EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION

F-16CM, T/N 91-0364 & F-16CM, T/N 91-0365
26NM EAST OF CHARLESTON AFB, SC
15 OCTOBER 2009

On 15 October 2009 at 2024:09 local time, two F-16CM aircraft, tail numbers 91-0364 and 91-0365, assigned to the 77th Fighter Squadron, 20th Fighter Wing, Shaw Air Force Base (AFB) South Carolina collided over the Atlantic Ocean in Warning Area 161 approximately 126 nautical miles southeast of Shaw AFB. The mishap pilot (MP2) in aircraft 91-0365 died upon collision and did not attempt to eject. Aircraft 91-0365 impacted the water and was destroyed. There was no damage to private property. The other mishap pilot (MP1), in aircraft 91-0364, was uninjured. Aircraft 91-0364 had moderate damage to flight control surfaces and external stores. MP1 landed safely at Charleston AFB, South Carolina.

The purpose of the mishap mission was night Close Air Support training to prepare MP2 for possible Air Expeditionary Force deployment and to complete his familiarization with the Advanced Targeting Pod. The flight was conducted in accordance with applicable service and unit guidelines. Both mishap pilots were current and qualified to perform the mission. MP1 was an experienced instructor pilot. MP2 had 126.1 hours in the F-16. Because he had less than 500 hours, he was considered inexperienced in the F-16.

At the time of the mishap, the flight was returning to Shaw AFB and MP2 was rejoining on MP1, the flight lead.

The Accident Investigation Board (AIB) President found, by clear and convincing evidence, this mishap was caused by MP2's improper night rejoin. Specifically, MP2 failed to reduce airspeed and establish the appropriate flight path vector, as recommended by Air Force guidance.

The AIB President also found that channelized attention substantially contributed to the mishap. Channelized attention occurs when an individual focuses all attention on a limited number of cues to the exclusion of others of a higher priority. MP2 experienced a radar failure during the rejoin, which diverted his attention from recognizing and correcting the airspeed and flight path errors.

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

SUMMARY OF FACTS AND STATEMENT OF OPINION
F-16CM, T/N 91-0364 & F-16CM, T/N 91-0365
15 OCTOBER 2009

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COMMONLY USED ACRONYMS AND ABBREVIATIONS

A/A	Air-to-Air
ACMI	Air Combat Maneuvering Instrumentation
AEF	Air Expeditionary Forces
AF	Air Force
AFB	Air Force Base
AFI	Air Force Instruction
AFIP	Air Force Institute of Pathology
AFTTP	Air Force Tactics, Techniques and Procedures
AGL	Above Ground Level
AIB	Aircraft Investigation Board
AIM	Air Intercept Missile
AFE	Aircrew Flight Equipment
AMU	Aircraft Maintenance Unit
AMXS	Aircraft Maintenance Squadron
ATP	Advanced Targeting Pod
AUX	Auxiliary
BD	Battle Damage
BFM	Basic Fighter Maneuver
BPO	Basic Post or Pre-Flight Inspection
C	Celsius
CAMS	Computer Automated Maintenance System
Cann	Cannibalization
CAS	Close Air Support
CSFDR	Crash Survivable Flight Data Recorder
Dash-1	T.O. 1F-16CM-1 Flight Manual
FCR	Fire Control Radar
FS	Fighter Squadron
FW	Fighter Wing
G	Force of Gravity
HUD	Heads up Display
IAW	In Accordance With
IFF	Introduction to Fighter Fundamentals
IMDS	Integrated Maintenance Data System
IP	Instructor Pilot
JTAC	Joint Terminal Attack Controller
KCAS	Knots Calibrated Air Speed
L	Local time
MA	Mishap Aircraft
MAJCOM	Major Command
MDS	Mission Design Series
MFL	Maintenance Fault List
MIL or MIL POWER	Military Power
MOA	Military Operating Area
MP	Mishap Pilot
MPD	Multi-Purpose Display
MQT	Mission Qualification Training
MSL	Mean Sea Level
NVGs	Night Vision Goggles
NM	Nautical Miles
NOTAMS	Notices to Airman
OG	Operations Group
OPTEMPO	Operations Tempo
OSC	On-Scene Commander
P and S	Plans and Scheduling
PA	Aircrew Life Support Public Affairs
PFL	Pilot Fault List
PGM	Precision Guided Munition
PRD	Pilot Reported Discrepancy
PRO SUPER	Production Supervisor
QA	Quality Assurance
QC	Quality Check
QUAL	Qualification
QVI	Quality Verification Inspection
RAP	Ready Aircrew Program
RED X	Safety of Flight
RTB	Return to Base
SAR	Search and Rescue
SEFE	Standardization Evaluation Flight Examiner
S/N	Serial Number
Sortie	Flight
Stan Eval	Standardization and Evaluation
SUU-20	Suspension Utility Unit-20
TACAN	Tactical Aid to Navigation
TCI	Time Change Inspection
T.C.T.O.	Time Compliance Technical Order
T/N	Tail Number
T.O.	Technical Order
TSgt	Technical Sergeant
UHF	Ultra High Frequency
USAF	United States Air Force
VHF or Victor Frequency	Very High Frequency
VSD	Vertical Situation Display
W161	Warning Area 161
Z	Zulu or Greenwich Mean Time

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, PURPOSE, AND CIRCUMSTANCES

a. Authority

On 15 October 2009, General William M. Fraser III, Commander, Air Combat Command (ACC), appointed Major General Stanley T. Kresge to conduct an aircraft accident investigation of a mishap that occurred on 15 October 2009 involving two F-16CM aircraft from Shaw Air Force Base (AFB), South Carolina (SC). (Tab Y-3) The investigation was conducted at Shaw AFB from 12 November 2009 through 20 November 2009. Technical advisors were Lieutenant Colonel Richard N. Bradley (Medical), Captain Jason R. Smith (Legal), Captain Patrick B. Ragan (Pilot), Captain Michael G. Fleming (Physiologist), Master Sergeant Ray A. Atanacio (Maintenance), and Technical Sergeant James M. Watson (Recorder). (Tab Y-4, Y-5)

b. Purpose

The purpose of this investigation is to provide a publicly releasable report of the facts and circumstances surrounding the accident, to include a statement of opinion on the cause or causes of the accident; to gather and preserve evidence for claims, litigation, disciplinary, and adverse administrative actions; and for other purposes. This report is available for public dissemination under the Freedom of Information Act (Title 5, United States Code, Section 552).

c. Circumstances

The accident board was convened to investigate the Class A accident involving two F-16CM aircraft, tail number (T/N) 91-0364 and T/N 91-0365, assigned to the 77th Fighter Squadron (77 FS), 20th Fighter Wing (20 FW), Shaw AFB, which occurred during a training mission on 15 October 2009. (Tab Y-3 thru Y-5)

