# UNITED STATES AIR FORCE
# AIRCRAFT ACCIDENT INVESTIGATION
# BOARD REPORT

**F-16C, T/N 85-1413**

**422d TEST AND EVALUATION SQUADRON**
**53RD WING**
**NELLIS AIR FORCE BASE, NV**

**LOCATION: NEVADA TEST AND TRAINING RANGE, CALIENTE, NV**

**DATE OF ACCIDENT: 28 JUNE 2011**

**BOARD PRESIDENT: BRIGADIER GENERAL DONALD J. BACON**

**Conducted IAW Air Force Instruction 51-503**

# EXECUTIVE SUMMARY

**F-16C, T/N 85-1413**
**NELLIS AIR FORCE BASE, NEVADA**
**28 JUNE 2011**

On 28 June 2011, at 1716 local time, an F-16C aircraft, tail number (T/N) 85-1413, impacted the ground approximately 95 miles north of Nellis Air Force Base (AFB), while participating in a training mission. The mishap pilot (MP) was killed. The MP was assigned to the 53rd Wing out of Eglin AFB, but was based at Nellis AFB with the 422d Test & Evaluation Squadron (TES). The mishap aircraft (MA) belonged to the 57th Wing at Nellis AFB. The MP was flying a basic fighter maneuver (BFM) training mission with a mishap wingman (MW) in a second F-16C. The MW is assigned to the United States Air Force Warfare Center, but flies missions with the 422 TES. The MA was completely destroyed upon impact, with a loss valued at $21,298,607. The MA crashed in an unpopulated Bureau of Land Management wilderness area causing incidental damage to a small area of vegetation but no damage to property.

The primary purpose of this mission was to provide a final proficiency training sortie for the MP prior to his start at USAF Weapons Instructor Course (WIC), which was to begin the following week. The MP was focused on WIC preparation and needed one more sortie to complete the attendance prerequisites.

The mishap occurred during F-16 simulated air-to-air combat engagements between the MP and MW. The training engagements subjected the pilots to high levels of sustained gravitational forces (G forces, or Gs) of up to 9 Gs, often at high G onset rates (greater than 6 Gs per second). Twenty-six minutes into the mission, during a planned high-speed turning maneuver likely involving 8 or more Gs, the MA stopped maneuvering and began a steep descending flight path consistent with an aircraft no longer being controlled by the pilot. The MA impacted the ground. There was no evidence of an attempt by the MP to eject or to maneuver the MA prior to impact.

The AIB President found clear and convincing evidence to conclude the cause of the mishap was a G-Induced Loss of Consciousness (G-LOC) experienced by the MP during the high G maneuver. The AIB President found by a preponderance of the evidence that the MP did not adequately perform an anti-G straining maneuver (AGSM) which led to the G-LOC. A preponderance of evidence indicates the MP had excessive motivation to succeed during his fourth engagement and had slight fatigue, which resulted in the MP not adequately performing an AGSM. Furthermore, the MA was in a clean configuration (minimal external stores) that would have enabled a higher G onset rate than what the MP was used to flying. The AIB President found no evidence the MP's physical or mental condition, or Operations' supervision and training contributed to the accident. Additionally, a thorough review of maintenance procedures revealed no problems or adverse trends which could have contributed to the accident.

