UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

F-16C, T/N 89-2019, and F-16C, T/N 89-2034

125TH FIGHTER SQUADRON
138TH FIGHTER WING
TULSA AIR NATIONAL GUARD BASE, OKLAHOMA

LOCATION: MOLINE, KANSAS
DATE OF ACCIDENT: 20 OCTOBER 2014

BOARD PRESIDENT: COLONEL CHRISTOPHER ALDERDICE
Conducted IAW Air Force Instruction 51-503

EXECUTIVE SUMMARY
AIRCRAFT ACCIDENT INVESTIGATION

F-16C, T/N 89-2019, and F-16C, T/N 89-2034
Moline, Kansas
20 October 2014

On 20 October 2014, at 1421 hours (all times local), two F-16Cs, tail numbers (T/N) 89-2019 and 89-2034, assigned to the 125th Fighter Squadron, 138th Fighter Wing, Tulsa Air National Guard Base (ANGB), collided during a training mission near Moline, Kansas. Mishap pilot 1 (MP1), was an instructor pilot with over 2,400 hours of flight time in the F-16. Mishap pilot 2 (MP2) was a student pilot with 106 flying hours in the F-16. MP1 ejected and experienced minor injuries; MP2 was unharmed. Mishap aircraft 1 (MA1), T/N 89-2019 was destroyed. Five feet of the right wing tip was severed from mishap aircraft 2 (MA2), T/N 89-2034. The total loss to government property was $22,490,842. There was no significant damage to private property.

The mishap flight (MF) departed Tulsa ANGB at 1403 for an air combat maneuvers (ACM) training mission. The MF included three F-16s; MP1 and MP2 planned to operate as a coordinated two ship, while mishap pilot 3 (MP3) would play the role of simulated adversary. The MF flew 83 nautical miles (NM) northwest to the Eureka Military Operating Area (MOA), to perform a series of ACM engagements, wherein MP1 and MP2 would patrol the Eureka MOA and MP3 would approach from an unknown direction to simulate an attack, to which MP1 and MP2 must respond. MP1 and MP2 would fill the role of either an engaged fighter (EF) whose primary responsibility is to kill the adversary, or supporting fighter (SF) whose primary responsibilities are to maintain visual and ensure flight path de-confliction with the EF. The first engagement finished without incident. For the second engagement, MP3 approached from the north, separated by 20 NM. By default, MP1 was the EF and MP2 was the SF. MP1 and MP2 were headed north with MP1 left of MP2. MP3 targeted MP2, and MP1 then directed MP2 to bracket right, but did not initiate an exchange of EF and SF roles. At 14:21:03 MP2 saw MP1 for the last time before impact, 16 seconds later. At 14:21:08 MP2 stated he had merged with MP3. MP2 then took a hard left turn in an attempt to get behind MP3. MP1 saw MP2 turn but misperceived it as a right turn, away from him, and accordingly focused on simulating a kill on MP3. At 14:21:16, MP2 made a request to exchange roles; MP1 then saw MA2's belly on a rapid collision course. MP1 and MP2 collided at 14:21:19. The impact resulted in sheering MA1's right wing flaperon and horizontal tail, causing MP1 to lose control. MP1 successfully ejected from MA1 and landed near Moline, Kansas. MP2 landed MA2 safely at Tulsa ANGB.

The Accident Investigation Board (AIB) president found, by clear and convincing evidence, the cause of the mishap was MP2's failure to fulfill his primary responsibilities of maintaining visual and flight path de-confliction with MP1. Additionally, the AIB president found, by a preponderance of evidence, three factors substantially contributed to the mishap: 1) MP2's failure to call "blind" when he could not see MP1, 2) MP1's misperception of MP2's turn at the merge, and 3) MP1's failure to initiate a role exchange when MP2 was most defensive.

SUMMARY OF FACTS AND STATEMENT OF OPINION
F-16C, T/N 89-2019, and F-16C, T/N 89-2034
20 October 2014

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ACRONYMS AND ABBREVIATIONS

1v1	One verses One
125 FS/CC	125th Fighter Squadron Commander
125 FS/DO	125th Fighter Squadron Director of Operations
125 FS/IP	125th Fighter Squadron Instructor Pilot
138 OG/CC	138 Operations Group Commander
138 OG/CD	138th Operations Group Deputy
2 FLUG	Two ship flight lead upgrade training
4 FLUG	Four ship flight lead upgrade training
4vX	Four verses any number of Aircraft
ACC	Air Combat Command
ACES	Advanced Concept Ejections Seat
ACM	Aircraft Combat Maneuver
ACT	Air Combat Tactics
AF	Air Force
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AFTP	Air Flying Training Period
AFTTP	Air Force Techniques, Tactics and Procedures
AGR	Active Guard Reserve
AGL	Above Ground Level
AGSM	Anti-G Straining Maneuver
AIB	Accident Investigation Board
AIM	Air Intercept Missile
AIMWTS	Aeromedical Information Management Waiver Tracking System
ALE	Air Launched Expendable
AMD	Air and Missile Defense
ANG	Air National Guard
ANGB	Air National Guard Base
AOA	Angle of Attack
AOO	Air Operations Officer
AOR	Area of Responsibility
ARM	Aircrew Resource Management
ATC	Air Traffic Control
AUX	Auxiliary
B-Course	Basic Course
BDU	Bomb Dummy Unit
BFM	Basic Fighter Maneuver
BSA	Basic Surface Attack
CA	Convening Authority
CAF	Combat Air Force
Capt	Captain
CAS	Close Air Support
CATM	Captive Air Training Missile
Civ	Civilian
CIVWIT 1	Civilian Witness 1
CIVWIT 2	Civilian Witness 2
CMR	Combat Mission Ready
Col	Colonel
COMM	Communications
Config	Configuration
CONUS	Continental United States
CRC1	Crew Chief 1
CRC2	Crew Chief 2
CSFDR	Crash Survivable Flight Data Recorder
CT	Computerized Tomography
CT Flying	Continuation Training Flying
CP	Chase Pilot
DACT	Dissimilar Air Combat Tactics
DCA	Defensive Counter Air
DELAT	Designated Geographic Reference Point
Det	Detachment
DOC Statement	Designed Operational Capability Statement
DoD	Department of Defense
DRS	Digital Recovery Sequencer
DSA	Drogue Severance Assembly
DTC	Data Transfer Cartridge
EF	Engaged Fighter
EMT	Emergency Medical Technician
EPU	Electrical Power Unit
FCF	Functional Check Flight
FCIF	Flight Crew Informational Files
FCR	Fire Control Radar
FDP	Flight Duty Periods
FL	Flight Lead
FLCS	Flight Control System
FRC	Fault Reporting Codes
FS	Fighter Squadron
Ft	Feet
FTU	Flying Training Unit
FW	Fighter Wing
G	Gravitational Force
GX	Gravitational Force Exercise
HFACS	Human Factors Analysis and Reports
HMCS	Helmet Mounted Cueing System
HQ	Headquarters
HSD	Horizontal Situation Display
HUD	Heads-Up Display
IAP	International Airport
IAW	In Accordance With
ID	Identification
IFDL	Intra-Flight Data Link
IFF	Identification, Friend or Foe
IMDS	Integrated Maintenance Data System
IP	Instructor Pilot
IPUG	Instructor Pilot Upgrade
IQT	Initial Qualification Training
JHMCS	Joint Helmet Mounted Cueing System
JOAP	Joint Oil Analysis Program
K	Thousand

KCAS	Knots Calibrated Air Speed
KEAS	Knots Equivalent Air Speed
kts	Knots
L	Local Time
LAO	Local Area Orientation
LAU	Launch Adapter Unit
LFE	Large Force Exercise
Lt Col	Lieutenant Colonel
MA	Mishap Aircraft
MA1	Mishap Aircraft 1
MA2	Mishap Aircraft 2
Magnetic	Magnetic North
Maj	Major
MAJCOM	Major Command
MAR	Minimum Abort Range
MAU	Munitions Adapter Unit
MED	Medical
ME	Mishap Element
MF	Mishap Flight
MFD	Multi-function Display
MFL	Maintenance Fault List
MKK	Advanced Flanking Variant
MOA	Military Operating Area
MP	Mishap Pilot
MP1	Mishap Pilot 1
MP2	Mishap Pilot 2
MP3	Mishap Pilot 3
MR	Mission Ready
MS	Mishap Sortie
MSgt	Master Sergeant
MSL	Mean Sea Level
MQT	Mission Qualifying Training
ND	Nose Down
NM	Nautical Miles
NOTAMs	Notices to Airmen
NORAD	North American Aerospace Defense Command
OCA	Offensive Counter Air
OG	Operations Group
OG/CC	Operations Group Commander
OKANG	Oklahoma Air National Guard
OPS	Operations
Ops Tempo	Operations Tempo
ORE	Operation Readiness Exercise
ORM	Operational Risk Management
OSF	Operation Support Flight
PA	Primary Aircraft
PAA	Primary Assigned Aircraft
PHA	Physical Health Assessment
PFL	Practice Forced Landing
PLF	Parachute Landing Fall
PPLI	Precise Participant Location and Identification
PR	Pre-Flight Inspection
PRI	Primary
QA	Quality Assurance
RAP	Ready Aircrew Program
Rep	Representative
ROE	Rules of Engagement
RTB	Return-To-Base
RTU	Replacement Training Unit
RWD	Right Wing Down
RWR	Radar Warning Received
SA	Situational Awareness
SAR	Search and Rescue
SARCAP	Search and Rescue Civil Air Patrol
STAPAC	Stabilization Package
SAT	Surface Attack Tactics
SDR	Seat Data Recorder
SEFE	Standardization & Evaluation Flight Examiner
SF	Supporting Fighter
SOF	Supervisor of Flight Operations
SIB	Safety Investigation Board
SII	Special Interest Item
Sim	Simulation
SP1	Search Pilot 1
SP2	Search Pilot 2
SOF	Supervisor of Flying
Stan Eval	Standardization & Evaluation
TCTO	Time Compliance Technical Order
TDRM	Trajectory Divergence Rocket Motor
TD	Target Designator
TDY	Temporary Duty
TER	Triple Ejection Rack
TH	Thru-Flight Inspection
TI	Target Intercept
T/N	Tail Number
TO	Technical Order
TOD	Technical Order Data
TRB	Training Review Board
True	True North
TSgt	Technical Sergeant
UAV	Unmanned Arial Vehicle
UCMJ	Uniform Code Military Justice
UHF	Ultra High Frequency
USAF	United States Air Force
VFR	Visual Flight Rules
VHF	Very High Frequency
Z	Zulu

The above list was compiled 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 7 November 2014, Major General James N. Post, III, Vice Commander, Air Combat Command, appointed Colonel Christopher R. Alderdice to conduct an aircraft accident investigation of the 20 October 2014 mishap of two F-16C Fighting Falcon aircraft near Moline, Kansas. (Tab Y-3). On 2 December 2014, the accident investigation board (AIB) convened at Tulsa Air National Guard Base (ANGB), Oklahoma. A legal advisor (Captain), pilot (Captain), flight surgeon (Colonel), maintenance member (Senior Master Sergeant), and a recorder (Technical Sergeant) were also appointed to the board (Tab Y-6). The AIB was conducted in accordance with Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*.

b. Purpose

This is a legal investigation convened to inquire into the facts surrounding the aircraft 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 20 October 2014, at 1421 hours (all times in local time), two F-16Cs, tail numbers (T/N) 89-2019 and 89-2034, assigned to the 125th Fighter Squadron (FS), 138th Fighter Wing (FW), Tulsa Air National Guard (ANG), collided during an Air Combat Maneuvers (ACM) training mission near Moline, Kansas (Tabs V-1.2 and J-4). Mishap pilot 1 (MP1), was an instructor pilot with approximately 2,400 hours of flight time in the F-16 (Tab G-2). Mishap pilot 2 (MP2) was a relatively inexperienced student pilot with 106 flying hours in the F-16 (Tab G-11). MP1 successfully ejected and experienced minor injuries, while MP2 was unharmed (Tab X-3). Mishap aircraft 1 (MA1), T/N 89-2019, impacted the ground in a field near Moline, Kansas and was destroyed with a loss valued at $20,104,852 (Tabs J-4 and P-3). Mishap aircraft 2 (MA2), T/N 89-2034, sustained significant damage to the right wing but was able to safely land at Tulsa International Airport (IAP), Oklahoma (Tabs J-4, N-7, N-10 and N-14). Repair cost for MA2 is estimated at $2,335,990 (Tab P-6). The environmental clean-up cost was estimated at $50,000.00 for contaminated soil removal and reclamation (Tab P-2). The mishap did not result in significant damage to private property.