2. ACCIDENT SUMMARY

The mishap flight, consisting of T/N 91-0364, mishap aircraft 1 (MA1), and T/N 91-0365, mishap aircraft 2 (MA2), departed Shaw AFB at 1919 local time (L) on 15 October 2009, to conduct a training mission. While returning to base at 2024L, at a position 126 nautical miles (NM) southeast of Shaw AFB, MA2 flown by mishap pilot 2 (MP2) collided with MA1 flown by the flight lead, mishap pilot 1 (MP1). (Tab EE-3) MP2 died at the collision with MA1 and MA2 crashed into the ocean and was destroyed. (Tab X-3, EE-3) MA1 sustained damage to the left and right stabilators (stabs), left wing, and Suspension Utility Unit-20 (SUU-20) under the left wing. (Tab S-5 thru S-10) MP1 was uninjured and landed at Charleston AFB, SC. (Tab X-4) Damage to aircraft and equipment totaled $26,893,341.69. (Tab P-5) The accident caused no damage to private property. There has been significant media interest in the mishap. (Cross-section of media coverage included in Tab CC-16 thru CC-21)

3. BACKGROUND

Both mishap aircraft were assigned to the 77 FS, 20 FW, Air Combat Command.

a. **20th Fighter Wing**

The 20 FW is equipped to provide, project and sustain combat ready air forces ... any challenge, anytime, anywhere. The wing is capable of meeting all operational requirements worldwide, maintains a state of combat readiness and operates as the host unit at Shaw by providing facilities, personnel and material. The 20 FW operates the 55th, 77th and 79th Fighter Squadrons. The wing currently flies F-16CMs. It has flown the F-16C/D Fighting Falcon since 1994. (Tab CC-10, CC-11)

b. **77th Fighter Squadron "Gamblers"**

The 77 FS employs F-16CM fighter aircraft in conventional and anti-radiation suppression of enemy air defenses, strategic attack, counter air, air interdiction, joint maritime operations and combat search-and-rescue missions. The 77 FS, along with its sister fighter squadrons, maintains a mission-ready, multi-role capability to mobilize, deploy and tactically employ forces worldwide for any contingency in support of U.S. national objectives. The 77 FS is responsible for providing the people and resources necessary for conventional air-to-surface, air superiority, suppression of enemy air defenses, destruction of enemy air defenses and maritime operations. (Tab CC-12)

c. **F-16CM "Wild Weasel"**

The F-16CM is a Block 50 version of the F-16 Fighting Falcon. The first Block 50 F-16 was delivered to the USAF in November 1991. (Tab CC-4, CC-7)

The F-16 Fighting Falcon is a compact, multi-role fighter aircraft. It is highly maneuverable and has proven itself in air-to-air combat and air-to-surface attack. It provides a relatively low-cost, high-performance weapon system for the United States and allied nations. (Tab CC-8)

Since September 11, 2001, the F-16 has been a major component of the combat forces committed to the Global War on Terrorism flying thousands of sorties in support of Operations NOBLE EAGLE, ENDURING FREEDOM and IRAQI FREEDOM. (Tab CC-9)

4. **SEQUENCE OF EVENTS**

a. **Mission**

The mission was a night Close Air Support (CAS) training flight involving two F-16CMs with call signs DIAMOND 41 and 42 (Tabs K-4, V-4). MP1, DIAMOND 41, was the flight lead. MP2, DIAMOND 42, was the wingman. (Tabs K-4). CAS involves aircraft supporting a ground commander. (Tab BB-6) The purpose of the mission was upgrade training with the advanced

targeting pod (ATP) and Air Expeditionary Forces (AEF) spin up for MP2. (Tab V-4) MP1 was the instructor pilot (IP) supervising the upgrade training for MP2. (Tab V-4) During the mission, MP1 and MP2 conducted simulated attacks utilizing the ATP. (Tab V-5)

The mission was flown in airspace designated as warning area 161 (W161) scheduled by 20 FW for training purposes. (Tab V-7) W161 is an over water designated military training area of the coast of South Carolina. (Tab K-15, K-16) The 77 FS Director of Operations properly authorized the mission. (Tab K-4)

b. **Planning**

MP1 and MP2 arrived in the squadron at 1300L for planning; however, they suspended planning until 1430L to gain a better understanding of developing weather conditions in the area. (Tab V-4, V-5) The mission was planned and briefed as an AEF-2 and ATP-2 CAS sortie in accordance with the 20th Operations Group (OG) AEF 10.2 Spin-up Plan and syllabus. (Tab V-4) The mission was originally scheduled to be conducted in the Bulldog Military Operating Area (MOA) with a Joint Terminal Attack Controller (JTAC). (Tab R-3) After evaluating the weather conditions in Bulldog MOA, MP1 changed the planned operating area to W161. (Tab R-3, V-5) At 1625L, squadron supervision conducted a mass briefing for all pilots flying that night. (Tabs K-8 thru K-10, V-5) MP1 and MP2 attended the mass briefing and the flight briefing that followed. (Tab V-5) The briefings were conducted in accordance with Air Force Instruction (AFI) 11-2F-16, Volume 1; the 20 FW Standards; the 20 OG AEF 10.2 Spin up plan; and the 20 OG syllabus. The briefings included weather, Notices to Airman (NOTAMS), training rules, and information needed to safely conduct the planned upgrade ride and CAS training. (Tabs K-8 thru K-10, V-5) MP1 evaluated MP2's planning and mission coordination as "very good and better than most." (Tab V-5)

c. **Preflight**

MP1 and MP2 met at the operations desk at 1819L for a final briefing on weather, NOTAMS and other pertinent information prior to proceeding to their aircraft. (Tab V-6) MP1 went to a spare aircraft because the initial aircraft was not configured with an ATP. (Tab V-6) MP2 delayed starting his aircraft due to a communication problem with his crew chief. This did not significantly rush or delay the flight. (Tab V-6)

Both MA1 and MA2 were equipped with Air Combat Maneuvering Instrumentation (ACMI) pods. (Tab P-5, K-7) ACMI pods record precise aircraft flight parameters used to reconstruct aircraft movements during mission debriefings.

d. **Summary of Accident**

Start, taxi, and takeoff was unremarkable. MA1 and MA2 departed Shaw AFB at 1919L for W161. (Tabs K-4, V-6) Flight to W161 and the CAS training portion of the sortie was executed as briefed and was unremarkable. (Tab V-6) MP1 and MP2 completed their last CAS training event at approximately 2021L. (Tab AA-39)

Both mishap aircraft were operating normally, with the exception of a fire control radar (FCR) problem in MA2. (Tab U-19) The crash survivable flight data recorder (CSFDR) reported that MA2 first experienced an automatic radar computer reset at 1956:43L, and experienced at least

eight more between 2012:42L and 2016:42L. (Tab U-19, BB-10) It is not possible to discern from the CSFDR if the radar automatically reset after this time. The maximum number of occurrences the system is capable of recording is nine unless the pilot clears the maintenance fault list (MFL). (Tab BB-10) MP2 did not clear the fault list prior to collision. (Tab U-19)

A radar computer reset lasts 4 to 12 seconds and all target information is removed and the radar is inoperative. (Tab U-27) The first time MP2 notified MP1 about a radar problem was 2024:03L, immediately prior to the collision. (Tabs V-14, AA-36)