# SUMMARY OF FACTS AND STATEMENT OF OPINION
# F-16C, T/N 85-1413
# 28 JUNE 2011

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# COMMONLY USED ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 53 WG | 53rd Wing |
| 57 WG | 57th Wing |
| 64 AGRS | 64th Aggressor Squadron |
| 422 TES | 422d Test and Evaluation Squadron |
| AB | Afterburner |
| ACC | Air Combat Command |
| ACES II | Advanced Concept Ejection Seat II |
| ACM | Air Combat Maneuver |
| ADO | Assistant Director of Operations |
| AF | Air Force |
| AFB | Air Force Base |
| AFE | Aircrew Flight Equipment |
| AFI | Air Force Instruction |
| AFIP | Air Force Institute of Pathology |
| AFMAN | Air Force Manual |
| AFP | Augmenter Fuel Pump |
| AFPAM | Air Force Pamphlet |
| AFSC | Air Force Specialty Code |
| AFTO | Air Force Technical Order |
| AFTTP | Air Force Tactics, Techniques and Procedures |
| AGE | Aerospace Ground Equipment |
| AGSM | Anti-G Straining Maneuver |
| AIB | Aircraft Investigation Board |
| AIM | Air Intercept Missile |
| AMU | Aircraft Maintenance Unit |
| AMXS | Aircraft Maintenance Squadron |
| ARMS | Aviation Resource Management System |
| ATC | Air Traffic Controller |
| ATG | Adversary Tactics Group |
| AUX | Auxillary |
| BFM | Basic Fighter Maneuver |
| BINGO | Minimum Fuel Required to Head Home |
| BMC | Basic Mission Capable |
| BPO | Basic Post or Pre-Flight Inspection |
| CAMS | Computer Automated Maintenance System |
| Capt | Captain |
| CAF | Combat Air Forces |
| CAPs | Critical Action Procedures |
| CARA ALOW | Combined Altitude Radar Altimeter Altitude Low |
| CATM | Captive Air Training Missile |
| CDC | Career Development Course |
| Cert | Certification |
| CGO | Company Grade Officer |
| Col | Colonel |
| COMM | Communication |
| CSAR | Combat Search and Rescue |
| Dash one | A.F.T.O. 1F-16C-1 Flight Manual |
| DO | Director of Operations |
| DOD HFACS | Department of Defense Human Factors Analysis and Classification System |
| DSN | Defense Switch Network |
| DTC | Data Transfer Cartridge |
| DVR | Digital Video Recorder |
| DWAT | Descent Warning After Takeoff |
| EFT | Engine Flight Time |
| EOR | End of Runway |
| EP | Emergency Procedures |
| EPU | Emergency Power Unit |
| EU | Electronic Unit |
| F | Fahrenheit |
| FCIF | Flight Crew Information File |
| FDP | Flight Duty Period |
| FLCS | Flight Control System |
| FTU | Flying Training Unit |
| G | Force of Gravity |
| G-LOC | G-Induced Loss of Consciousness |
| GAAF | Ground Avoidance Advisory Function |
| GCAS | Ground Collision Avoidance System |
| GRR | Ground Range Restrictions |
| HARM | High-Speed Anti-Radiation Missile |
| HUD | Heads up Display |
| IAW | In Accordance With |
| IFF | Introduction to Fighter Fundamentals |
| IMDS | Integrated Maintenance Data System |
| IP | Instructor Pilot |
| JHMCS | Joint Mounted Helmet Cueing System |
| JMP | Joint Mission Planning |
| JOAP | Joint Oil Analysis Program |
| K | Thousand |
| L | Local |
| LASDT | Low Altitude Step Down Training |
| LAU | Launch Adaptor Unit |
| LEF | Leading Edge Flaps |
| LIS | Line-in-the-Sky |
| LOX | Liquid Oxygen |
| LPT | Low Pressure Turbine |
| Lt Col | Lieutenant Colonel |
| LZ | Landing Zone |
| MA | Mishap Aircraft |
| Maj | Major |
| MAJCOM | Major Command |
| MAU | Munitions Adapter Unit |
| MDS | Mission Design Series |
| ME | Mishap Engine |
| MF | Mishap Flight |
| MIL or MIL POWER | Military Power |
| MOA | Military Operating Area |
| MP | Mishap Pilot |
| MSL | Mean Sea Level |
| MW | Mishap Wingman |

