO-focused mass briefing provided by Red Flag personnel at 0730 hours L on the day of the mishap (Tab R-3). Afterwards, the 457 FS and Red Flag operations supervisors validated Go/No-Go items, authorized the flight, and briefed the MF prior to departure (Tab V-1.5).

There is no evidence to suggest operations or supervision were a factor in this mishap (Tab V-1.5 and V-6.11).

11. HUMAN FACTORS ANALYSIS

The AIB considered all human factors as prescribed in the Department of Defense Human Factors Analysis and Classification System 7.0 (DoD HFACS 7.0) (Tab BB-23 to BB-26).

The AIB identified four human factors relevant to the mishap: (1) Procedure Not Followed Correctly; (2) Misperception of Changing Environment; (3) Interference/Interruption; and (4) Rushed or Delayed a Necessary Action.

a. Procedure Not Followed Correctly:

The definition of 'Procedure Not Followed Correctly' is when a procedure is performed incorrectly or accomplished in the wrong sequence in accordance with DoD HFACS version 7.0 (AE103) (Tab BB-23 to BB-24).

MP2 did not follow procedures correctly for landing configuration, landing distance, and aerobrake (Tab BB-34 to BB-35).

MP2 configured for landing without opening his speedbrakes (Tabs BB-34 and FF-2 to FF-3). Procedure requires pilots to open the speedbrakes on final approach (Tab BB-34). MP2's speedbrakes remained closed throughout the mishap sequence (Tab EE-4).

Procedure dictates landing within the first 150-1000' of the runway, however MP2 landed 1192' down the runway (Tabs BB-12, EE-70, and Z-8).

MP2 did not properly aerobrake after landing (Tabs BB-35 and Z-8 to Z-10). Procedure directs the pilot to maintain a nose high attitude of 11-13 degrees until approximately 80 knots in order to accomplish a proper aerobrake (Tab BB-35). During landing, MP2 maintained a nose high attitude of approximately 9 degrees until 116 knots GS (Tabs EE-76 and Z-9).

b. Misperception of Changing Environment:

The definition of 'Misperception of Changing Environment' is when an individual misperceives or misjudges altitude, separation, speed, closure rate, road/sea conditions, aircraft/vehicle location within the performance envelope or other operational conditions in accordance with DoD HFACS version 7.0 (PC504) (Tab BB-23 and BB-25).

Upon landing, MP1 and MP2 were flying similarly loaded aircraft (gas, configuration, and stores) (Tabs EE-3 and R-15). However, MP2's misperception of his energy state led him to land faster, touch down longer, and reduce the throttle to idle later in the landing sequence than MP1 (Tabs EE-18 to EE-23, EE-69 to EE-73, Z-2, and Z-8). Combined, these actions created substantial closing velocity between the aircraft (Tab EE-18 to EE-82).

MP2 misperceived closure with MP1 as his nose-wheel lowered and MP2 applied moderate braking for 8 seconds while the distance between the aircraft further reduced (Tab EE-117 to EE-119). MP2 applied maximum braking pressure with approximately 220 feet to impact (Tab EE-118 to EE-119).

MA2 could have passed MA1 on the left and remained on paved surface (Tabs EE-4 and Z-14). This passing may have caused MA2 to go slightly outside the painted edge of the runway (still on paved surface) (Tabs EE-4 and Z-12 to Z-14). MP2 misperceived the ability to overtake MP1 safely on the left (Tab V-2). This misperception led MP2 to abandon normal runway deconfliction procedures (Tabs BB-17, V-2.12, and V-2.19). MP2 turned hard right to pass MA1 on the right (Tabs EE-118 to EE-119, V-2.31, and Z-15). MP2's hard right maneuver coincided with MP1's maneuver to the right resulting in ground collision (Tab Z-16).

c. Interference/Interruption:

The definition of 'Interference/Interruption' is when an individual is performing a highly automated/learned task and is distracted by another cue/event resulting in the interruption and subsequent failure to complete the original task or results in skipping steps in the original task. (PC108) (Tab BB-23 and BB-26).

MP1 initially drifted to the hot (left) side of the runway on landing rollout (Tabs R- 4, V-1.10 to V-1.11, and Z-3 to Z-5). When MP2 made an ambiguous radio call for "one, [to] clear to the right," MP1 processed the call only as "…right" (Tabs N-4, R-4, and V-1.11). This led MP1 to believe MP2 was advising him to look rightward for a problem or an aircraft passing him on the right side (Tabs R-4 and V-1.11). MP1 thus continued leftward toward the hot side of the runway (Tabs V-1.11, and Z-14 to Z-15).

Following MP2's repeated radio calls of "One, clear to the right," MP1 correctly understood MP2's verbal directives to clear right (Tab V-1.11). MP1 then turned sharply rightward utilizing

brake input and nose-wheel steering (Tabs EE-105 to EE-106, V-1.11, and Z-14 to Z-16). However, MP2 simultaneously turned rightward thus impacting MA1 (Tabs EE-118 to EE-119 and Z-14 to Z-16).

d. Rushed or Delayed a Necessary Action:

The definition of 'Rushed or Delayed a Necessary Action' is when an individual takes the necessary action as dictated by the situation but performs these actions too quickly or too slowly in accordance with DoD HFACS version 7.0 (AE107) (Tab BB-23 to BB-24).