After completing his last attack, MP2 reached the briefed fuel level to return to base. (Tab V-6) MP1 and MP2 were approximately 14,500 feet above Mean Sea Level (MSL) and 400 Knots Calibrated Airspeed (KCAS). (Tab AA-39) MP1 directed MP2 to rejoin to a position 500 to 3,000 feet and 30 to 60 degrees behind MP1's aircraft. (Tab V-10) Both aircraft were operating with anti-collision beacons and wingtip lights flashing throughout the sortie. (Tab V-7, V-10)

At 2022L, MP2 trailed MA1 by 6NM. (Tabs V-9, U-28) MP1 established a heading of 310 degrees and informed MP2 he would hold the briefed 300 KCAS during the rejoin. (Tab V-10) MP1 believed he was maintaining 300 KCAS, but his airspeed was actually 265 to 270 KCAS. (Tab V-10, AA-39) He began a 5 degree nose high climb toward 20,000 feet MSL. (Tabs N-26, V-9) MP2 selected MIL (full non-afterburning) power and 400 KCAS, which initially provided 220 knots of closure. (Tab U-28) MP1 received a Radar Warning Receiver indication that MP2 had a radar lock on MA1. (Tab V-10)

Radar is a useful aid during a night rejoin. It provides range, position, and closure rate information. MP2 had other non-radar sources of data to assist in the rejoin. The Air-to-Air tactical air navigation system (A/A TACAN) and Fighter Data Link (LINK-16) were operating and both provided MP2 range data to MA1. (Tab V-10, V-11) MP2 was wearing night vision goggles (NVGs). (Tab R-74, V-11) The NVGs would have enabled him to maintain visual contact, but would not have provided range and closure cues until aircraft were within 1NM. (Tab R-26)

Air Force Tactics, Techniques and Procedures 3-3.F-16, *Combat Aircraft Fundamentals*, recommendations the following for performing night rejoins:

- "Generally, plan to have 50 to 100 KCAS of airspeed advantage over lead's airspeed until 1.5NM slant range."
- "Closing to 1NM, plan to cut overtake to 50 KCAS over the flight lead's airspeed when reaching 5,000 feet. From 5,000 feet to 3,000 feet, continue to reduce closure (e.g. 50 knots at 5,000 feet, 40 knots at 4,000 feet, 30 knots at 3,000 feet)."
- "Ensure flight path is to a position 750 to 1,000 feet left or right of lead. Do not have lead in or near the HUD (Heads Up Display)." (Tab O-20)

At 2023:37L, MA2 was 1.5NM behind MA1 at 397 KCAS maintaining MIL power. (Tab U-28) MA1 was almost centered in MP2's HUD, approximately 1.5 degrees from the flight path marker. The flight path marker shows where the aircraft is going. (See figure 1)

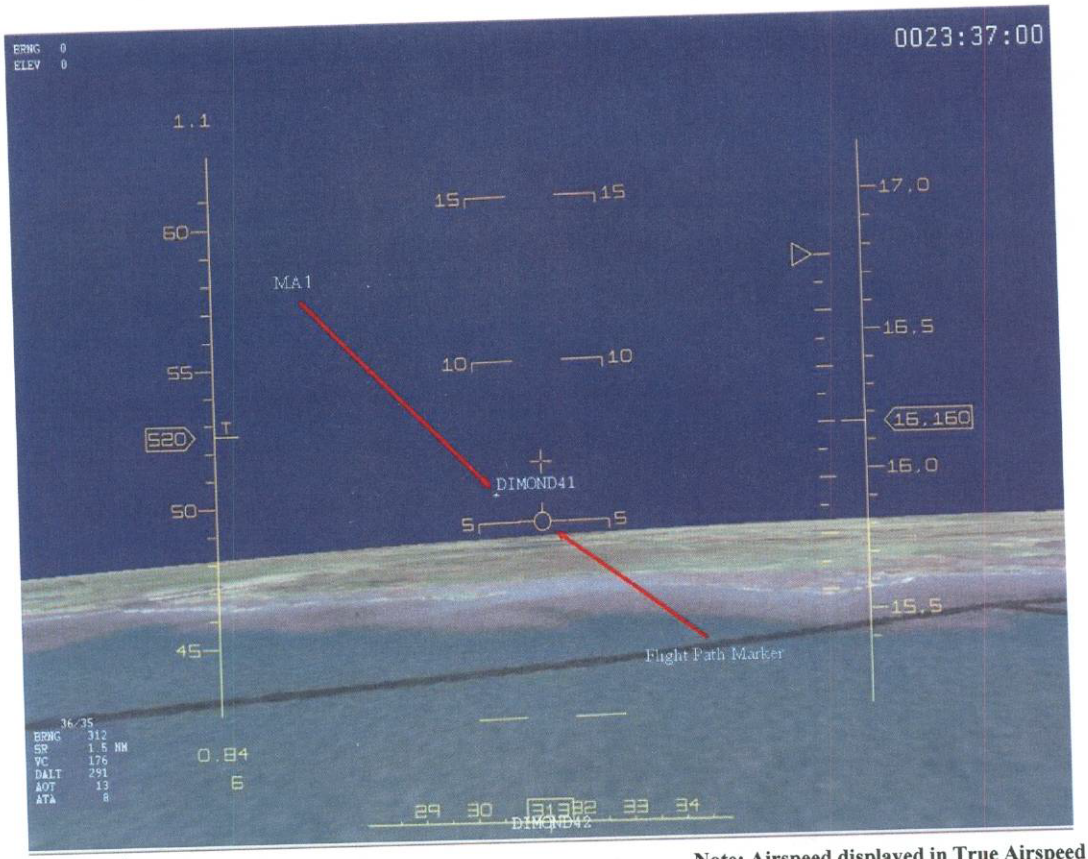

Figure 1

Note: Airspeed displayed in True Airspeed

At 2023:46L, MP2 was 1NM from MA1 at 391 KCAS in MIL power with the same flight path relative to MA1. (Tab U-28) (See figure 2)