3. BACKGROUND

MA1 and MA2 belong to the 125th FS, 138th FW, Air National Guard, Air Combat Command, stationed at Tulsa ANGB, Oklahoma (Tabs V-1.2, V-1.14 and V-3.2). Both MP1 and MP2 were assigned to the 125th Fighter Squadron (Tabs G-2 and G-10). MP1 and MP2 were participating in ACM Mission Qualifying Training (MQT) at the time of the mishap (Tab V-1.3).

a. Air Combat Command

Air Combat Command (ACC), with headquarters at Joint Base Langley-Eustis, Virginia, is a major command created on June 1, 1992 by combining Strategic Command and Tactical Air Command (Tab CC-3). ACC is the primary provider of air combat forces to America's warfighting commanders (Tab CC-3).

To support the global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management, and electronic-combat aircraft (Tab CC-3). It also provides command, control communications and intelligence systems, and conduct global information operations (Tab CC-3).

As a force provider, ACC organizes, trains, equips and maintains combat-ready forces for rapid deployment and employment while ensuring strategic air defense forces are ready to meet the challenges of peacetime and wartime air defense (Tab CC-3). ACC numbered air forces provide the air component to U.S. Central, Southern and Northern Commands, with Headquarters ACC serving as the air component to Joint Forces Command (Tab CC-3). ACC also augments forces to U.S. European, Pacific and Strategic Command (Tab CC-3).

b. Air National Guard

The Air National Guard (ANG) is administered by the National Guard Bureau, a joint bureau of the departments of the Army and Air Force, located in the Pentagon, Washington, D.C. (Tab CC-9). It is one of the seven Reserve components of the United States armed forces that augment the active components in the performance of their missions (Tab CC-9).

The Air National Guard's federal mission is to maintain well-trained, well-equipped units available for prompt mobilization during war and provide assistance during national emergencies, such as natural disasters or civil disturbances (Tab CC-9). During peacetime, the combat-ready units and support units are assigned to most Air Force major commands to carry out missions compatible with training, mobilization readiness, humanitarian and contingency operations, such as Operation Enduring Freedom in Afghanistan (Tab CC-9).

c. 138th Fighter Wing

The federal mission of the 138th Fighter Wing is to maintain combat forces ready for mobilization, deployment and employment as needed to support national security objectives (Tab CC-13). Additionally, its state mission is to support the governor of the state of Oklahoma with units organized, equipped and trained in the protection of life and property, and preservation of peace, order and public safety under competent orders of authority (Tab CC-13).

Since conversion to the F-16, the 138th Fighter Wing has participated in multiple contingency operations. (Tab CC-13).

d. 125th Fighter Squadron

The 125th Fighter Squadron (FS) is the supported command on Tulsa Air National Guard Base (Tab CC-15). When it deploys, all other wing members come under the command of the 125th FS commander to carry out whatever mission they are tasked to accomplish (Tab CC-15). The 125th FS and 138th Operation Support Squadron are responsible to train all pilots assigned to 138th Fighter Wing and serves as force supplier to the other 138 Operations Group organizations (Tab CC-16).

e. F-16 Fighting Falcon

The F-16 Fighting Falcon is a compact, multi-role fighter aircraft (Tab CC-21). It is highly maneuverable and has proven itself in air-to-air combat and air-to-surface attack (Tab CC-21). It provides a relatively low-cost, high-performance weapon system for the United States and allied nations (Tab CC-21).

In an air combat role, the F-16's maneuverability, as well as the distance the F-16 can fly to enter air combat, stay, fight and return, exceed that of all potential threat fighter aircraft (Tab CC-21). It can locate targets in all weather conditions and detect low flying aircraft in radar ground clutter (Tab CC-21). In an air-to-surface role, the F-16 can fly more than 500 miles (860 kilometers), deliver its weapons with superior accuracy, defend itself against enemy aircraft, and return to its starting point (Tab CC-21). The primary tactical doctrine for F-16 pilots is contained in Air Force Tactics, Techniques, and Procedures (AFTTP) 3-3.F-16 Combat Aircraft Fundamentals (Tab BB-14).

f. Air Combat Maneuvering

Air Combat Maneuvering (ACM) is pilot training designed to apply aircraft handling skills in an element formation of multiple fighter aircraft (Tab BB-16). ACM focuses on coordinated movement to simulate a kill or defend against a simulated adversary (Tabs BB-16 and V-2.2). Such training is commonly accomplished through a series of "Tap the Cap" exercises, wherein two or more aircraft patrol a pre-planned airspace as an element, while a "bandit" or simulated adversary approaches the element from an area and direction unknown to the element (Tab V-2.3). The element must then properly respond with coordinated movement (Tab V-2.3).

(1) Flight Path De-confliction

During an ACM mission, aircraft ensure they do not collide by establishing flight path de-confliction roles and responsibilities (Tab BB-16). At all times during an ACM mission, the element will include an engaged fighter (EF) and a support fighter (SF) (Tab BB-16). While both pilots are responsible for avoiding collision, the primary role and highest priority of the SF

is flight path de-confliction, and to maintain sight of the EF (Tabs BB-16 and BB-17). Conversely, the top priority of the EF is to kill the adversary as quickly as possible (Tab BB-17). The Element Lead is the EF by default, but roles may switch during an engagement through a series of radio communications between the EF and SF (Tabs BB-17 and BB-20). Communication during an ACM mission follows a "challenge and response" format, wherein the EF will direct and the SF will acknowledge, or the SF will request and the EF will grant or deny (Tabs BB-17 and BB-20). The roles are not exchanged until both the challenge and response have occurred (Tabs BB-17 through BB-20 and V-3.8). The determination of whether and when to switch roles is a scenario specific, tactical decision (Tab V-2.4 and V-2.5).

4. SEQUENCE OF EVENTS

a. Mission

On 20 October 2014, the mishap flight (MF), call sign Brave 1 (MP1) and Brave 2 (MP2) performed an ACM Mission Qualifying Training (MQT) mission for Brave 2, with Brave 3 (MP3) as the adversary, as authorized by 125 FS (Tabs V-1.3 and K-3). This occurred in Eureka Military Operating Area (MOA), located in central Kansas, approximately 40 nautical miles (NM) east of Wichita, KS and 83 NM northwest of Tulsa, OK (Tabs AA-6, V-1.4, V-3.3 and V-4.4). The MF scheduled to depart Tulsa IAP at 1400, fly to the Eureka MOA to conduct the ACM training and return at 1505 (Tabs AA-6 and K-11).

b. Planning

MP1 and MP2 followed the normal planning process for an ACM mission (Tab V-1.4, V-3.8 and V-4.8). MP1 was the Operations Supervisor for the morning schedule, which was uneventful (Tab V-1.3). There was a mass brief at 0705 (Tabs K-17- K-19 and V-1.3). The MF briefing started at 1200 for a 1400 takeoff (Tab V-1.3). The briefing was instructional because MP2 was in MQT upgrade (Tab V-1.3). MP2 had passed two previous ACM flights and this was an additional training sortie for MP2 (Tab G-89, G-90, and V-1.3). The overview and coordination portion of the briefing was conducted with all flight members (Tab V-1.3). After the overview and coordination brief, MP3 was excused per normal procedures (Tabs V-1.3 and V-4.10).

The scenario for the training mission was a "Tap the Cap" scenario (Tabs V-1.4 and V-3.4). This type of scenario has the element holding over a predetermined point in the airspace, usually 10 NM legs, like an oval racetrack straightway, and does not know from what direction the adversary will attack (Tabs V-1.4 and V-2.5). Reserved ranges of altitude are established so all aircraft will remain altitude de-conflicted until all pilots are visual (Tab V-1.4). During the briefing, MP1 emphasized the ACM de-confliction roles and responsibilities (Tabs V-1.4 and V-1.9).

There are two specific roles used to define visual de-confliction responsibilities during all F-16 visual tactical maneuvering (Tab BB-16). Those roles are engaged fighter (EF) and supporting fighter (SF) (Tab BB-16). The SF owns the primary flight path de-confliction responsibility between the EF and SF (Tab BB-16). However, both fighters carry some responsibility to ensure the flight does not have a mid-air collision (Tab BB-16). Role establishment or exchange within

the ACM environment should use a "challenge and response" format whenever possible to avoid conflicts and ensure comprehension (Tab BB-16).

The following are the EF responsibilities:

- Maneuver to identity and kill the adversary in minimum time
- Allow the SF to engage if in a better position to quickly kill or control the adversary
- Maintain situational awareness on the SF
  (Tab BB-17)

The SF may have to perform several tasks at once while surviving the threat. However, the SF holds the following priorities in descending order:

- Maintain the visual and ensure flightpath deconfliction with the engaged fighter
- Maneuver to kill the adversary in minimum time. During maneuvering, devote maximum attention to defeating any weapons in flight and denying/minimizing and adversary weapons engagement zone opportunity
  (Tab BB-17)

The hierarchy to determine which fighter should be relieved of de-confliction responsibilities, and thus become the EF, is as follows, in descending order of priority:

- The fighter whom the adversary appears to be maneuvering (most defensive)
- The fighter in the best position relative to the adversary (most offensive)
- The fighter with the highest situational awareness
- The flight lead (default state until altered)
  (Tab BB-20)

The underlying premise of the ACM communication construct is consistency (Tab BB-20). To achieve this end, both flight lead and wingman will use identical terms to affect role changes (Tab BB-20). During short-range detects, communications should be directive and then descriptive (Tab BB-20). For example, if Viper 1 detects a threat at close range, his or her call should be "VIPER 2, BRACKET RIGHT, VIPER 1, ENGAGED OVER BULLSEYE, 11,000" (Tab BB-21).

An optimum entry against a high-aspect threat is one that allows the element to identify the threat and bring ordnance to bear quickly, while denying the enemy the ability to sequentially attack both fighters (Tab BB-24). The primary attack option versus high-aspect adversaries is a bracket, whereby each fighter maneuvers to attack the adversary from opposite sides of the bandit's flightpath (Tabs BB-21 and V-2.6). Additionally, the element should bracket in altitude to give the adversary a greater challenge to see both fighters at the same time (Tab BB-21). In high aspect merges, the flight lead begins as the EF by default; a switch of role assignments should be delayed until adversary's intent can be accurately determined (Tab BB-20). For example, if Viper 1 owns the group, Viper flight is visually bracketing, and it becomes obvious that the adversaries are leaning on Viper 2, Viper 1 should transmit "VIPER 2, PRESS" (Tab

BB-20). Viper 2 should then respond with "VIPER 2, ENGAGED," assuming Viper 2 has sufficient situational awareness to properly respond (Tab BB-20).

The primary responsibility of the SF is to maintain the visual, fly formation, and listen to build three-dimensional situational awareness of the developing picture (Tab BB-17). SF must never forget flight path de-confliction duties (Tab BB-19). Nothing will hurt the team more than forcing the flight lead to take critical time away from primary duties to perform the task of reorienting or de-conflicting from a blind wingman (Tab BB-19). It is difficult to monitor shot status while trying to regain the visual (Tab BB-19). If task-saturated to the point that complying with a flight lead's directive will cause SF to be blind, it is better to reply "VIPER 2, UNABLE, PADLOCKED," than to accept the task (Tab BB-19).

MP1 generated desired learning objectives (DLO) for MP2 before the MF briefing (Tab V-1.4). MP1 briefed MP3 guidelines to help achieve the DLOs and to ensure that MP2 was performing the correct maneuvers to defeat the adversary (Tab V-1.4). They had planned on four ACM engagements (Tab V-1.8). For the first engagement, MP3 was to target MP1 (Tab V-4.3). If MP1 defended correctly and defeated MP3's radar, MP3 was to switch targets and attack MP2 (Tab V-4.3). The second engagement was to be the opposite, first targeting MP2, and if he defended correctly, MP3 would switch to MP1 (Tab V-4.3). After these two initial engagements, MP3 was cleared to attack either MP1 or MP2 and maneuver as he saw fit (Tab V-4.3).