| | |
|---|---|
| NACTS | Nellis Air Combat Training System |
| NCOIC | Noncommissioned Officer in Charge |
| NOTAMS | Notices to Airmen |
| NVGs | Night Vision Goggles |
| OFP | Operational Flight Program |
| OPR | Officer Performance Report |
| OPSAT | Opposed Surface Attack |
| ORM | Operational Risk Management |
| PCS | Permanent Change of Station |
| PERCH | Set up for an Engagement |
| PHA | Preventative Health Assessment |
| PRD | Pilot Reported Discrepancy |
| PT | Physical Training |
| QA | Quality Assurance |
| QUAL | Qualification |
| RAF | Royal Air Force |
| RED X | Safety of Flight |
| RPM | Revolutions Per Minute |
| RTB | Return to Base |
| RTU | Replacement Training Unit |
| SADL | Situational Awareness Data Link |
| SAR | Search and Rescue |
| SATAF | Sight Activation Task Force |
| SEAD | Suppression of Enemy Air Defenses |
| SEFE | Standardization Evaluation Flight Examiner |
| SIB | Safety Investigation Board |
| S/N | Serial Number |
| SOF | Supervisor of Flying |
| Sortie | Flight |
| TACAN | Tactical Aid to Navigation |
| TCI | Time Change Inspection |
| T.C.T.O. | Time Compliance Technical Order |
| TDY | Temporary Duty |
| TH | Thru-Flight |
| THC | Tetrahydrocannabinol |
| TI | Tactical Intercept |
| T/N | Tail Number |
| T.O. | Technical Order |
| Tox. Screening | Toxicology Screening |
| TSgt | Technical Sergeant |
| US | United States |
| U.S.C. | United States Code |
| USAF | United States Air Force |
| VFR | Visual Flight Rules |
| WIC | Weapons Instructor Course |
| 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 AND PURPOSE

### a. Authority

On 29 June 2011, General William M. Fraser, III, Commander, Air Combat Command (ACC), appointed Brigadier General Donald J. Bacon, to conduct an aircraft accident investigation of a mishap that occurred on 28 June 2011 involving an F-16C aircraft, tail number (T/N) 85-1413, near Nellis Air Force Base (AFB), Nevada (NV). (Tab Y-3 to Y-6) Additional members appointed to the AIB included a Legal Advisor, a Pilot Member, a Maintenance Member, a Medical Member, an Aircrew Flight Equipment Member, an Egress Member, and a Recorder. (Tabs Y-3 and Y-6) The investigation was conducted at Nellis AFB, NV, from 2 August 2011 through 26 August 2011, in accordance with Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, dated 26 May 2010. (Tabs Y-3 to Y-6)

### 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

During an F-16 Basic Fighter Maneuver (BFM) training mission on 28 June 2011 at 1716 local time, F-16C, T/N 85-1413, the mishap aircraft (MA) impacted the ground 95 miles north of Nellis AFB near the town of Caliente, NV. (Tab C-3, N-6) The mishap pilot (MP) was killed in the accident. (Tab X-4) The MA, assigned to the 57th Wing (57 WG), Nellis AFB, was destroyed upon impact with a loss valued at $21,298,607. (Tabs C-4, P-5) The MA crashed in an unpopulated Bureau of Land Management wilderness area causing incidental damage to a small area of vegetation but no damage to private property or structures. (Tab P-4)

## 3. BACKGROUND

The MP was a member of the 422d Test and Evaluation Squadron (422 TES). (Tab R-18) The 422 TES is a squadron within the 53rd Test and Evaluation Group (53 TEG). The 53 TEG is, in turn part of the 53rd Wing (53 WG) headquartered at Eglin AFB. The MA was maintained by the 57th Aircraft Maintenance Squadron (57 AMXS) which is part of the 57th Maintenance Group (57 MXG). Pilot members of the 64th Aggressor Squadron (64 AGRS) normally flew the MA. The 64 AGRS is a squadron within the 57th Adversary Tactics Group (57 ATG). The 57 MXG and 57 ATG are, in turn, part of the 57 WG and the United States Air Force Warfare Center (USAFWC). (Tabs CC-3 thru CC-15)

**a. 57th Wing**


The 57 WG is the largest composite wing in the USAF. It provides advanced aerospace training to world-wide Combat Air Forces (CAF) and showcases aerospace power to the world while overseeing the dynamic and challenging flying operations at Nellis AFB, NV. It oversees all flying operations at Nellis and conducts advanced aircrew, space, logistics and command and control training through the USAF Weapons School, RED FLAG and GREEN FLAG exercises. Important components of the training include adversary tactics replication (provided by the wing's aggressor squadrons) and graduate level instruction and tactics development (accomplished through each of its schools). The wing additionally supports the USAFWC's test and evaluation activities and showcases United States (US) air power through the USAF Air Demonstration Squadron.