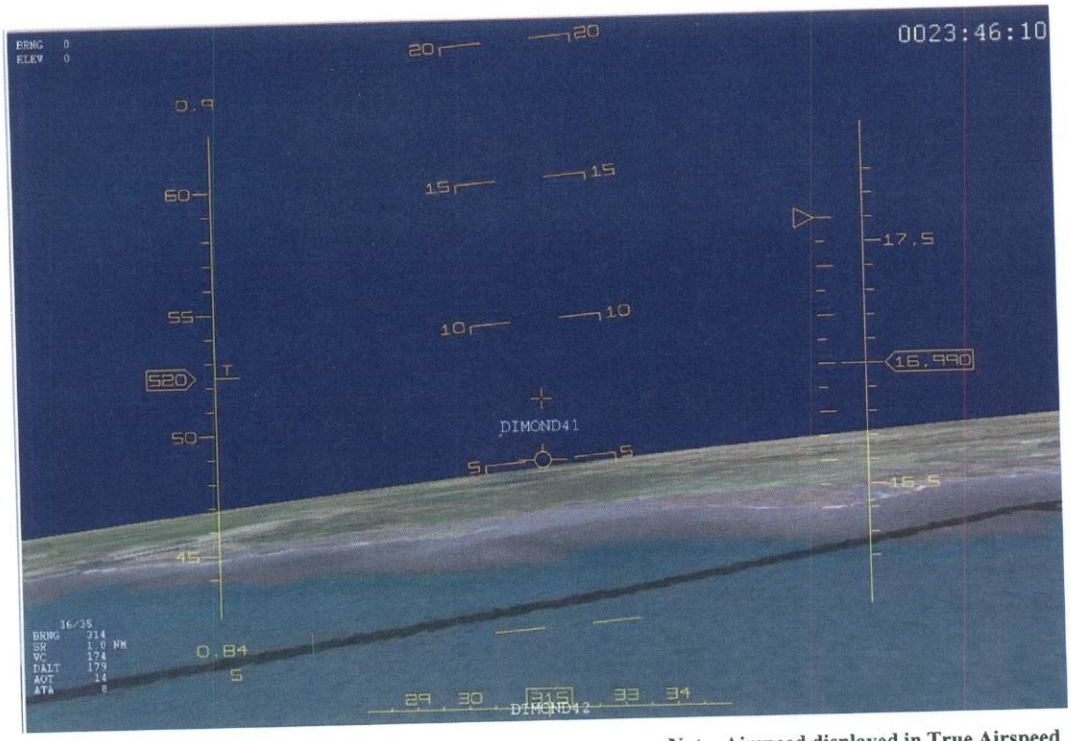

Figure 2

Note: Airspeed displayed in True Airspeed

At 2023:56L MP1 set a 20 degree right hand bank and MP2 began to match that bank at 2023:58L. By 2023:58L, MP2 resumed MIL power following a 10-second slight power reduction. He was 3,000 feet from MA1 at 381 KCAS with 164 knots of closure with the same relative flight path. (Tab U-28) (See figure 3)

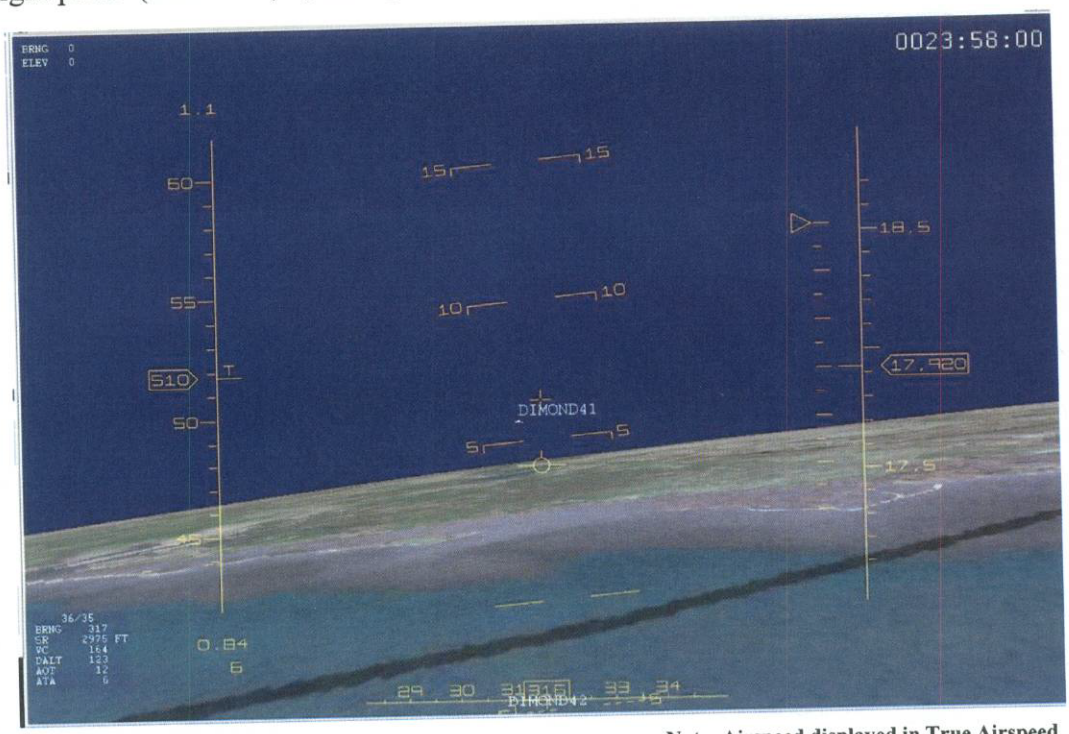

Figure 3

Note: Airspeed displayed in True Airspeed

At 2024:03, MP2 began a radio transmission to MP1. (Tab AA-36) MP2 told MP1, "my radar keeps cycling on, off, on, off, on, off." (Tab V-14) The transmission continued until the aircraft collided. (Tabs V-14, AA-31)

At 2024:05L, MP2 was 1,000 feet from MA1 with no change in airspeed, power setting, closure, or relative flight path. (Tab U-28) (See figure 4)

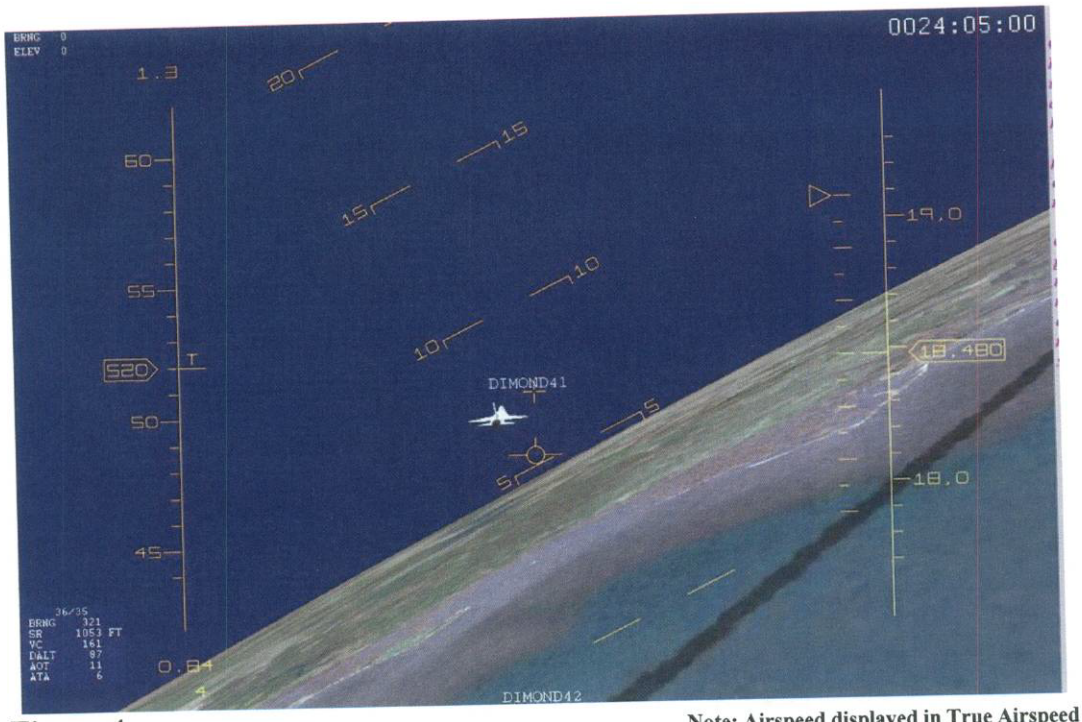

Figure 4

Note: Airspeed displayed in True Airspeed

At 2024:07.5L MA2 was 512 feet from MA1 with 159 knots of closure flying directly toward MA1. (Tab U-28) MA2 encountered wake turbulence from MA1's right wing tip causing MA2 to roll right and increase angle of attack (AOA). MP2 made control inputs and reduced power consistent with countering this wake turbulence. (Tabs J-4, AA-32)