Squadron supervisory personnel did not attend the briefing (Tabs V-6.2, V-7.3 and V-8.3).

c. Preflight

MP1, MP2, and MP3 followed the normal preflight briefing (Tab V-1.4). This included a review of the following: scenario, objectives and overview, weather, and Notices to Airmen (NOTAMs) (Tab K-5 through K-10), special interest items, Flight Crew Informational Files (FCIF), individual training requirements, mission materials, personal equipment, ground operations, takeoff/departure, working area, return to base (RTB), alternate mission, special subjects, and training rules (Tabs AA-3 and AA-4).

Once the MF briefing was finished, they inspected and donned flying gear, and went to the operation desk for their step brief from the Operations Supervisor (Tab V-4.4). All their individual training currencies, FCIFs, Operational Risk Management (ORM) (Tab K-13) and weather (Tab F) were covered again (Tabs K-17 through K-19). The flight plan was filed and aircraft tail numbers and configurations given to the pilots (Tab K-2). After the step brief, the pilots walked to the aircraft, reviewed the maintenance forms, and performed a preflight inspection of the aircraft (Tabs V-4.3 and V-4.4). Once accomplished, the pilots climbed into the aircraft, strapped in, and started the aircraft (Tab V-4.4).

d. Summary of Accident

Start, taxi, and arming the aircraft were all uneventful (Tabs V-1.4 and V-4.4). The flight took off at 1403 from Tulsa ANGB, OK in a 2+1 formation with 1 NM between the mishap element (ME) and MP3 to Eureka MOA (Tabs V-3.3 and V-4.4). There was nothing of note with Air Traffic Control (ATC) or weather during the departure to the MOA (Tab V-4.4). After entering

the airspace, the MF performed a G-Awareness exercise, which is a turning exercise to determine a pilot's tolerance of gravitational force, prior to beginning air to air engagements (Tabs V-1.4 and V-4.4). As mentioned previously, they planned a "Tap the Cap" scenario with one continuous fight (Tab V-1.5). The ME was holding in the center of the airspace with the adversary free to engage at any point throughout the flight after the "FIGHTS ON" call (Tabs V-4.4 and N-3).

The first engagement began at 14:17:15 with 20 NM of separation (Tabs N-3 and V-1.4). At 14:18:01, MP1 saw MP3 on his radar and directed MP2 to target MP3, the unidentified adversary (Tab N-3, V-1.5). As the flight turned towards MP3, MP1 received auditory indications that he was being targeted, and at 14:18:09 defended west, defeating MP3's radar (Tabs N-3 and V-1.5). MP2 requested to split from MP1 and continued to process the adversary (Tab N-3). After a few "SPLIT" calls, MP1 pitched back toward MP3 and called "2 PRESS," to exchange the EF role to MP2 (Tabs BB-17 and N-3). As per the briefing, since MP1 defeated MP3's radar, MP3 switched targets and began to attack MP2 (Tab V-4.4). At 14:18:27, MP1 directed MP2 to look off his nose for 6 NM to see the adversary (Tab N-3). At 14:18:35, MP2 called "2's TALLY ONE," and MP1 called "1's TALLY ONE, BANDITS SWITCHING ON YOU" (Tab N-3). At 14:18:47, MP2 called "2's MERGED HOSTILE VIPER" and one second later called "2's ENGAGED" (Tabs N-3 through N-4). This last radio call completed the EF and SF role exchange, 25 seconds after MP1's "2 PRESS" call (Tab BB-11). MP1 killed the hostile adversary with a missile shot and the ME separated south to end the first engagement and prepare for the next one (Tabs N-3 through N-4 and V-1.5).

The ME rejoined and continued south for twenty-one seconds (Tabs N-4 and V-1.5). They hooked right, back to the north in their cap while they assessed fuel state (Tabs N-4 and V-1.5). The second engagement began at 14:20:17, when MP1 picked up radar histories and directed MP2 to target that group (Tabs N-4 and V-1.5). The adversary was 15-20 NM off their nose, which was shorter than planned (Tabs N-3, J-4 and V-4.5). MP2 called targeted at 14:20:26 (Tab N-4, and V-7). MP1 then directed MP2 to bracket right to the east (Tab N-4). The mishap element (ME) maneuvered in an offensive manner in order to identify, and if hostile, attack the adversary (Tab V-1.5). MP2 called that he was targeted by the adversary and defended to the northeast (Tabs N-4 and V-1.5). At this point, MP2 was the most defensive fighter (Tabs N-4, V-1.5). MP1 could have given MP2 the EF role by calling "2 PRESS" at any point from now until MP2 merged (as in opposite traffic on a two lane highway) with MP3; however, he did not initiate a role exchange (Tab V-2.9). MP1 acknowledged that he should have initiated a role exchange to give the engaged fighter responsibilities to MP2 since he was clearly the most defensive fighter in accordance with AFTTP 3-3, but did not initiate this role swap (Tab V-2.9). MP2 did not defend effectively enough to defeat MP3's radar, so MP3 continued to attack MP2 as per the briefing (Tabs V-4.3 and V-4.4). At 14:21:00 MP1 called "1's TALLY ONE" to indicate that he is in sight of the adversary, but unable to make a declaration of hostile intent (Tab N-4). MP1 turned into the adversary to be in a position to take a shot if MP2 identifies the adversary as hostile (Tab DD-9). MP2 called "TWO's IN 14 THOUSAND" at an altitude of 14,600 feet at 14:21:03, three seconds after his "TALLY" call (Tab N-4, DD-9). During an interview with MP2, he stated this call was made to inform MP1 that MP2 was maneuvering into the fight; however, MP2 subsequently acknowledged this was an incorrect and mistimed call. The correct term would have been "greasing in" (Tab V-3.18 through V-3.19). At this point,

MP2 looked at MP1 for the last time, and assumed de-confliction for the remainder of the engagement without maintaining the visual on the EF, MP1 (Tab V-3.24). MP2 called "2'S MERGED HOSTILE VIPER," at 14:21:08 (Tab N-4). MP2 turned across MP3's tail in an effort to fight his best Basic Fighter Maneuvers (BFM); however, he did not have sight on MP1 and was still the SF (Tab V-3.24). At this point, MP1 saw that the adversary turned away from him to the east and towards his wingman in a vertical type maneuver (Tab V-1.6). MP1 misperceived that MP2 had also turned away from him to the east (Tabs V- 1.6 and V-1.29), (Figures 1 and 2 below). Viewing an F-16, 1.5-2 NM away, rotating either toward or away from you, and similar in color, top and bottom can be misperceived as attested by MP1 (Tab V-1.29 through V-1.30). Due to MP1's misperception of turn direction as the EF, MP1 continued to point at and radar locked MP3 without continuing to crosscheck MP2's position (Tab V-1.6). He assessed his range and clear avenue of fire and employed his first weapon at the adversary (Tab V-1.6). He then assessed range and clear avenue of fire again, and took a second shot before looking for MP2 (Tab V-1.6). A total of eight seconds passed during this process and at 14:21:16, MP2 called "2's ENGAGED," which was three seconds prior to impact (Tab N-4). At this point, the aircraft were between 2,000-2,500 feet apart with over 800 knots of closure (Tab DD-9). MP1 realized that MP2 made a left hand turn when he saw the belly of MP2's aircraft (Tab V-1.6). MP1 described their orientation as co-altitude, with zero line-of-sight, at a range of 1,000 feet from MP2, and closing on a collision course (Tab V-1.6). MP1 attempted to react and maneuver out of the way by bunting the aircraft or pushing it down (Tab V-1.6). However, he was unsuccessful and the two aircraft collided at 14:21:19 (Tabs DD-9, J-4, N-4 and V-1.6).