The wing is comprised of seven distinct organizations: the 57th Adversary Tactics Group, 57 MXG, 57th Operations Group, USAF Weapons School, USAF Advance Maintenance and Munitions Officers School, USAF Air Demonstration Squadron, and 561st Joint Training Squadron. (Tab CC-3)

**b. 64th Aggressor Squadron**


The 64 AGRS prepares CAF joint and allied aircrews for tomorrow's victories through challenging, realistic threat replication, training, test support, academics, and feedback. They accomplish this as the USAF's professional adversaries, flying F-15 (65 AGRS) and F-16 (64 AGRS) aircraft for RED FLAG and MAPLE FLAG exercises, USAF Weapons School syllabus support, priority test mission support and road shows that visit various units throughout the CAF. (Tab CC-4)

**c. 53rd Wing**


The 53 WG, located at Eglin AFB, Florida, serves as the focal point for the CAF in electronic warfare, armament and avionics, chemical defense, reconnaissance and aircrew training devices. The wing is responsible for operational testing and evaluation of new equipment and systems proposed for use by these forces. Current wing initiatives include advanced self-protection systems for combat aircraft, aircrew flight equipment systems, aerial reconnaissance improvements, new armament and weapons delivery systems, and improved maintenance equipment and logistics support. The 53 WG, comprised of four groups, numbers more than 2,000 military and civilians at 20 various locations throughout the U.S. The wing reports to the USAFWC at Nellis AFB, NV, a direct reporting unit to Headquarters Air Combat Command (HQ ACC). (Tab CC-7)

### d. 422d Test and Evaluation Squadron

The 422 TES at Nellis AFB, Nevada, is a composite squadron that executes HQ ACC-directed operational test and evaluation for A/OA-10, F-15C, F-15E, F-16CM and F-22A hardware, software, and weapons upgrades prior to CAF release. The squadron conducts tactics development, foreign materiel exploitation, and special access programs to optimize system combat capability. The squadron also conducts field visits to instruct operational aircrews on new systems tactics. (Tab CC-12)

### e. F-16 Fighting Falcon

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

In an air combat role, the F-16's maneuverability and combat radius (distance it can fly to enter air combat, stay, fight and return) exceed that of all potential threat fighter aircraft. It can locate targets in all weather conditions and detect low flying aircraft in radar ground clutter. 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. An all-weather capability allows it to accurately deliver ordnance during non-visual bombing. (Tab CC-16)

In designing the F-16, advanced aerospace science and proven reliable systems from other aircraft such as the F-15 and F-111 were selected. These were combined to simplify the airplane and reduce its size, purchase price, maintenance costs and weight. The light weight of the fuselage is achieved without reducing its strength. With a full load of internal fuel, the F-16 can withstand up to 9 Gs — nine times the force of gravity — which exceeds the capability of other current fighter aircraft. (Tab CC-16)

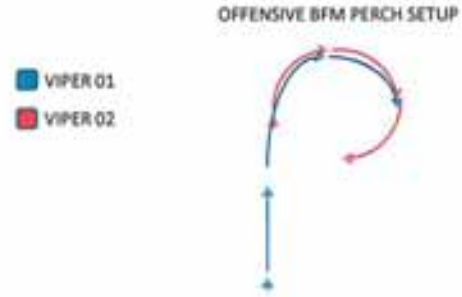
The cockpit and its bubble canopy give the pilot unobstructed forward and upward vision, and greatly improved vision over the side and to the rear. The seat-back angle was expanded from the usual 13 degrees to 30 degrees, increasing pilot comfort and gravity force tolerance. The pilot has excellent flight control of the F-16 through its "fly-by-wire" system. Electrical wires relay commands, replacing the usual cables and linkage controls. For easy and accurate control of the aircraft during high G-force combat maneuvers, a side stick controller is used instead of the conventional center-mounted stick. Hand pressure on the side stick controller sends electrical signals to actuators of flight control surfaces such as ailerons and rudder. (Tab CC-16)