MP1 initially drifted to the hot (left) side of the runway on landing rollout (Tabs V-1.11 and Z-14 to Z-15). MP1 delayed clearing to the cold side of the runway longer than was necessary (Tabs V-1.11 and Z-14 to Z-15).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publicly Available Directives and Publications Relevant to the Mishap

- (1) AFI 11-2 F-16 Vol 3, F-16—Operations Procedures, 18 December 2013
- (2) AFI 91-204, Safety Investigations and Reports, 12 February 2014
- (3) AFI 51-503, Aerospace and Ground Accident Investigation, 14 April 2015
- (4) Department of Defense Human Factors Analysis and Classification System (DoD HFACS) Version 7.0
- (5) AFI 48-123, Medical Examinations and Standards, 5 November 2013
- (6) AFI 11-2 F-16 Vol 2, *F-16—Aircrew Evaluation Criteria*, 10 December 2009 Change 1, 27 August 2010
- (7) AFI 11-202 Volume 3, General Flight Rules, 7 November 2014

NOTICE: All directives and publications listed above are available digitally on the Air Force Departmental Publishing Office website at: http://www.e-publishing.af.mil.

b. Other Directives and Publications Relevant to the Mishap

- (1) TO 00-20-1 Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures, 1 April 2013
- (2) TO 1F-16C-1, *Flight Manual USAF Series F-16C and F-16D CCIP Aircraft Blocks* 25, 30, 32, 1 September 2014
- (3) DoD Instruction 6055.06, *DoD Fire and Emergency Services (F&ES) Program*, 21 December 2006
- (4) Federal Aviation Administration Handbook 8083-30, *Aviation Maintenance Technician Handbook*, 2008.
- (5) Ripple GR, Torrington KG, Phillips YY. Predictive criteria for burns from brief thermal exposures. *Journal of Occupational Medicine*. 1990; 32 (3):215-219.
- (6) Marx JA, Hockberger RS, Walls RM, et al., eds. Rosen's Emergency Medicine: concepts and clinical practice. Philadelphia, PA: Saunders/Elsevier; 2014.

(7) Moritz AR, Henriques FC. Studies of thermal injury: II. The relative importance of time and surface temperature in the causation of cutaneous burns. *Am J Pathol.* 1947;23:695-720.

c. Known or Suspected Deviations from Directives or Publications

None.

4 November 2015

PETER S. FORD, Colonel, USAF President, Accident Investigation Board

STATEMENT OF OPINION

F-16C, T/N 85-01546 and F-16C, T/N 85-01549 NELLIS AFB, NV 15 AUGUST 2015

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.

1. OPINION SUMMARY

On 15 August 2015 at 1102 local time two F-16Cs collided on a Nellis Air Force Base runway. Mishap Aircraft 2 (MA2) impacted Mishap Aircraft 1 (MA1) conjoining them. Mishap Pilot 1 (MP1) suffered no injuries and Mishap Pilot 2 (MP2) suffered life-threatening injuries. Nellis AFB first responders were on scene in 68 seconds. Nellis AFB medical personnel initiated critical life-saving measures. The efforts of these two organizations saved MP2's life. The F-16Cs (tail numbers 85-01546 and 85-01549) are assigned to the 457th Fighter Squadron, 301st Fighter Wing, Joint Reserve Base, Fort Worth, Texas. The estimated repair cost of MA1 is \$5,412,111. MA2, valued at \$64,036,628, was destroyed. Total government loss is valued at \$69,501,839.

I find by a preponderance of evidence the causes of this mishap were MP2's landing, lack of comprehensive braking and flight path deconfliction, combined with MP1's delayed transition to the cold (exit) side of the runway.

I developed my opinion by analyzing recorded flight data, interviewing mishap flight pilots, supervisory pilots, first responders, and medical personnel in person. I also reviewed Air Force directives, engineering analysis, animated simulations, information provided by technical experts, and other witness testimony.

2. CAUSES

The causes of this mishap were MP2's landing, lack of comprehensive braking and flight path deconfliction, combined with MP1's delayed transition to the cold side of the runway.

a. Landing

MP2 landed with proper spacing behind MP1 (3052 feet). However, MP2 landed too fast (181 knots ground speed (GS)), touched down long (1192 feet down the runway), with speedbrakes closed, and the engine above idle power. Procedure requires landing 150-1000 feet down the runway, and prudence dictates landing on speed, with the engine stabilized at idle power. In contrast, MP1 landed at 163 knots GS, 750 feet down the runway, with his speedbrakes open, and the engine stabilized at idle power.

b. Lack of comprehensive braking

As noted, MP2 did not open his speedbrakes or correctly aerobrake. His aerobrake was less than 10 degrees Angle of Attack (AOA) which only slowed his aircraft to 116 knots GS when his nose gear touched down (6172 feet down the runway). In contrast, MP1 properly aerobraked by maintaining an AOA of 13 degrees, slowing his aircraft to 101 knots GS when his nose gear touched down (4999 feet down the runway). As MP2's nose gear touched down, he applied heavy (not maximum) braking pressure and directed MP1 to "clear to the right" (cold side of the runway). Upon seeing MA1 drift further left, MP2 then applied maximum braking (minus extended speedbrakes).

c. Lack of flight path deconfliction

When MP2 recognized the excessive closure combined with MA1's position on the hot (landing) side of the runway, MP2 applied maximum braking pressure (minus extended speedbrakes). Simultaneously, MP2 abandoned normal runway deconfliction with a hard right maneuver in the attempt to pass MA1 on the right. MP2's hard right maneuver coincided with MP1's maneuver to the right resulting in ground collision.

d. MP1 delayed transition to the cold side of the runway

After properly aerobraking, MP1 allowed his aircraft to drift from the centerline to the hot (landing) side of the runway. Furthermore, while mentally processing MP2's first directive radio call, MP1 continued drifting left, further complicating runway deconfliction.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

Not applicable.

4. CONCLUSION

I find by a preponderance of evidence the causes of this mishap were MP2's landing, lack of comprehensive braking and flight path deconfliction, combined with MP1's delayed transition to the cold side of the runway.

4 November 2015

PETER S. FORD, Colonel, USAF President, Accident Investigation Board

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