Figure 1: Mishap Engagement Illustration First Half

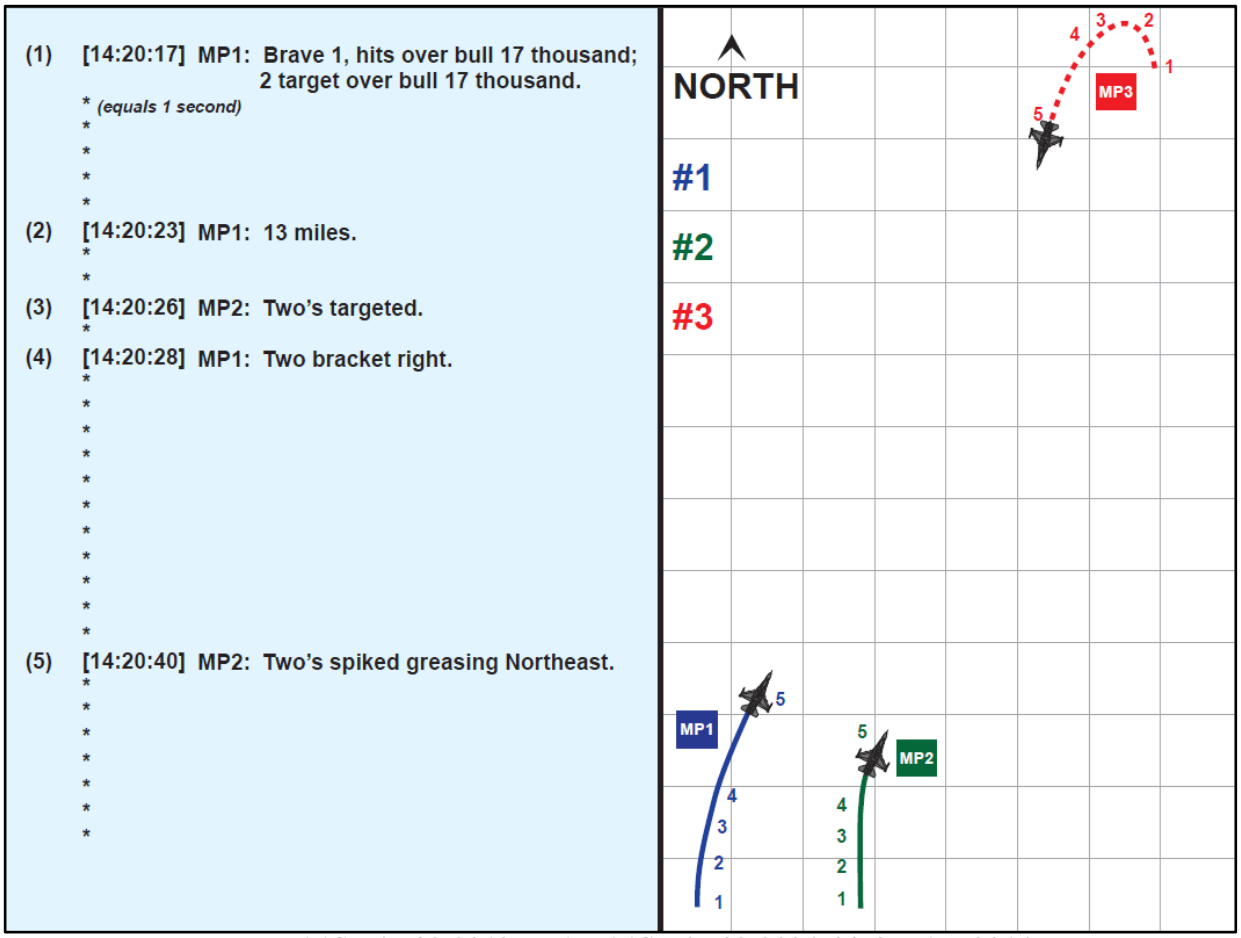


Figure 2: **Mishap Engagement Illustration Second Half**

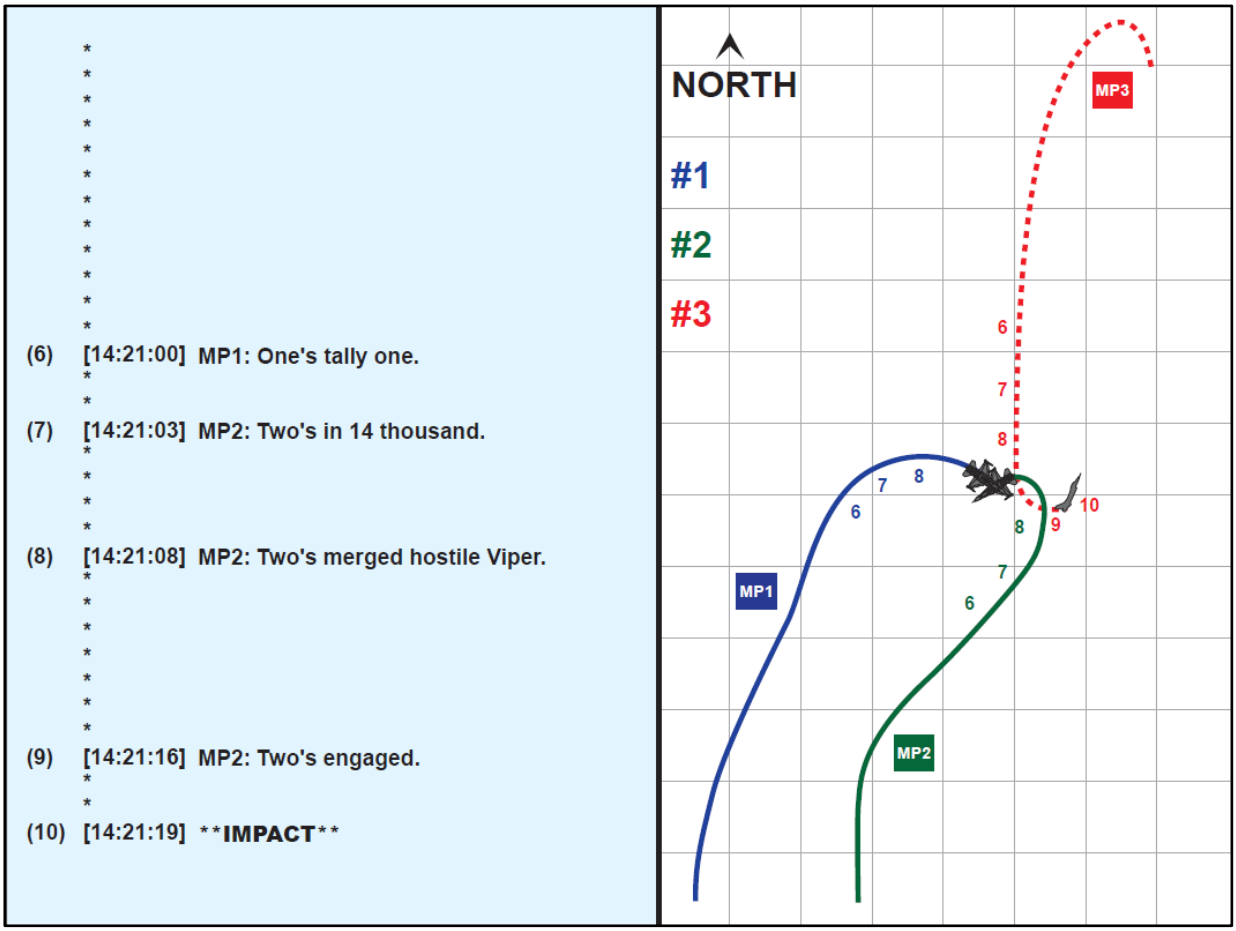
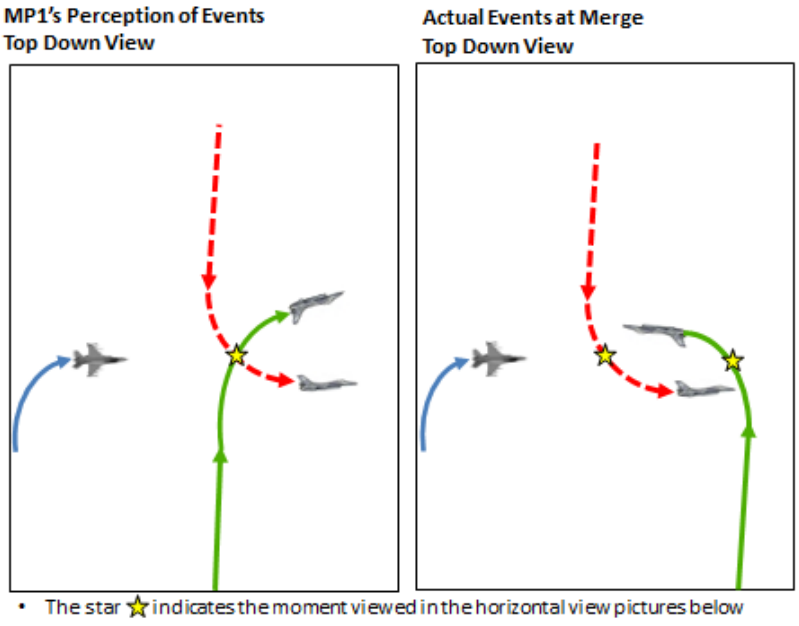
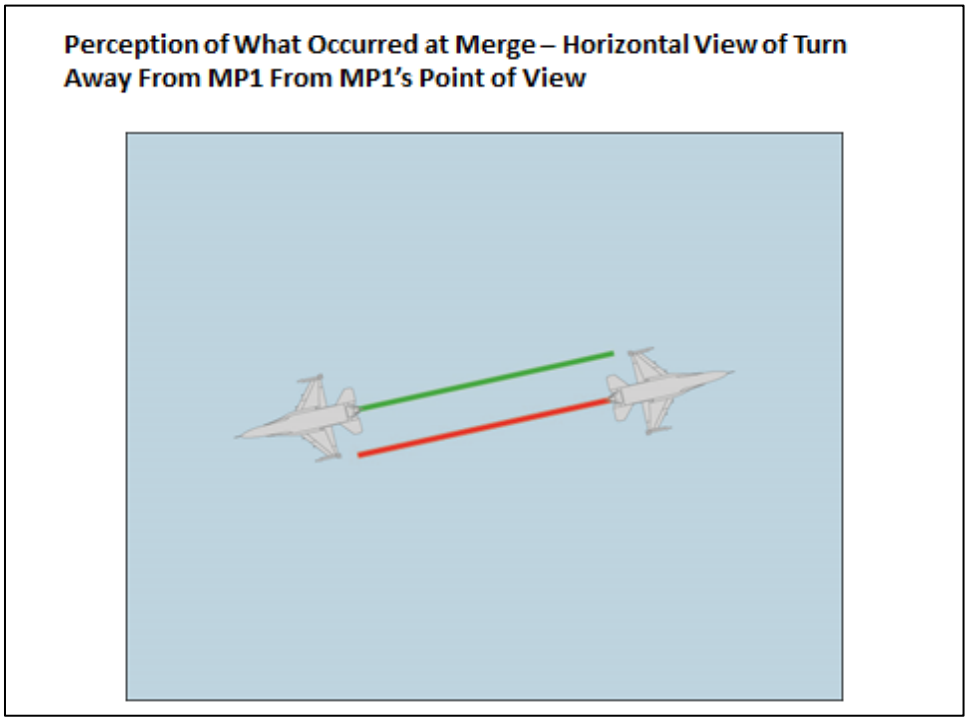


Figure 3: Merge View from MP1



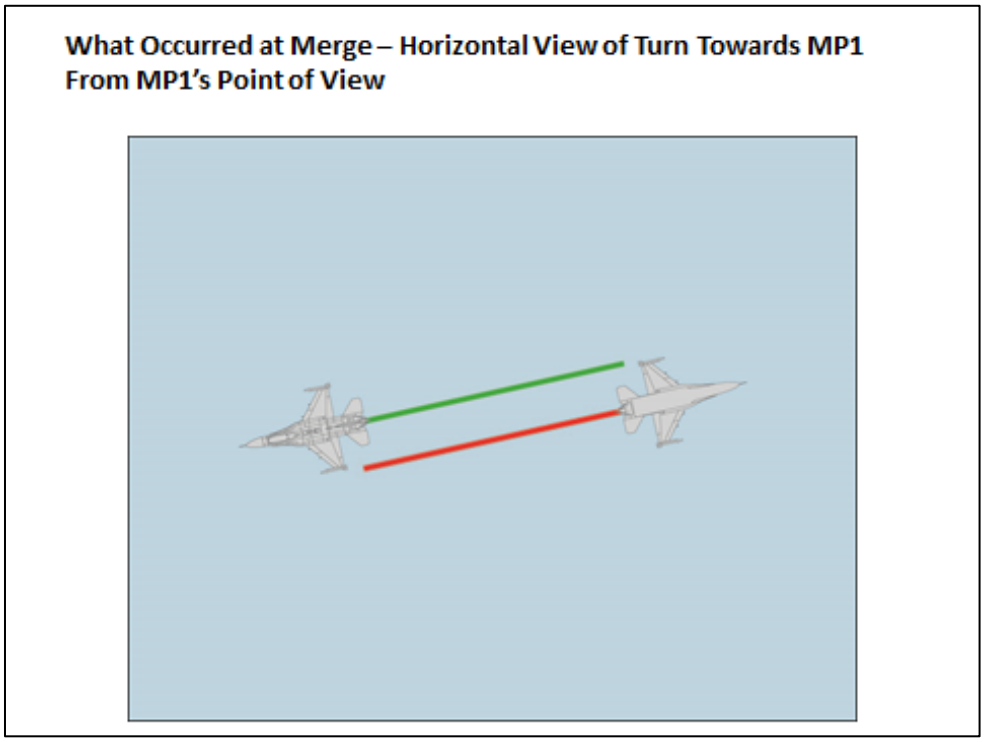
(Tabs V-2.1 and V-2.2)

Figure 4: Horizontal View of MP1



(Tabs V-2.1 and V-2.2)

Figure 5: Horizontal View of MP1 #2



(Tabs V-2.1 and V-2.2)

MP2 did not call "blind" during the engagement and focused exclusively on MP3 following his "2'S IN 14 THOUSAND" call (Tabs BB-8, N-4, V-3.24). MP2 never saw MP1 prior to the collision and described the impact as passing through jet wash (Tab V-3.5). After impact, MP3 initiated a "knock-it-off" call several times to end the fight (Tabs N-4 and N-5). While recovering his aircraft, MP2 saw MP1's aircraft trailing white smoke and appeared as though it was skidding across the ground with a high angle of attack (Tab DD-9, V-3.5). At 14:21:32, MP2 realizing MA1 had departed controlled flight, called "BAILOUT, BAILOUT, BAILOUT" in an effort to convince or direct MP1 to eject from the aircraft (Tab N-5).

MP2's right wingtip missile and five feet of his right wing sliced through MP1's right wing root, destroyed the flaperon, severed the fuel manifold and shattered the entire right horizontal tail (Tab J-6). MP1's aircraft was uncontrollable (Tab V-1.6). He described the scene in the cockpit as violent and was unsure if the aircraft was out of control (Tab V-1.6). His vision, memory, and senses were foggy after impact (Tabs V-1.6 and V-2.11). MP1 was unsure whether the fog was due to smoke in the cockpit or his reaction to the violent event (Tabs V-1.6 and V-2.11). MP1 received warnings from most of his systems (Tab V-1.6). He could barely see the bright warning lights on the glare shield and his vision outside the cockpit was only of light or dark fog in relation to being pointed at the sky or at the ground (Tab V-1.6). MP1 described the fall of the aircraft as a leaf falling from a tree (Tab V-1.6). MP1 attempted to add control inputs with no reaction and could not perceive whether he was getting any thrust from his engine (Tab V-1.6). MP1 estimated the collision occurred at 12,000 – 14,000 feet, but he was unsure of his altitude and could not decipher if he was climbing or descending (Tab V-1.6). He heard the radio call from MP2 to bailout of the aircraft, and with no real understanding of where he was in space, pulled the ejection handle (Tab V-1.6). MP1 stated that MP2's bailout call is what convinced him it was time to abandon the aircraft (Tab V-1.13). The initial part of the ejection was uneventful; however, the man-seat separation sequence did not occur in the expected timeframe (Tab V-1.7). MP1 had to pull the manual man-seat separation handle to deploy the recovery parachute (Tab V-1.7). After this action, MP1 landed safely on the ground (Tabs N-14 and V-1.7).