MA2 collided with MA1 at 2024:08.8L. (Tabs J-4, J-5, U-19, AA-32) MA2's canopy struck MA1's left horizontal stab then impacted MA1's left SUU on weapon station 3. MA2 had approximately 15 degrees of left roll causing the right wing tip to contact MA1's right horizontal stab. Finally, MA2's vertical stabilizer impacted the left one third of MA1's horizontal stab sheering the outer one third off and then contacted MA1's left trailing edge wing tip just inside of the outboard missile rail launcher. (Tab J-4)

MP2 died upon impact with the SUU. (Tab X-3)

e. **Impact**

MA2 impacted the water at approximately 2024:40L at latitude 32 49.78 North and longitude 079 20.21 West. (Tabs U-28, EE-3) At impact, MA2 was traveling at 770 KCAS, 60 degrees nose low and 120 degrees of left bank. (Tab H-4)

f. **Life Support Equipment, Egress and Survival**

MP2 did not attempt to eject and MP1 was able to safely land his aircraft at Charleston AFB. Therefore, aircrew flight equipment was only used for normal operations. (Tab X-3)

g. **Search and Rescue (SAR)**

MP1 initiated a rescue call immediately after the collision. (Tab N-6) Poker 51 and Poker 52, were 20 to 30NM from the incident and the first to respond. (Tabs N-7, R-90)

Poker 51 assumed on-scene commander duties. (Tab R-13) He initiated a search for MA2 and requested Double Shot, the air traffic controller responsible for the area, to notify the US Coast Guard (USCG) to respond and to have Charleston Approach Control restrict the airspace. (Tabs N-8, N-9, R-13) Poker 51 assigned Poker 52 to escort MA1. (Tab N-7) Poker 52 remained with MP1 until he landed safely at Charleston AFB at 2049L. (Tab R-90, R-94) Poker 52 returned to the accident site to assist in the SAR. (Tab R-9)

After waiting 18 minutes to allow any possible parachute to splash down, Poker 51 began a visual search using multiple flares. (Tab R-14)

Within an hour of the crash, the USCG began launching rescue resources into the area. The first were a 41 foot utility boat and an H-65 helicopter. At 2137 hours, the H-65 spotted debris in the water at latitude 32° 47' N, longitude 79° 17.6' W. (Tab FF-3)

The USCG, assisted by other agencies, continued the SAR effort for two days until they determined the maximum in-water survival time had been exceeded, and after the next-of-kin was notified of the decision to suspend the search. (Tab FF-6, FF-7)

The equipment involved in the search effort included two F-16CMs, one C-17, two KC-135s, one C-130, two H-60s, two F-18s, several H-65s, two 41 foot UTBs, the Coast Guard Cutters *Blue Fin* and *Bear*, and the Motor Vessel *Honor*. These resources searched over 8,000 square NM, and the combined search time was over 170 hours. (Tab FF-3 thru FF-7)

h. **Recovery of Remains**

Navy divers recovered remains from the crash site. (DD-9) Air Force Mortuary Affairs recovered remains from the exterior of MA1. (Tab DD-5) The Armed Forces Institute of Pathology conducted DNA testing and positively identified the remains as MP2. (Tab DD-7)

5. **MAINTENANCE**

a. **Forms Documentation**

The Air Force Technical Order (AFTO) 781 series forms are used to document aircraft maintenance, inspections, servicing, and airworthiness of the aircraft. The board conducted a detailed review of active and historical AFTO Forms for both MA covering the 60-day period prior to the mishap. The Integrated Maintenance Data System (IMDS) is an electronic system used for maintenance data collection, maintenance management, and trend analysis. IMDS data from both MA was also reviewed for the 60 days prior to the mishap. Maintenance

documentation was satisfactorily accomplished in accordance with applicable maintenance directives.

b. **Inspections**

AFTO Form 781Ks are used to track and document all scheduled inspections. A detailed review for both MA on the 60 days prior to the mishap showed no overdue scheduled inspections. Phase inspections are major inspections conducted on Air Force aircraft at specific flying hour intervals. The F-16 has a 400 flight hour inspection cycle. At the time of mishap, MA1 had a total of 5,332.1 flight hours, and the last Phase was completed at 5,185.0 flight hours. MA2 had 5,180.4 flight hours, and the last Phase was completed at 5,100.0 flight hours. Minor inspections, such as preflight, thru-flight, and post flight, were also reviewed. All inspections performed prior to the mishap were completed in accordance with applicable Air Force technical orders. (Tab U-23, U-26)

c. **Maintenance Procedures**

Maintenance procedures are described in applicable AFTO, Major Command, and local procedures. Maintenance procedures and practices were not relevant to the mishap.

d. **Maintenance Personnel and Supervision**

Training and supervision of personnel performing assigned tasks on the MA was appropriate and was not relevant to the mishap.

e. **Fuel, Hydraulic and Oil Inspection Analysis**

Fuel samples were collected from the refueling trucks that serviced the mishap aircraft. All samples were found to be within allowable limits. (Tab D-41)

Shaw AFB has no capability to test hydraulic fluid. However, MA1 flew four times since its hydraulic oil was last serviced with no hydraulic or flight control related faults. MA2 flew six times since last having its hydraulic oil serviced with no hydraulic or flight control related faults. (Tab U-21, U-22, U-24, U-25)

The oil carts that serviced MA1 and MA2 were tested and found to be within allowable limits. (Tab D-41)

f. **Unscheduled Maintenance**

In the past 30 days, MA1 flew 8 times with one Code 1 (no pilot reported discrepancy) and seven Code 2s (minor discrepancies that do not detract from safety of flight or prevent continued flights). (Tab U-21, Tab U-22)

In the past 30 days, MA2 flew 12 times with five Code 1s, four Code 2s, and three Code 3s (maintenance required before the MA could fly again.) All Code 3 discrepancies were repaired before MA2 was returned to service. (Tab U-24, U-25)

On 27 August 2009, a pilot flying MA2 reported a problem with the Fire Control Radar (FCR) resetting multiple times. Maintenance personnel corrected the problem by replacing the antenna. They ran an operational check to ensure it was working properly. (Tab U-30) Afterwards, MA2

accumulated 19 flight hours prior to the mishap with no reported radar problems. (Tab U-24, U-25)

There is no evidence that unscheduled maintenance actions contributed to the mishap.