MP2's right wing was severed outside of Station 7, about five feet from the end of the wing (Tab J-6). He joined with another F-16C, call sign Loco 3, another aircraft that was not part of the MF (Tabs N-7 and V-3.37). They performed a controllability check over an unpopulated area before making the decision to return to Tulsa ANGB (Tabs N-8, V- 3.38 through V-3.40 and V-5.3). It was determined during the controllability check that MA2 was controllable at approach and landing speeds, even though part of the right flaperon was missing (Tabs V-3.39 and V-5.3). MP2 landed safely without further incident out of a visual straight-in approach (Tab V- 5.3).

e. Impact

At 14:21:19, MP1 and MP2 collided approximately 15 NM from the north border of the Eureka MOA (Tabs N-4 and J-4). At impact, MP1's aircraft was heading between 128 to 139 degrees True, 5 to 60 degrees right wing down and between 1 to 12 degrees nose up, 395 knots calibrated air speed (KCAS), or approximately 472 knots true airspeed (KTAS) (Tabs J-22 and J-23). MP2's aircraft was heading approximately 222 degrees True, 78 degrees left wing down and 10 degrees nose down, 292 KCAS, or 369 KTAS (Tabs J-22 and J-23). The right wing of MP2's

aircraft outboard of station 7, impacted the right side of MP1's aircraft from the wing root to the horizontal tail on an axis of approximately 83 to 94 degrees right of the nose (Tabs J-22 and J-23). The aft portion of the AIM-120 on station 9 of MP2's aircraft between the missile wings and fins hit the right wing root of MP1's aircraft (Tabs J-22 and J-23). The Captive Training Missile (CATM)-9X on station 8 of MP2's aircraft remained intact except for the missile seeker (Tabs J-22 and J-23). There were two marks on the right side of the engine duct of MP1's aircraft that appeared to be from an aft fin from the CATM-9X on station 8 of MP2's aircraft (Tabs J-22 and J-23). The rest of the damage to MP1's aircraft, including the right horizontal tail, appears to be a result of the collision with the right wing of MP2's aircraft outboard of station 8 (Tabs J-22 and J-23).

MP2's station 8 missile rail and CATM-9X were relatively intact (Tabs J-22 and J-23). They had separated from each other and were found close together, approximately 215 degrees True at 0.6 NM from the mid-air collision point (Tab J-6). MP2's AIM-120 and station 9 missile rail were broken into numerous pieces and found in various areas of the main debris field (Tab J-3). There was a gray paint smear on the right side of MP2's vertical tail that was probably from pieces of its wing and/or flaperon that separated on collision (Tab J-3).

Figure 6: MA1's and MA2's Mishap Sortie Configuration

(Tab S-2)

MP1 and MP2's aircraft were similarly configured (Tab J-6). The numbers in Figure 6 correspond to the station numbers below:

Station 1: LAU-129 missile launcher and CATM-120
Station 2: 16S301 pylon LAU-129 missile launcher and AMD pod
Station 3: Weapons pylon and MAU-12
Station 4: Empty
Station 5: Centerline pylon and MAU-12
Station 6: Empty
Station 7: Weapons pylon and MAU-12
Station 8: 16S301 pylon LAU-129 missile launcher and CATM-9M
Station 9: LAU-129 missile launcher and CATM-120
(Tabs J-6 and S-2)

f. Egress and Aircrew Flight Equipment (AFE)

The ACES II Ejection seat operated normally from the time MP1 pulled the ejection handle until man-seat separation (Tab H-6).

Seat ejection is initiated by pulling the ejection handle (Tab BB-8). This action retracts the shoulder harness straps and locks the inertia reel (like car seatbelt does when you brake), fires the initiators for canopy jettison, and ignites two canopy removal rockets (Tab B-8). The canopy then leaves the aircraft, and fires two seat ejection initiators (Tab BB-8).

A rocket catapult propels the seat from the cockpit exposing the seat environmental sensor pitot tubes, which senses airspeed and altitude and activates the emergency oxygen (Tab BB-8). The recovery sequencer selects the correct ejection mode, ignites the stabilization package (STAPAC) rocket and the trajectory divergence rocket motor (TDRM), and (if in mode 2 or 3) initiates the drogue gun to fire a chute that slows down the seat for 1 second (Tab BB-8). MP1 ejected within Mode 1 parameters (Tabs BB-8 and J-11 through J-12).

Mode 1 operation is for ejection with speeds less than 250 +/- 25 knots equivalent air speed (KEAS) at sea level and for altitudes from ground level to 15,000 feet mean sea level (MSL) (Tab H-5). The difference between Modes 1, 2, and 3 is that in Mode 1 the seat drogue parachute does not deploy, thereby reducing time required for personnel parachute deployment and inflation (Tab H-5).

If the automatic pilot/seat separation and recovery parachute deployment system fails, pulling the EMERGENCY MANUAL CHUTE handle, deploys the recovery parachute assembly, releases the lap belt and inertia reel straps, and unlatches the seat pan lid (Tab BB-8).

Figure 6: Ejection Mode Envelopes (Tab H-5):

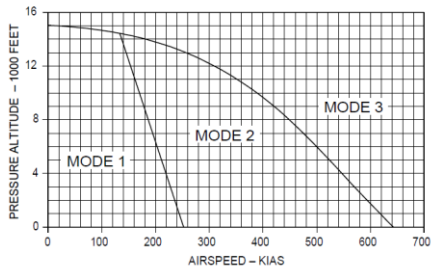
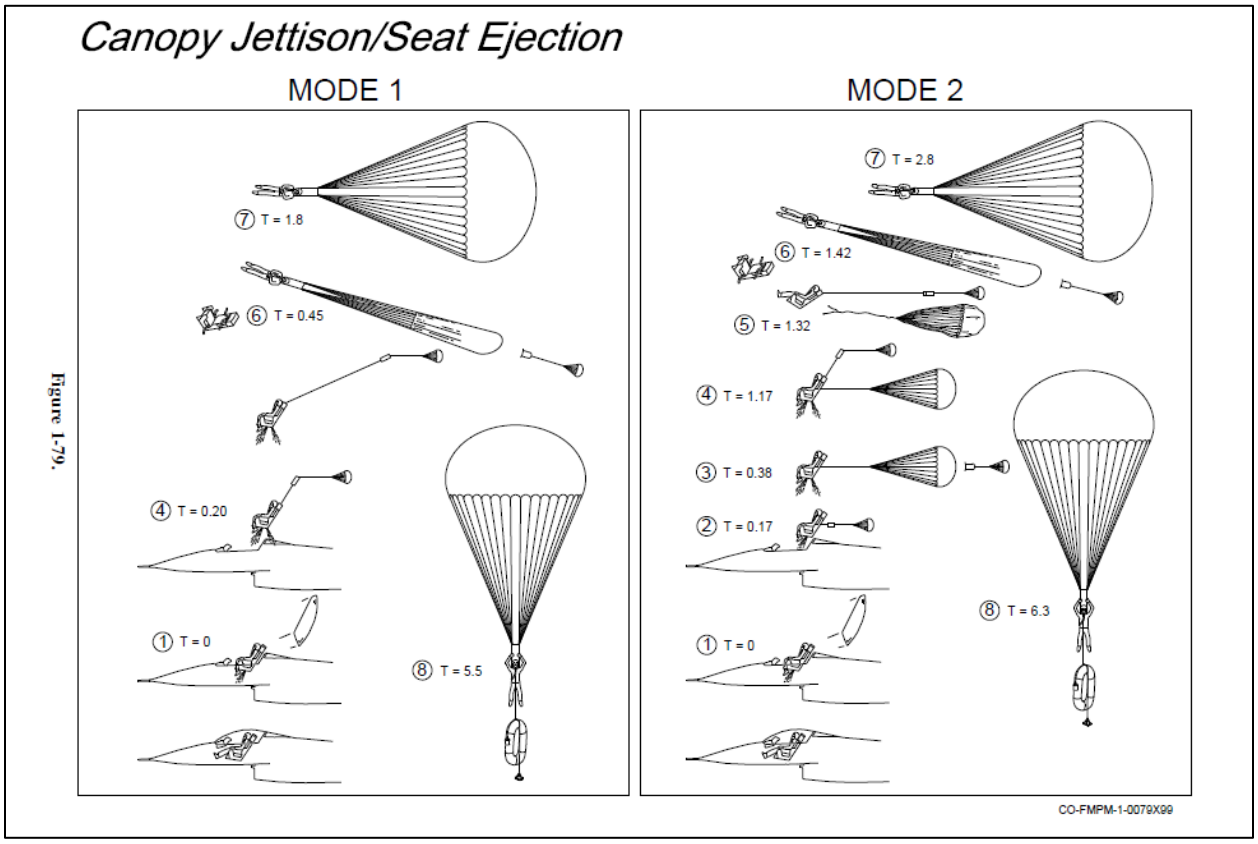


Figure 7: Mode 1 and Mode 2 Ejection Illustration



(Tab BB-10)

The ejection occurred between 19:21:48 and 19:22:00 (Tabs J-12 and N-5). This was the last recorded data from MA1 (Tab J-12). MP1 ejected within the Mode 1 envelope of the system and suffered minor injuries (Tabs H-14 and X-3). MP1 ejected at an approximate altitude of 7,500 feet above ground level (AGL) (Tab H-14). The ejection seat fell within twenty yards of the aircraft indicating little or no forward airspeed at the time of the ejection (Tab H-14). The digital recovery sequencer (DRS) accelerometer data also showed a "G" spike in the x, y and z axis, three to four seconds after the DRS start switch (Tab H-14). This spike likely represented the firing of the secondary mortar cartridge and man-seat separation. This occurred when the manual chute handle was pulled (Tab H-14).

Preliminary analysis of the DRS data indicates that the DRS sent firing voltage to the STAPAC, gyro spin up gas generator, and the TDRM (Tab H-14). The STAPAC and the TDRM fire regardless of the ejection mode (Tab H-14). The DRS did not send firing signals to the drogue gun cartridge, the drogue severance assembly (DSA), the primary parachute mortar cartridge, and the harness release cartridge (Tab H-14). In a Mode 1 ejection, the drogue gun cartridge would not normally fire; however, the DSAs, primary parachute mortar cartridge, and harness release cartridge should have fired (Tab H-14).

Preliminary analysis of the DRS shows differences in three different data points (Tab H-14). A lack of agreement between data resulted in no firing signals being sent to the DSAs, primary

parachute mortar cartridge, and harness cartridge (Tab H-14). This explains why man-seat separation did not occur, requiring MP1 to pull the manual chute handle (Tab H-14). After ejection, MP1 states he realized he was still in the seat for what appeared to be an unexpectedly long period, and then pulled the manual chute handle, which fired the harness release cartridge and primary parachute mortar cartridge allowing man-seat separation (Tab V-1.7).

MP1's and MP2's flight equipment records show that all inspections were current (Tabs T-3 through T-21 and T-23 through T-44).

g. Search and Rescue (SAR)

At 14:22:47, MP3 witnessed a good parachute from MP1 (Tab N-14). He took a mark point of MP1's estimated location and started to coordinate for the rescue operation (Tabs N-14 and V-4.6 through V-4.7). MP3 facilitated the rejoin of MP2 and Loco 3 (Tab N-6). Loco flight was a second flight that was airborne and en route to the airspace (Tab N-6). Loco 3 was the most experienced pilot in the formation and became the chase pilot (CP) by aiding in getting MP2 back to Tulsa ANGB safely (Tab N-6, V-5.2 through V-5.3). MP3 started to coordinate with Loco 1 and 2 to set up rescue operations (Tabs N-6 and V-4.7). MP3 called Kansas City Center, the air traffic control agency responsible for controlling Eureka MOA, and advised them of the situation (Tab V-4.5). After confirming the position of MP1 and the fuel state of MP3, Loco flight continued to MP3's location (Tab N-14).

MP1 landed in his parachute approximately a quarter mile southwest of where MA1 hit the ground (Tab V-1.7). MP3 first attempted contact with MP1 at 14:30:02 (Tab N-15). He got a response quickly thereafter at 14:30:08 from MP1 (Tab N-15). MP3 let MP1 know that he was overhead and checked on his condition (Tab N-15). MP1's first response was "Copy, where's Brave 2?" (Tab N-15). At 14:30:49, MP1 confirmed that MP3 saw the downed aircraft and asked if he saw the farmhouse near his position (Tab N-16). MP3 confirmed that MP1 was in good health while Loco 1 and 2 continued communication attempts (Tab N-17). At 14:34:47, MP1 made his way to the farmhouse and continued to lead his flight by telling MP3 to watch his fuel (Tab N-17). At 14:45:30, MP1 stated he was in the ambulance and attempting to call back to home station on a cell phone (Tab N-17). At 14:45:47, MP3, Loco 1 and 2, left the Eureka MOA and returned to Tulsa ANGB as a three-ship (Tab N-22).

MP1's crash site was located in southeastern Kansas, approximately three miles north of the town of Moline, approximately 76 NM, 335 degrees True of Tulsa ANGB, OK (Tab J-4). The crash site was grassy and relatively flat (Tab J-4). The aircraft hit the ground on a heading of approximately 060 degrees True with essentially no forward velocity as indicated by a witness mark under the pitot probe (Tab J-4).

FIGURE 8: MA1's Crash Site Photo

(Tab S-3)

Figure 9: MA1's Crash Site Photo #2

(Tab S-4)

Figure 10: MA1's Crash Site Photo #3

(Tab S-4)

SAR Timetable:
14:21:19 – Aircraft collision
14:22:47 – MP3 witnessed good parachute
14:30:02 – Emergency sirens heard on MP1 radio
14:45:30 – MP1 states they are leaving for McConnell AFB, KS
(Tabs N-4 through N-22 and V-1.7)

Elk County Emergency Medical Technicians and the Elk County Fire Department were the responding units and picked up MP1 in just under eight minutes from when MA1 hit the ground (Tabs V-1.7 and N-4 though N-22).

h. Recovery of Remains

Not Applicable.

5. MAINTENANCE

a. Forms Documentation

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-37). Integrated Maintenance Data System (IMDS) is a comprehensive database used to track maintenance actions, flight activity, and to schedule future maintenance (TAB BB-44).

Review of the active 781 forms and IMDS revealed no overdue inspections or open Time Compliance Technical Orders (TCTO's) that would ground MA1 or MA2 from flight operations (Tabs U-68, U-69, U-144, and U-145). Review of inactive AFTO 781 series forms and IMDS data for MA1 and MA2 covering a 60-day period prior to the mishap revealed maintenance documentation was properly accomplished under applicable maintenance directives (Tab U-3 through U-134).

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-45). The PR is valid for 72 hours (Tab BB-34). 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-46). Phase inspections are a thorough inspection of the entire aerospace vehicle (Tab BB-47).

The total airframe operating time of MA1 at takeoff of the mishap sortie was 5682.4 hours (Tab D-3). MA1 had flown 102.3 hours since the last phase inspection completed on 19 May 2014 at 5580.1 hours (Tab U-59). The last PR inspection occurred on 20 October 2014 at 0855, with no discrepancies noted (Tab D-3). A TH inspection was completed on 20 October 2014 at 1140 after the first sortie with no discrepancies noted (Tab D-3).

The total airframe operating time of MA2 at takeoff of the mishap sortie was 5570.8 hours (Tab D-7). MA2 had flown 378.4 hours since the last phase inspection was completed on 14 November 2011 at 5192.4 flight hours (Tab U-139). The last PR inspection occurred on 20 October 2014 at 0830 (Tab V-16.1). No discrepancies were noted (Tab D-7). A TH inspection was completed on 20 October 2014 at 1200 after the first sortie with no discrepancies noted (Tab D-7).

Engine data from IMDS, Joint Oil Analysis Program (JOAP), and Comprehensive Engine Management System was reviewed in detail for inspections, TCTO’s, and any other anomalies to ensure both MA1 and MA2 engines were serviceable. No discrepancies were noted (Tabs D5, D-9, U-9, U-71, U-72, U-80, U-147, U-148, U-167, and U-169).

c. Maintenance Procedures

Maintenance procedures are described in applicable AFTO, MAJCOM, ANG, and local procedures. Supervision and personnel are currently operating within guidelines of applicable AFTO's, Air Force and ANG Instructions, and local procedures (Tab U-3 through U-197).

d. Maintenance Personnel and Supervision

138th Maintenance Group personnel performed all required inspections, documentation, and servicing for MA1 and MA2 prior to flight (Tab U-3 through U-148). A detailed review of maintenance activities and documentation revealed minor documentation errors typical of any maintenance unit. Personnel involved with MA1's and MA2's preparation for flight had adequate training, experience, expertise, and supervision to perform their assigned tasks (Tab U-157 through U-179).

e. Fuel, Hydraulic, and Oil Inspection Analyses

Fuel samples were taken from the fuel trucks used to refuel MA1 and MA2 after the first sorties on 20 October 2014 and from MA2 after the mishap sortie (Tab U-150 through U-153). The Air Force petroleum lab at Wright-Patterson AFB, OH analyzed the samples and reported no volatile contamination (Tab U-150 through U-153). There were no viable MA1 post mishap fuel samples (Tab DD-11). Joint Oil Analysis Program (JOAP) samples were taken from: Oil servicing carts, MA1 and MA2 after the first sortie, and MA2 after the MF on 20 October 2014. (Tab U-166 through U-169) All samples were within acceptable levels (Tab U-166 to U-169). Hydraulic samples were taken from the servicing cart, hydraulic mules and MA2 after the mishap sortie (Tab U-156 through U-165). The Air Force petroleum lab at Wright-Patterson AFB analyzed the samples and reported no volatile contamination (Tab U-156 through U-165).

f. Unscheduled Maintenance

A review of unscheduled maintenance events for MA1 and MA2 for the previous 60 days and pilot reported discrepancies for the previous year were accomplished (Tab U-3 through U-148). MA2 had two unscheduled discrepancies in the active forms which affected aircraft status: (1) Air Launched Expendable (ALE)-47 would not dispense in bypass mode and (2) no tone with AIM 9X uncaged at 6 O'clock with a Fire Control Radar lock (Tab U-74 through U-84). MA2 Exceptional Release was signed off as a Conditional Release and deemed airworthy (Tab D-7).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

MA1 impacted the ground with essentially no forward velocity as evidenced by an impression of the pitot tube in the soft soil under the nose of the aircraft (Tab J-4). Due to the lack of forward velocity, wreckage scatter was limited (Tab J-4). A majority of the debris not at the crash site was recovered between 0.68 to 1.2 statute miles northwest of the ground impact site and 0.2 to

0.65 statute miles south of the mid-air collision point (Tab S3.1). Additional debris was found as far as four miles south of the mid-air collision point (Tab J-5). All debris was found on uninhabited farmland (Tab Z-15).

(1) MA1 Fuselage

The lower portion of the fuselage was crushed due to ground impact and the entire fuselage was further damaged due to post impact fire (Tab J-5).

(2) MA1 Wings

The wings were mostly intact with the exception of the right inboard wing root and flaperon, which had separated because of the collision (Tabs S-4, Tab J-4).

(3) MA1 Vertical Tail

Upon ground impact, the vertical tail separated at its base from the fuselage and was lying 15 feet to the right of the exhaust nozzle (Tab J-4).

(4) MA1 Horizontal Tail

The left horizontal tail was still intact and connected to the tail empennage (Tab S-4). The right horizontal tail, actuator, and nearby structure had separated due to the collision (Tab J-5). The control surface shattered during collision and scattered across the debris field (Tab J-5).

(5) MA1 Crash Survivable Flight Data Recorder (CSFDR)

The CSFDR separated from MA1 during the collision (Tab J-7). The AIB found the CSFDR utilizing a metal detector in the debris field approximately one mile northeast of the impact site leaning upside down against a wire fence pole under twelve inches of grass (Tabs Z-3 through Z-7). Noteworthy, there was a witness mark in the form of a shattered dead tree that exploded upon CSFDR impact and pointed to where the CSFDR lay (Tab Z-7). It fell along an axis that coincided with MA1's flight path at collision and the main debris field (Tabs Z-15 and Z-3 through Z-7). Although factual flight data was obtained from MA1's CSFDR, MA1's actual heading, pitch, and attitude could only be estimated because of differing time correlations between the CSFDR and SDR (Seat Data Recorder) readings. (Tabs J-22 and J-23)

(6) MA1 Engine Fuel Supply Manifold

Pieces of the engine fuel-supply manifold were recovered in the debris field approximately 1 mile northeast of the impact site (Tabs J-4 and Z-15).

(7) MA2 Aircraft Condition

MA2 was flown back to Tulsa ANGB with nearly five feet of the right wing missing (Tabs V-3.39 through V-3.40 and V-5.3). Many pieces of the missing wing material were recovered in the debris field near Moline Kansas (Tab S-16).

Figure 9: MA2 Post-Mishap

(Tab S-15)

(Tab Z-11)

(Tab Z-12)

(Tab S-12)

b. Evaluation and Analysis

Analysis conducted by Lockheed-Martin Aerospace utilized data from both MA1's and MA2's CSFDR, SDR, and reconstructed wreckage (Tab J-3 through J-18). The analysis revealed flight control surfaces, engine, electrical, and hydraulic systems were performing as expected until the mishap occurred (Tab J-4 through J-18).

MP1 confirmed by witness testimony that MA1 had no reportable maintenance issues prior to the mishap (Tab V-1.14). MP2 confirmed via witness testimony that MA2 had only one aircraft malfunction to report prior to the mishap (Tab V-3.9). The malfunction was the same as the morning sortie, regarding the AIM 9X, as previously noted (Tab V-3.10). Based on aircraft maintenance documentation and analysis, there is no evidence to suggest that aircraft maintenance contributed to this mishap (Tabs D-2 through D-10 and U-3 through U-179).

7. WEATHER

a. Forecast Weather

The 26th Operational Weather Squadron provided the forecasted weather for the MF (Tab F-3). Tulsa ANGB winds were from the south at 4 knots with greater than 6 statute miles visibility, clouds scattered at 5,000 feet AGL. There was no forecasted precipitation (Tab F-3).

b. Observed Weather

The observed weather at 1315 on the day of the mishap was winds out of the northeast at 5 knots, clear of clouds, altimeter 30.03 pounds per square inch, with visibility of 7 statute miles (Tab F-6). No icing or turbulence was observed (Tab F-6). Winds at altitude, in the airspace, were out of the North at 15 knots (Tab F-6). The weather post-mishap did not change (Tab F-6 through F-17).

c. Space Environment

Not Applicable.

d. Operations

No evidence was found to suggest that either of the MAs were operating outside its prescribed operational limitations with respect to weather.

8. CREW QUALIFICATIONS

a. Mishap Pilots

MP1 was a current and qualified Instructor Pilot and Evaluator Pilot in the F-16 (Tab G-2). He had a total of 2,628.5 hours with 2,407.7 hours in the F-16 (Tab G-2).

His recent flight time was as follows on the day of the mishap:

	Hours	Sorties
Last 30 Days	11.7	8
Last 60 Days	14.1	10
Last 90 Days	27.8	16

(Tabs G-3 and G-9)

MP2 was an Initially Qualified Pilot in the F-16 (Tab G-10). He was working on Mission Qualification Upgrade Training at the time of the mishap (Tab V-1.3). He had a total of 287.2 hours with 106.2 hours in the F-16 (Tab G-10).

His recent flight time was as follows on the day of the mishap:

	Hours	Sorties
Last 30 Days	10.6	11
Last 60 Days	10.6	11
Last 90 Days	10.6	11

(Tab G-16)

There is no evidence to suggest crew qualifications were a factor in this mishap.

9. MEDICAL

a. Qualifications

(1) Mishap Pilot (MP1)

MP1 was medically qualified for flying duties at the time of the mishap (Tab X-3). MP1's most recent annual military Periodic Health Assessment (PHA) was performed on 5 June 2014 (Tab X-3). MP1's annual dental examination was performed on 5 June 2014 (Tab X-3). His medical records contained a current Air Force Form 1042, Medical Recommendation for Flying or Special Operational Duty, dated 5 June 2014 (Tab X-3). MP1 did not have a medical waiver at the time of the mishap (Tab X-3).