6. AIRCRAFT AND AIRFRAME

a. Condition of Systems and Structures

MA1 was moderately damaged by the collision. Both horizontal stabs, left wing and the vertical stabilizer were damaged. (Tab P-3, S-5 thru S-8) MP1 was able to land the aircraft at Charleston AFB.

MA2's high speed at impact resulted in destruction of the airframe and its components. (Tab P-3 thru P-5) Minimal wreckage was recovered. (Tab P-3 thru P-5) Recovered components were returned to Shaw AFB. The crash survivable flight data recorder (CSFDR) was recovered intact. (Tabs J-4, L-3, S-13)

b. Repair and Testing Stations

The 20th Equipment Maintenance Squadron, Non-Destruction Inspection Section, conducted a spectrometric analysis of oil taken from oil servicing carts used to service both MA and determined they were within acceptable limits. (Tab D-41)

MA2's data transfer cartridge (DTC) was sent to the Ogden Air Logistics Center (OO-ALC) at Hill AFB, Utah. OO-ALC was unable to recover data due to damage to the DTC. (Tab J-3)

The CSFDRs from MA1 and MA2 were sent to Lockheed Martin Aeronautics for flight data analysis. MA1's data was not relevant to the mishap. Lockheed recovered the last 15 minutes of flight data from MA2's CSFDR. (Tab J-4, J-5)

c. Functionality of Equipment

Both aircraft were operating properly with exception of the MA2's radar problem, discussed in paragraph 4(d). (Tab V-6)

7. WEATHER

a. Forecast Weather

The Shaw AFB weather forecast for 15 October 2009, published at 1625L, predicted a broken layer of clouds from 1,200 feet to 13,000 feet. The term "broken" refers to cloud layers that cover more than 50% of the sky. The visibility was forecast to be 7 statute miles with showers in the vicinity, and winds were forecast to be from the west at 5 knots. Additionally, the weather was expected to change from 1800L to 1900L with the broken cloud layers lowering to 500 feet with light rain. The night illumination was briefed as 2.2 millilux indicating high illumination. (Tab BB-10) The forecast weather in W161 called for scattered cloud layers from 2,000 to 7,000 feet and 15,000 feet with visibility of 7 miles. The minimum forecast altimeter setting was 29.73 inches of mercury, and flight level winds at 10,000 feet were forecast to be from the west at 35 knots. (Tab F-3, F-9, F-29)

b. **Observed Weather**

On Shaw AFB, at 1933L, the winds were southwest at 3 knots with an overcast layer of clouds at 1,200 feet and 3 miles visibility with mist. The term "overcast" refers to cloud layers that cover more than 75% of the sky. The temperature measured 16° C with a dew point of 14° C and a pressure of 29.73 inches of mercury. (Tab F-21, F-23. F-29)

Actual conditions included a widely scattered cloud deck at 2,000 to 3,000 feet above ground level (AGL) in the western part of W161 and a broken to scattered cloud deck at the same altitudes in the eastern part of W161. MP1 reported he had no problem visually acquiring ships to use as simulated targets in the western part of W161. (Tab N-6) A thin, high-level broken cloud deck existed to the west of Charleston, SC, and aircrews could clearly see the cultural lights of Charleston. Weather at Shaw AFB was as briefed, with a broken cloud deck at 1,100 to 1,200 feet AGL when the mishap crew departed, and the broken cloud deck lowered to 500 feet AGL at the time they were scheduled to land. The illumination on the weather briefing slide was incorrect. The observed illumination from 2015L to 2100L was 1.62 millilux. (Tab F-29) Anything below 2.2 millilux is considered low. (Tab BB-11) During the rejoin, MP1 said the view forward (the direction MP2 was viewing MA1) was normal with no distractions. (Tab V-7)

c. **Conclusion**

The mission was flown within operational weather limitations and weather was not relevant to the mishap.

8. CREW QUALIFICATIONS

a. **Mishap Pilot 1**

MP1 was an experienced F-16CM instructor and evaluator with 967.2 hours in F-16C/D aircraft and 1,205.8 hours of total military flying time. (Tabs T-3, T-4, BB-7, BB-8) MP1 was current and qualified. His leadership described him as a great fighter pilot who surpassed his peers. (Tab R-29, R-56) MP1 was selected to attend test pilot school at Edwards AFB following his current assignment at Shaw AFB. (Tab R-29) MP1's flight time before the mishap is listed below (numbers in parenthesis are NVG hours and sorties) (Tab G-10):

	Hours	Sorties
Last 30 Days	4.8 (1.8)	3 (1)
Last 60 Days	20.1 (6.8)	10 (1)
Last 90 Days	26.9 (7.5)	15 (3)

b. **Mishap Pilot 2**

MP2 was a combat mission ready wingman. He had 1,551.6 hours of total military flying time, 126.1 hours of F-16C/D time, and 12.1 hours of NVG time. (Tab G-15) With less than 500 hours in the airframe, MP2 was categorized as an inexperienced F-16CM pilot. (Tab BB-7, BB-8) MP2's total time includes 1,127 hours in the T-37, with 862.1 of those hours as an instructor pilot. (Tab G-15) MP2 completed F-16 transition training at Kelly AFB, Texas, in May 2009 under syllabus Air Education Training Command F16C0B00PL Air National Guard, July 2007. Transition training included night flying, NVG, and targeting pod training. (Tab G-19)

MP2 completed his instrument qualification check in the F-16C on 22 October 2008, and his initial mission qualification check on 17 September 2009. He was rated "Qualified No Discrepancies" on both. (Tab G-16 thru G-30)

The 77 FS leadership considered MP2 an average wingman and an outstanding officer. (Tab R-23, R-53) There were no areas of his flying noted as particularly strong or weak during his mission qualification training (MQT). (Tab-34 thru G-63) His replacement training unit (RTU) supervision rated MP2 as below average and recommended placing him under additional supervision during MQT. (Tab G-19) 77 FS supervision ensured MP2 flew with IPs during MQT. (Tab R-28, R-67)

MP2 flew 3 night sorties within the two weeks prior to the MS. (Tab R-6, R-30) The first of these sorties was a dedicated NVG sortie for MP2 to regain his NVG currency since he had not flown with NVGs within 120 days. The IP described MP2 as a very strong aviator on that flight. (Tab R-54) MP2's last flight prior to the mishap was a night CAS training sortie on 13 October 2009. (Tabs G-31, R-30)

The MP2's flight time before the mishap is listed below (numbers in parenthesis are NVG hours and sorties). (Tab G-10):

	Hours	Sorties
Last 30 Days	11.9 (3.9)	8 (3)
Last 60 Days	22.2 (3.9)	16 (3)
Last 90 Days	22.2 (3.9)	16 (3)

Both pilots were fully qualified to perform the mission.

9. MEDICAL

a. Qualifications

MP1 had an annual flying physical on 17 February 2009. He was medically qualified for flying class 2 duties at the time of mishap. A current Air Force (AF) Form 1042, *Medical Recommendation for Flying*, was issued on 17 February 2009 wherein MP1 was "medically cleared for flying." (Tab DD-3) MP1's medical record contained no other information relevant to the mishap.