MP1's records and verbal testimony reflected he was in good health and had no recent performance-limiting illnesses prior to this mishap (Tabs X-3 and V-1.15). No evidence suggests that physical or medical qualifications of MP1 were factors in this mishap.

(2) Mishap Pilot (MP2)

MP2 was medically qualified for flying duties at the time of the mishap (Tab X-3). MP2's most recent annual military PHA was performed on 3 May 2014 (Tab X-3). MP2's annual dental examination was performed on 21 June 2013 (Tab X-3). His medical records contained a current Air Force Form 1042, Medical Recommendation for Flying or Special Operational Duty, dated 15 September 2014 (Tab X-3). MP2 had an indefinite waiver for myopia (nearsightedness) and corneal refractive surgery at the time of the mishap (Tab X-3).

MP2's records and verbal testimony reflected he was in good health and had no recent performance-limiting illnesses prior to this mishap (Tabs X-3 and V-3.27). No evidence suggests that physical or medical qualifications of MP2 were factors in this mishap.

(3) Mishap Pilot 3 (MP3)

MP3 was a member of the MF, but not involved in the collision (Tab J-4). MP3 was medically qualified for flying duties at the time of the mishap (Tab X-4). No evidence suggests that physical or medical qualifications of MP3 were factors in this mishap (Tab X-4).

b. Health

(1) MP1

MP1 successfully ejected from his aircraft (Tab J-4). Local emergency responders recovered MP1 after he walked to a nearby house to call for help (Tab V-1.7). MP1 was taken to the nearest military treatment facility where he was evaluated in the Flight Medicine department (Tab X-3). Medical history and exams were completed, blood and urine specimens were obtained, and it was determined he required a higher level of care, to include X-rays (Tab X-3). Because he complained of neck pain, he was sent to a nearby local emergency room in a cervical spine splint, to conduct a post-mishap physical examination (Tab X-3). During an evaluation by the emergency room physician, MP1 complained of mild injuries during his ejection and parachute landing fall (Tab X-3). These included left ankle pain and neck and upper back discomfort (Tab X-3). X-rays of the ankle, neck and mid-back, and computerized tomography (CT) scans of the cervical and mid-back noted no dislocations or fractures except some straightening of the cervical spine indicating a neck sprain (Tab X-3).

(2) MP2

MP2 was evaluated by a flight surgeon at the Flight Medicine clinic at a nearby military treatment facility (Tab X-3). MP2 had no physical complaints and his exam was unremarkable (Tab X-3). Blood and urine samples were drawn for analysis (Tab X-3).

(3) MP3

MP3 had an otherwise uneventful flight and landed safely without physical complaints or apparent injury (Tabs X-3 and J-4). The AIB was unable to find any records documenting medical care or interaction after the mishap involving MP3.

c. Toxicology

Immediately following the mishap and in accordance with safety investigation protocols, blood and urine samples were collected and submitted to the Armed Forces Medical Examiner System at Dover Air Force Base, Delaware for toxicological analysis (Tab X-3). Blood samples for both MP1 and MP2 tested within normal limits for carbon monoxide levels and negative for ethanol (Tab X-3). Blood and urine testing for all maintainers was negative for carbon monoxide and ethanol (Tab X-3). Urine drug screen testing for MP1, MP2, and all but one maintainer was negative for amphetamine, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates, and phencyclidine by immunoassay or chromatography (Tab X-3). One maintainer tested positive for oxycodone in his urine (Tab X-4). This positive testing is not believed to be significant, contributory, or noteworthy to the aircraft mishap (Tab X-6). Toxicology was not performed on MP3 (Tab X-4).

d. Lifestyle

72-hour and 14-day histories, medical charts, and interviews with MP1 and MP2, and interviews with all three mishap pilots, revealed no lifestyle factors relevant to the mishap (Tabs X-3, V-1.14, V-1.15, V-3.27). Review of the medical charts of the maintainers revealed no lifestyle factors relevant to the mishap (Tabs X-3 and X-4).

e. Crew Rest and Crew Duty Time

Air Force Instruction (AFI) 11-202, Volume 3, *General Flight Rules*, dated 22 October 2010, *ACC Supplement*, dated 28 November 2012, prescribes mandatory crew rest and maximum Flight Duty Periods (FDP) for all personnel who operate USAF aircraft. Based on the information provided, crew rest was adequate and in accordance with published guidance. (Tabs X-3, V-1.15 and V-3.27).

10. OPERATIONS AND SUPERVISION

a. Operations

The 138th Operations Group Commander (OG/CC) and the 125th Fighter Squadron Director of Operations (FS/DO) stated the operations tempo has been very high over the last several years (Tabs V-7.6 and V-8.5). The Wing deployed to Iraq in 2011 for OPERATION NEW DAWN, and subsequently trained for and deployed to Afghanistan for OPERATION ENDURING FREEDOM returning November 2013 (Tab V-6.5). The training for the 2013 deployment involved a Red Flag Exercise, a Tucson Deployment, and a local Operational Readiness Exercise (ORE) (Tab V-7.6). Neither combat deployment exceeded 90 days in length (Tab V-8.6). Other factors were identified as causing increased tempo, such as runway construction, sunshade and ramp construction, sequestration and the prohibition to fly pilots other than those that support the alert detachment at Ellington Field, TX, and alert detachment scheduling. (Tabs V-7.6 through V-7.7 and V-8.6).

MP1 is a highly experienced instructor and evaluator pilot (Tab G-2). He has been assigned to the base for approximately twenty years and flying with the unit since 2001 (Tab V-1.2). He has been an evaluator pilot for over two years and an instructor pilot for approximately five years (Tabs G-2, and V-1.8).

MP2 is a relatively inexperienced wingman (Tab G-10). He arrived at Tulsa ANGB for MQT in August 2014 and started flying with the squadron in September 2014 (Tabs G-10 and V-3.3).

There is no evidence to suggest that operations tempo was a factor in the mishap.

b. Supervision

The 125th FS holds an Instructor Pilot (IP) meeting every drill weekend and Training Review Board (TRB) quarterly to discuss all training related programs and the squadron's progression (Tabs V-6.4, and V-7.4). The instructor pilots discuss any student in an upgrade as to progression through the upgrade and any issues or weak areas; new arrivals at Tulsa to begin

MQT with the squadron are also discussed (Tabs V-6.4 and V-7.4). They note upgrade pilot training progress and their strengths and weaknesses (Tab V-6.4). Supervision notes the replacement training unit (RTU) pilot's return date and ensures that they enter into MQT and begin upgrade in a timely manner (Tab V-8.5). Finally, during quarterly TRBs, supervision and IP pilots review and nominate pilots for upgrade training programs not associated with the MQT syllabus (Tabs V-6.4 and V-7.4).

The 125th FS utilizes a phased base approach for all continuation (day-to-day) training and upgrade training alike. (Tabs V-6.5 and V-7.4) Phased base training allows pilots to gain continuity and proficiency in a given mission set before moving to a different phase of training. (Tab V-6.5). Moreover, utilizing this approach eases the maintenance tempo greatly by allowing standard aircraft configurations necessary for the phase vice constantly changing configurations due to scheduling constraints (Tabs V-6.5 and V-7.4 through V-7.5). This allows more suitably configured aircraft to be available to meet the schedule (Tab V-6.5 and V-7.5).

The strength of this phased training approach resulted in upgrading students and Combat Mission Ready (CMR) pilots alike, being more proficient in either air-to-air or air-to-ground missions prior to moving to a different phase, rather than hopping back and forth between phases reducing continuity (Tab V-8.5). According to leadership from the mishap unit, limitations from the phased based training approach are phase continuity and the fact that it takes longer to produce a CMR pilot in a MQT program due to the time between phases (Tabs V-6.5, V-7.5). All pilots interviewed agreed that the advantages of phased base training outweighed the limitations. (Tabs V-1.26, V-6.5, V-7.5, V-8.5, V-9.6, V-10.4). All pilots interviewed agreed that supervision supports the pilots in areas such as leave, time for fitness, staffing and resources, informational support (intelligence, weather, safety, etc.), advancement, and training (Tabs V-1.25, V-3.28, V-6.7, V-7.11, V-8.11).

There is no evidence to suggest supervision or lack of supervision was a factor in the mishap.

11. HUMAN FACTORS

a. Introduction

AFI 91-204, *Safety Investigations and Reports,* 24 September 2008, Attachment 5, contains the Department of Defense (DoD) Human Factors Analysis and Classification System which lists potential human factors that can play a role in aircraft mishaps (Tab BB-30). A human factor is any environmental, technological, physiological, psychological, psychosocial, or psycho-behavioral factor a human being experiences that contributes to or influences task performance (Tab BB-30). DoD has created this framework to analyze and classify human factors and human error in mishap investigations (Tab BB-30). The framework consists of four main categories: Acts, Preconditions, Supervision, and Organizational Influences (Tab BB-30). Each category is subdivided into related human factors (Tab BB-30). This framework allows for a complete analysis of all levels of human error, including their interaction, to determine their contribution to the mishap (Tab BB-30).

b. Applicable Factors

(1) AE202 Task Misprioritization

Task Misprioritization is a factor when the individual does not organize, based on accepted prioritization techniques, the tasks needed to manage the immediate situation. (Tab BB-32)

The following events represent misprioritization errors made during the engagement.

MP2 was the SF during the entire mishap engagement (Tab V-3.23). The SF's highest priorities are maintaining visual and flight path de-confliction (Tab BB-16). MP2 was not de-conflicting from MP1 (Tab V-3.29). From shortly before the merge until collision, MP2 focused exclusively on MP3 and did not maintain visual on MP1 (Tab V-3.24). MP2 mistakenly assumed that he was de-conflicted from MP1 (Tab V-3.19).

MP2 made his "ENGAGED" call too late (Tab BB-20). MP2 realized that he was targeted by MP3 and was more defensive than MP1 at the merge, which is the latest point he should have called "ENGAGED" (Tab BB-20). MP2 called "ENGAGED" 8 seconds after the merge (Tab N-4). This is a key mistake for if he would have obtained the engaged fighter role he would have been relieved of his primary responsibilities of flight path de-confliction and maintaining the visual and able to give his full attention to fighting his best BFM (Tabs BB-17 and BB-20).

Conversely, MP1 realized that MP2 was more defensive and testified that he should have exercised his option to call "2 PRESS" and initiate the change to make MP2 the engaged fighter (Tab V-2.9, Tab BB-20). MP1's failure to initiate this role exchange also represents a task misprioritization because the most defensive fighter should have priority over the flight lead to be the EF (Tab BB-20).

(2) PC 103 Cognitive Task Oversaturation

Cognitive Task Oversaturation is a factor when the quantity of information an individual must process exceeds their cognitive or mental resources in the amount of time available to process the information (Tab BB-34).

MP2 showed signs of task oversaturation during the engagement (Tab N-4). During the second engagement, he was behind normal pacing due to a reduced range of separation from the adversary (Tabs V-4.4, N-3 and J-6). In a short period of time, MP2 was required to: 1) Turn to bracket the adversary, 2) defend against an attack from MP3, 3) maintain visual of MP1, 4) acquire TALLY of MP3 with the aid of HMCS, 5) set up for the merge, 6) make radio calls, 7) perform Anti-G Straining Maneuver, 8) keep sight of MP3 during hard turn, 9) fight his best 1 v 1 BFM, and 10) kill MP3 (Tab V-1.11, Tab N-4). Based on MP2's relative inexperience, he may have been overwhelmed by having to make a number of nearly simultaneous decisions.

(3) PC 102 Channelized Attention

Channelized attention is a factor when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others of a subjectively equal or higher

or more immediate priority, leading to an unsafe situation (Tab BB-34). Channelized attention may be described as a tight focus of attention that leads to the exclusion of comprehensive situational information (Tab BB-34).

The following event represents a channelized attention error made during the engagement.

From a point shortly before the merge until impact, MP2 channelized his attention on killing MP3 (Tab V-3.24). He fully understood there had been no role exchange and he was still the SF (Tab V-3.24). MP2 failed to maintain visual and flight path de-confliction with MP1 due to his exclusive focus on MP3 (Tab V-3.24).

(4) PP106 Communicating Critical Information

Communicating critical information is a factor when known critical information was not provided to appropriate individuals in an accurate or timely manner (Tab BB-38).