MP2 had a routine physical as a part of in-processing to Shaw AFB on 22 July 2009. He was medically qualified for flying class 2 duties at the time of accident. A current AF Form 1042 was issued on 23 July 2009 wherein MP2 was "medically cleared for flying." (Tab DD-4) MP2's medical record contained no other information relevant to the mishap.

b. Health

The Charleston AFB Flight Medicine Clinic examined MP1 soon after he landed. The examination was normal, and no injuries were noted. Both mishap pilot's 14 day and 72 hour life style histories were reviewed and found normal. (Tab X-4) Post-mishap toxicology testing

on MP1 showed normal carbon monoxide levels and no evidence of drug or alcohol use. (Tab X-4)

c. **Pathology**

Remains were recovered from the exterior of MA1 and from the crash site. (Tab DD-5, DD-9) Remains matched a known genetic sample from MP2. (Tab DD-6) The presence of remains on MA1 provides clear evidence that MP2 died at collision. The cause of death was blunt force trauma. (Tab X-3) Toxicology testing on MP2 was not possible. There is no evidence that MP2 suffered from a medical problem or was intoxicated. (Tab V-8)

d. **Lifestyle**

Lifestyle factors were not relevant to the mishap. (Tab DD-8)

e. **Crew Rest and Crew Duty Time**

Aviators are required to have proper "crew rest" prior to performing in-flight duties. Crew rest is defined as a minimum 12-hour non-duty period before reporting for duty. During this time, an aircrew member must have the opportunity for at least eight hours of uninterrupted sleep. (Tab BB-4, BB-5) When night flying, aviators must complete the flight no later than 10 hours after reporting for duty.

Both pilots had a 12-hour non-duty period and the opportunity for eight hours of uninterrupted sleep prior to reporting for duty on 15 October 2009. The mishap occurred less than 8 hours after they reported for duty. Thus, both pilots had complied with crew rest and crew duty time requirements. (Tab DD-8)

10. OPERATIONS AND SUPERVISION

a. **Operations**

The 77 FS did not have an elevated operations tempo (OPTEMPO) in the six months prior to the mishap. Personnel from the 77 FS last deployed from May 2008 to October 2008 to Iraq in support of Operation IRAQI FREEDOM (OIF). (Tab V-13) The OPTEMPO was high, but not more than other similarly-tasked F-16 fighter squadrons.

b. **Supervision**

The mission was properly scheduled and the mishap pilots were current and qualified to fly. MP1 and MP2 discussed operational risks of the mission with the squadron supervision. MP1 assessed the operational risk management (ORM) level for the MS as medium due to MP2's experience and forecast weather conditions. (Tab V-12)

11. HUMAN FACTORS

A human factor is any environmental or individual factor a human being experiences that contributes to or influences his performance during a task. AFI 91-204, *Safety Investigations and Reports*, Attachment 5, contains the Department of Defense Human Factors Analysis and Classification System which lists potential human factors that can play a role in aircraft mishaps. The following defines and discusses human factors relevant to this mishap.

Channelized Attention

Channelized attention occurs when an individual focuses 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. It may be described as a tight focus of attention that leads to the exclusion of comprehensive situational information.

According to the CSFDR, MA2's microphone was cued for voice transmission prior to and during the time of collision. (Tab AA-36) MP1 testified that MP2 transmitted "my radar keeps cycling on, off, on, off, on, off". (Tab V-14) MP's attention was likely channelized on the radar malfunction. MP2's improper power setting, airspeed, and flight path, and the fact that he took no action to avoid MA1 are further indicators that MP2 was not focused on conducting the higher priority task—a safe rejoin. (Tabs U-28, AA-36) Based on MP2's final radio call to MP1 and the reset time of the radar, MP2 may have been focused on his radar problem well prior to impact.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications

1. Air Force Instruction (AFI) 11-2F-16, Volume 1, *F-16—Pilot Training*, 19 January 2007
2. AFI 11-2F-16, Volume 3, *F-16--Operations Procedures*, 30 September 2005
3. AFI 11-202, Volume 3, *General Flight* Rules, 5 April 2006
4. AFI 11-214, *Air Operations Rules and Procedures*, 22 December 2005, Incorporating Through Change 2, 2 June 2009
5. AFI 11-301, Volume 1, *Aircrew Flight Equipment (AFE) Program*, 25 February 2009
6. AFI 11-418, *Operations Supervision*, 21 October 2005
7. AFI 48-123, Volume 3, *Medical Examinations and Standards-Flying and Special Operational Duty*, 5 June 2006
8. AFI 51-503, *Aerospace Accident Investigations*, 16 July 2004
9. AFI 91-204, *Safety Investigations and Reports,* 24 September 2008
10. Air Force Tactics, Techniques and Procedures (AFTTP) 3-3.F-16, *Combat Aircraft Fundamentals F-16*, 5 May 2008
11. Technical Order (T.O.) 1F-16CM-1, *F-16C/D Flight Manual*, 15 April 2009
12. T.O. 1F-16CM-34-1-1, *F-16C/D Avionics and Nonnuclear Weapon Delivery Manual*, 15 March 2009
13. Joint Publication 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support*, 8 July 2009
14. *20th Fighter Wing Standards*, 15 May 2009

b. Maintenance Directives and Publications

1. AFI 21-101, *Aircraft and Equipment Maintenance Management*, 29 June 2006
2. AFI 21-124, *Oil Analysis Program*, 4 April 2003

3. T.O. 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies and Procedures*, 30 April 2003 with Change 3 dated 31 May 2005
4. T.O. 42B-1-1, *Quality Control of Fuels and Lubricants*, 1 August 2004 with Change 1 dated 1 June 2005

NOTICE: The AFIs listed above are available digitally on the AF Departmental Publishing Office internet site at: **http://www.e-publishing.af.mil.**

c. **Known or Suspected Deviations from Directives or Publications**

MP2 deviated from the AFTTP 3-3.F-16 guidance by failing to reduce airspeed and establish the appropriate flight path vector relative to MP1's aircraft.

13. NEWS MEDIA INVOLVEMENT

The USAF News Service issued two press releases on 16 October 2009 notifying the public of the mishap and releasing the name of the missing pilot. (Tab CC-13, CC-14) On 16 October 2009, Colonel Joseph Guastella, Jr., 20 FW Commander, held an initial press conference at Shaw AFB. He provided preliminary details regarding the mishap and answered questions from the local media. By 17 October 2009, USAF authorities had gathered sufficient evidence to conclude that the collision had been fatal. Colonel Guastella held a second conference on 17 October to announce that the search efforts had transitioned from rescue to recovery. (Tab CC-15) The 20 FW Public Affairs (20 FW/PA) office two more press releases on 17 and 18 October updating the public on the status of search and recovery efforts. (Tab CC-15) There has been significant media interest since the initial press release. (Cross-section of articles provided in Tab CC-18 thru CC-27) The USAF has kept the public fully informed of details related to the mishap.