The following errors in Communicating Critical Information occurred during the engagement:

MP2 made an "engaged" call that MP1 did not hear (Tabs N-4, V-1.10 and V-2.9). Additionally, this call was not made in a timely manner, and as a result, MP1 did not have time to respond even if he did hear it (Tab N-4, Tab BB-20).

MP2 never called "blind" when he lost visual of MP1 (Tab N-4, Tab V-3.24). MP2 had visual on MP1 until shortly before he merged with MP3 (Tab V-3.24). MP2 never had visual on MP1 again until after the collision and never made a "blind" call that would be typically expected within approximately two seconds of losing visual on the engaged fighter (Tab V-3.17).

(5) PC504 Misperception of Operational Conditions

Misperception of Operational Conditions is a factor 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 and this leads to an unsafe situation. (Tab BB-40).

MP1 continued as the EF when MP2 merged with MP3 and continued to pursue MP3 during MP2's left turn (Tab V-1.6). MP1 believed that MP2 turned right at the merge (Tab V-1.6). MP2 turning right at the merge would have de-conflicted MP1 and MP2's flight path to allow MP1 to engage MP3. The misperceived turn resulted in MP2 belly-up, blind, and quickly on a collision course without MP1s awareness.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

(1) AFI 51-503, *Aerospace Accident Investigation*, 26 May 2010
(2) AFI 91-204, *Safety Investigations and Reports*, Attachment 5, 24 September 2008
(3) AFI 11-202, Volume 3, *General Flight Rules*, 22 October 2010,

(4) AFI 11-202, Volume 3, *General Flight Rules,* ACC Supplement, 28 November 2012
(5) AFI 21-103, *Equipment Inventory, Status, and Utilization Reporting System/F16A/B/C/D Minimum Essential Subsystem List (MESL)*, Addenda-U, 23 December 2005
(6) AFI 21-201, *Aircraft and Equipment Maintenance Management*, ANG Supplement, 19 May 2014
(7) AFI 48-123, *Medical Examinations and Standards*, 5 November 2013

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) T.O. 1F-16CM, *Flight Crew Checklist*, 1 May 2014
(2) AFTTP 3.3-F-16, *Combat Aircraft Fundamentals*, 29 June 2012
(3) AFTTP 3.3-F-16, *Combat Aircraft Fundamentals*, 5 September 2014
(4) T.O. 1F-16CG-2-31GS-00-1, *Crash Survivable Flight Data Recorder System*, 1 July 2014
(5) T.O. 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policy & Procedures*, ANG Supplement 1, 30 October 2013
(6) T.O. 1F-16CG-6-4, *Scheduled Inspection and Maintenance Requirement*, 1 September 2014
(7) T.O. 1F-16-2697, *Installation of M6.2+ Operational Flight Program USAF F-16 C/D Block 40/42/50/52 Aircraft*, 31 July 2014
(8) T.O 1F-16C-34-1-1, *Avionics and Nonnuclear Munitions Delivery F-16C/D Blocks 40, 42, 50, 52 Aircraft*, 1 June 2014
(9) T.O. 42B-1-1, *Quality Control of Fuel Lubricants*, 15 July 2011

c. Known or Suspected Deviations from Directives or Publications

Not applicable.

13. ADDITIONAL AREAS OF CONCERN

Not applicable.

9 JANUARY 2015

CHRISTOPHER R. ALDERDICE, COL, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

F-16C, T/N 89-2019, AND F-16C, T/N 89-2034
MOLINE, KS
20 OCTOBER 2014

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 20 October 2014, the mishap flight (MF) of three, call sign Brave 1, mishap pilot 1 (MP1) and Brave 2, mishap pilot 2 (MP2) performed an Air Combat Maneuver (ACM) Mission Qualification Training (MQT) mission with Brave 3, mishap pilot 3 (MP3) as the adversary. MP1 was an instructor pilot with over 2,400 hours of flight time in the F-16. MP2 was a student pilot with 106 flying hours in the F-16. The MF take off time was 1403 (all times local) and the mission was flown in Eureka Military Operating Area (MOA) located in Kansas, approximately 83 NM northwest of Tulsa, OK. During the second ACM engagement, MP1 flying mishap aircraft 1 (MA1), an F-16C, tail number 89-2019 collided with MP2 flying mishap aircraft 2 (MA2), an F-16C, tail number 89-2034.

The briefed ACM plan was for MP1 and MP2 to patrol the Eureka MOA while MP3 would approach from an unknown direction to simulate an attack. MP1 and MP2 would respond and fill the role of either an engaged fighter (EF) whose primary responsibility is to kill the adversary, or supporting fighter (SF) whose primary responsibilities are to maintain visual and ensure flight path de-confliction. The first engagement finished without incident with an early shot of opportunity missile kill from MP1 the SF, after a role exchange with MP2, on MP3.

For the second engagement, MP3 approached from the north, separated by 20 NM. By default, MP1 was the EF and MP2 was the SF. MP1 and MP2 were headed north with MP1 left of MP2. MP3 targeted MP2. MP1 then directed MP2 to bracket right, but did not initiate an exchange of EF and SF roles. At 14:21:03 MP2 saw MP1 for the last time before impact, 16 seconds later. At 14:21:08 MP2 stated he had merged with MP3. MP2 then turned hard left, in an attempt to get behind MP3. MP1 saw MP2 turn but misperceived it as a right turn, away from him, and accordingly focused on simulating a kill on MP3. At 14:21:16, MP2 made a request to exchange roles, and MP1 soon saw MA2's belly on a rapid collision course. MP1 and MP2 collided at 14:21:19. The impact resulted in sheering MA1's right wing flaperon and horizontal tail, causing MA1 to become uncontrollable. Eleven seconds later MP1 successfully ejected from MA1 with minor injuries, walked to a farmhouse, and local emergency response drove him to a military treatment facility. MA1 hit the ground in a field near Moline, KS and was destroyed. Five feet of the right wing outboard of weapons station 7 was severed from MA2, but responded to MP2's control inputs. MP2 performed a controllability check at calculated approach/landing

speed and landed uneventfully at Tulsa Air National Guard Base (ANGB), OK. The aircraft were assigned to the 125th Fighter Squadron, 138th Fighter Wing, at Tulsa ANGB, Oklahoma. The replacement cost of MA1, and the estimated repair cost of MA2, is $22,440,842. There was no significant damage to private property.

I find by clear and convincing evidence that the cause of the mishap was MP2's disregard of his primary responsibilities as the SF, which were maintaining the visual and flight path de-confliction with MP1.

Further, I find by a preponderance of evidence that each of the following factors substantially contributed to the mishap: (1) MP2 did not call "blind" during the mishap sequence. (2) MP1 misperceived MP2's turn direction at the merge, and (3) MP1 did not initiate a role exchange after MP2 became the most defensive fighter.

I developed my opinion by analyzing factual data from historical records, Air Force directives and guidance, flight data and engineering analysis, animated simulations, information provided by technical experts, and witness testimony.

2. CAUSE

The cause of the mishap, supported by clear and convincing evidence, was MP2, as the supporting fighter, disregarded his primary responsibilities, which were to maintain the visual and ensure flight path de-confliction with MP1.

During the mishap engagement, a formal exchange of EF and SF roles did not occur. De-confliction communications within the ACM environment should use a "challenge and response" format to avoid conflicts and ensure comprehension. MP2 did not request a role swap until three seconds prior to impact with MP1 and should have continued the SF primary responsibilities. However, MP2 merged with MP3, called "2's MERGED HOSTILE VIPER", and maneuvered in a left 7.5 G turn fighting his best 1 vs 1 Basic Fighting Maneuvers (BFM) against MP3. By turning left, MP2 went belly-up to MP1 and was unable to see, and had no situational awareness (SA) of MP1. MP2 then initiated a formal role exchange and called "2's ENGAGED." This occurred three seconds prior to impact and was requested too late to receive confirmation of the role change.

MP2 misprioritized (human factor) his responsibilities from just prior to the merge until impact and showed signs of task oversaturation (human factor). MP2 was inundated by having to make a number of nearly simultaneous decisions in a compressed amount of time. Finally, MP2 exhibited channelized attention (human factor) by focusing solely on performing his best BFM against MP3, missing vital SA cues that he did not have flight path de-confliction with MP1. Had MP2 accomplished the primary responsibilities of the SF, he would have continued to watch MP1 throughout the engagement, rather than assuming de-confliction without looking for 16 seconds. This would have prevented the mishap.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

a. MP2 did not call blind during the mishap sequence.

The F-16 ACM primary reference document AFTTP 3-3.F-16 states the SF is assumed to be visual (sees the EF) unless communicated otherwise. The required call when not visual is "blind" with current altitude in a briefed visual formation. One of the SF's primary responsibilities is to maintain the visual. Maintaining visual in a visual formation is extremely important so the element lead does not have to spend time away from the tactical situation getting the element back together. Blind calls are common and required to ensure flight path de-confliction. During the mishap engagement, MP2 failed to maintain visual on MP1, from shortly before the merge until impact without a required blind call, a period of 16 seconds. Had MP2 called "blind," MP1 would have been made aware that MP2 could not see him, and would have therefore focused more attention on MP2, making the mishap far less likely. Therefore, by the preponderance of the evidence, MP2 not calling "blind" during the mishap sequence substantially contributed to the mishap. The human factors of misprioritization, task oversaturation, channelized attention, and communicating critical information and their applications all played a role in this contributing factor.

b. MP1 misperceived MP2's turn direction at the merge.

MP1 misperceived that MP2 turned away from him in a right turn to the east, creating a one-circle fight with MP3 vice the two-circle fight that resulted from MP2 turning towards him in a westward left turn. Viewing an F-16 1.5-2 NM distant, rotating either towards or away and similar in color top and bottom can easily be misperceived. Due to his misperception of MP2's turn direction and as the EF, MP1 continued to point at the merge and locked up MP3 with his radar without continuing to crosscheck MP2's position. MP1 assessed his range and clear avenue of fire and employed his first weapon at the adversary. He then assessed range, a clear avenue of fire again, and took a second missile shot before looking for MP2. Approximately eight seconds elapsed. After completing the second missile shot, MP1 observed MP2 in a left descending turn, belly up to MP1 with no line of sight rate, on a collision course, and closing rapidly. Had MP1 accurately perceived MP2's left turn, he likely would have focused more attention on MP2, rather than focusing exclusively on MP3 for the eight second period, making the mishap far less likely. Therefore, by the preponderance of the evidence, MP1's misperception of MP2's turn direction at the merge substantially contributed to the mishap. The human factor misperception of operational conditions and its application played a part in this contributing factor.

c. MP1 did not initiate a role exchange after MP2 became the most defensive fighter in accordance with published guidance.

The hierarchy to determine which fighter should be relieved of de-confliction responsibilities is as follows, in descending order of priority:

(1) The most defensive fighter, to whom the adversary appears to be maneuvering
(2) The most offensive fighter, who is in the best position relative to the adversary
(3) The fighter with the highest situational awareness
(4) The flight lead (default state until altered)

Although as flight lead he clearly was the engaged fighter, MP1 understood this hierarchy well, believed MP2 to be the most defensive fighter, and should have initiated a role exchange by calling "2 Press" no later than MP2's and MP3's merge. MP1's failure to initiate this role exchange was a contributing factor to the mishap. Had the role exchange occurred, MP1 would have become the SF, making MP2's conduct entirely proper and giving MP1 the responsibility of de-confliction. This would have made the mishap far less likely. Therefore, by the preponderance of the evidence, MP1 not initiating a role exchange, after MP2 became the most defensive fighter in accordance with published guidance substantially contributed to the mishap.

4. CONCLUSION

I find by clear and convincing evidence that the cause of the mishap was MP2, as the supporting fighter, disregarded his primary responsibilities, which were maintaining the visual and flight path de-confliction with MP1. Further, I find by a preponderance of evidence that each of the following factors substantially contributed to the mishap: (1) MP2 did not call blind during the mishap sequence, (2) MP1 misperceived MP2's turn direction at the merge, (3) MP1 did not initiate a role exchange after MP2 became the most defensive fighter.

9 JANUARY 2015

CHRISTOPHER R. ALDERDICE, Col, USAF
President, Accident Investigation Board

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