20 November 2009

STANLEY T. KRESGE, Major General, USAF
President, Accident Investigation Board

STATEMENT OF OPINION
F-16CM, T/N 91-0364 & F-16CM, T/N 91-0365
15 OCTOBER 2009

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report may not be considered as evidence in any civil or criminal 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 October 2009 at 2024:09 local time (L), two F-16CM aircraft, tail numbers 91-0364 and 91-0365, assigned to the 77th Fighter Squadron, 20th Fighter Wing, Shaw Air Force Base (AFB) South Carolina, collided over the Atlantic Ocean in W161 approximately 126 nautical miles southeast of Shaw Air Force Base. The mishap pilot (MP2) in aircraft 91-0365 died upon collision and did not attempt ejection. Aircraft 91-0365 was destroyed upon impact with the water and there was no damage to private property. The other mishap pilot (MP1) was uninjured. Aircraft 91-0364 had moderate damage to flight control surfaces and external stores. MP1 landed safely at Charleston AFB.

The purpose of the mishap mission was a night Close Air Support training mission to prepare MP2 for possible Air Expeditionary Force deployment and to complete his familiarization with the Advanced Targeting Pod. At the time of the mishap, the flight was returning to Shaw Air Force Base and MP2 was rejoining on the flight lead, MP1.

I find, by clear and convincing evidence, this mishap was caused by MP2's improper night rejoin. Specifically, MP2 failed to reduce airspeed and establish the appropriate flight path vector relative to MP1's aircraft.

I also find that channelized attention substantially contributed to the mishap. MP2 experienced a radar failure which diverted his attention from completing a safe rejoin.

2. DISCUSSION OF OPINION

a. Background

Both pilots were well prepared for the mission. MP1 was an experienced instructor pilot and flight examiner. MP2, although inexperienced in the F-16, had flown three night training missions in the past eight days. MP2 exhibited average performance during Mission Qualification Training, which he completed one month prior.

Mission planning, flight briefing, ground operations, departure, and area work prior to the rejoin were appropriate and uneventful. Both aircraft displayed full exterior lighting during the area work and rejoin. With the exception of MP2's radar, both aircraft were operating normally. The flight data recorder from aircraft 91-0365 reported a series of radar anomalies beginning 27 minutes prior to the mishap. The radar was experiencing a computer reset condition which

rendered it periodically inoperative. The number, times, and duration of the computer reset events cannot be determined from the flight data recorder. MP2 did not inform MP1 of radar problems until just prior to the collision.

The radar is a useful aid for a night rejoin. The radar provides range, position, and closure rate information. MP2 had other sources of data available to him. He was wearing night vision goggles, which enable the pilot to maintain visual contact with another aircraft, but would not enable him to assess range and closure rate until very close range. The air-to-air TACAN was working, which provides range, but not closure data. Finally, data link was working which, during periods of radar computer reset, provides range, but not closure data.

Air Force Tactics, Techniques, and Procedures (AFTTP) 3-3.F-16 offers the following guidance on night rejoins:

- "Generally, plan to have 50 to 100 KCAS (Knots Calibrated Airspeed) of airspeed advantage over lead's airspeed until 1.5NM slant range."

- "Closing to 1NM, plan to cut overtake to 50 KCAS over the flight lead's airspeed when reaching 5,000 feet. From 5,000 feet to 3,000 feet, continue to reduce closure to be 1 percent of the range (e.g. 50 knots at 5,000 feet, 40 knots at 4,000 feet, and 30 knots at 3,000 feet)."

- "Ensure flight path is to a position 750 to 1,000 feet to the left or right of lead. Do not have lead in or near the HUD."

b. **The Mishap**

At approximately 2022L, MP1 directed MP2 to rejoin. From this time until collision, MP1 maintained a steady climb from 13,000 feet to 18,800 feet and a constant heading of 315 degrees until 12 seconds prior to collision when MP1 began an easy right hand turn using 20 degrees of bank. MP1 briefed, told MP2 via the radio, and recalled flying 300 KCAS during the rejoin. He actually maintained airspeed between 265 and 270 KCAS.

The rejoin began with MP2 6 miles in trail, maintaining approximately 400 knots using high (MIL) power, with 220 knots closure. The evidence suggests that MP2's radar was operating normally at this time. MP1 specifically recalled Radar Warning Receiver indications from MP2's radar. Also, MP2 did not communicate a radar problem to MP1 at this point, although he would much later in the rejoin sequence.

During the next 1 minute and 15 seconds, MP2 maintained a constant airspeed of 400 KCAS (appropriate under AFTTP 3-3.F-16 given the presumption that MP1 was at 300 KCAS) and initiated a climb to match MP1's ascent with a gradual decrease in closure rate.

At 2023:37L, MP2 was 1.5 nautical miles from MA1. His airspeed was 397 KCAS with MIL power set. The closure was 176 knots. MA1 was almost centered in the HUD, approximately 1.5 degrees from MP2's flight path marker. The flight path marker shows where the aircraft is going.

At 2023:46L, MP2 was 1 nautical mile from MA1 with 391 KCAS. He maintained MIL power and the same flight path relative to MA1.

At 2023:58L, MP2 was 3,000 feet from MA1 with 381 KCAS and 164 knots closure. He had resumed MIL power following a 10 second power reduction. MP2's flight path marker remained 1.5 degrees from MA1.

At 2024:03L, MP2 initiated a radio call that continued until the collision. He told MP1 "my radar keeps cycling on, off, on, off, on, off." This radar indication is consistent with a computer reset condition. Given the number of on – off cycles that MP2 describes, and the 4-12 second on – off cycle time, the radar malfunction began well prior to the radio call.

At 2024:05L, MP2 was 1,000 feet from MA1 with no change in airspeed, power setting, closure, and flight path relative to MP1.

At 2024:08L and less than 1 second to impact, MP2 encountered wake turbulence from MP1's aircraft. MP2 initiated a power reduction and flight control inputs consistent with, and due to, the wake turbulence.

At 2024:09L, impact occurred with MA1 at 18,810 feet mean sea level and 267 KCAS. MP2's airspeed was 378 KCAS and closure rate was 148 knots. MP2's canopy struck the trailing edge of MP1's left horizontal tail and then impacted MP1's left wing external stores. MP2 died at the collision. At 2024:40L, aircraft 91-0365 was destroyed at water impact.

c. **Conclusion**

This mishap was caused by MP2's improper rejoin. While MP1's incorrect (slow) airspeed contributed to a higher closure rate, MP2 failed to slow to the airspeeds prescribed by AFTTP. His high power setting (MIL for 22 of the last 32 seconds of rejoin) is inconsistent with a safe rejoin. More importantly, MP2 failed to "not have lead in or near the HUD" and thereby pass MP1 at a safe distance. MP2's flight path was within 1.5 degrees of lead during the entire rejoin.

Channelized attention prevented MP2 from recognizing and correcting the airspeed and flight path errors. Channelized attention occurs when an individual focuses all conscious attention on a limited number of cues to the exclusion of others of a higher priority, leading to an unsafe situation. MP2's improper power setting, airspeed, flight path, his final radio call initiated 5 seconds prior to collision, and the lack of reaction to an impending collision, clearly indicate MP2 was not focused on accomplishing a safe rejoin.

20 November 2009

STANLEY T. KRESGE, Major General, USAF
President, Accident Investigation Board