## 4. SEQUENCE OF EVENTS

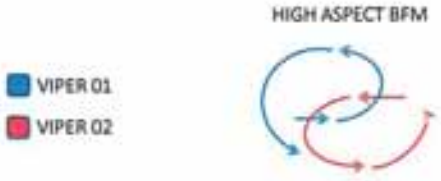
### a. Mission

VIPER flight, consisting of VIPER 01 and VIPER 02, hereinafter collectively referred to as the mishap flight (MF), was a formation of two F-16C aircraft, scheduled as a Weapons Instructor Course (WIC) spin-up mission for the MP. VIPER 01 was the MA/MP. (Tabs K-7, V-18.2) The MP was a current and qualified F-16 instructor pilot (IP) and was acting as the flight lead. (Tabs T-33, T-35, G-3, T-38 thru T-42, G-23 thru G-24) VIPER 02 was the mishap wingman (MW). (Tab K-7) The MW was a current and qualified F-16 IP, a WIC graduate, and was acting as the wingman. (Tabs T-33, T-35, T-45 thru T-49, V-18.2) Planned mission tasks included a military power takeoff, offensive BFM perch setups (see next paragraph), high aspect BFM setups (see second following paragraph), culminating via a return to Nellis AFB for a full stop landing. (Tabs K-5, Tab R-38 thru R-40) The mission was authorized by the 422 TES "Top 3" (squadron supervisor in charge of daily operations) on an Aviation Resource Management System (ARMS) Fighter Flight Authorization Form. (Tab K-7)

Offensive BFM perch setups refer to aircraft combat engagements that begin with the attacking aircraft starting in an offensive position (behind the other aircraft). Perch setups require high levels of G forces – up to 9 Gs – often at high G onset rates (greater than 6 Gs per second). Typically, at the start of the fight, the defensive aircraft begins a high G turn toward the offensive aircraft, attempting to defeat missile shots while creating angular problems for the offensive aircraft. The offensive aircraft maneuvers in relation to the defensive aircraft and normally attempts to enter the defensive aircraft's "turn-circle" (this is where high G onset rates begin) so that over time he can improve his position and shoot the defensive aircraft. (Tabs V-3.12, AA-15, AA-18, BB-10)




High aspect BFM setups refer to aircraft combat engagements that begin with opposing aircraft pointing towards each other at short range. The high G onset rates occur after the aircraft merge, or pass each other going in opposite directions, and then begin maneuvering in relation to one another. Each aircraft attempts to turn back towards the other to gain an offensively advantageous position and shoot the other aircraft. An offensively advantageous position is one in which an aircraft's nose is pointing at the opposing aircraft so that the pilot in advantage can employ ordnance (i.e. shoot missiles or the gun) against the enemy. (Tabs V-3.12 thru V-3.13, AA-14, AA-19, BB-10)



**b. Planning**

Mission planning was conducted in accordance with (IAW) Air Force Instruction (AFI) 11-2F-16V3 (F-16 Operations Procedures) and 422 TES Standards. (Tabs V-18.8, BB-8) On Monday, 27 June 2011, the MP set up his briefing boards (white boards are located in briefing rooms so the briefing pilot can use visual aids during briefings) to assist in the briefing that he would give prior to the mishap flight on Tuesday, 28 June 2011. The MP used the boards to give a practice briefing to Major B.S. on 27 June, and then left the information up on the boards to use the following day. (Tab V-4.5) The MP arrived at the squadron on 28 June at approximately 0800L, 6 hrs and 45 minutes prior to the planned flight brief time. (Tabs R-6, V-13.5, BB-8) He and the MW completed all mission planning, which included filling out a lineup card containing pertinent mission information, checking weather and Notices to Airmen (NOTAMS), and filling out an Operational Risk Management (ORM) Worksheet. (Tabs V-18.8, K-5, K-9 thru K-10) The MP also found out Tuesday morning that he would be flying a Block 25 F-16. While this is not a normal occurrence (the 422 TES normally flies Block 42 or Block 52 F-16s, but occasionally will fly a Block 25), the different block aircraft have negligible differences concerning BFM engagements. The differences between the blocks include analog (Block 25) versus digital (Block 42/52) Flight Control Systems (FLCS) and minor avionics differences. Additionally, the Block 25 does not support the Joint Helmet Mounted Cueing System (JHMCS) whereas the Block 42 and 52 do. To ensure that the MP was comfortable flying the Block 25, Lieutenant Colonel K.J. (an F-16 instructor pilot with approximately 1,000 hrs in the Block 25) talked with the MP about aircraft differences on 28 June, before the flight brief. (Tabs V-13.3 thru V-13.6, V-15.7 thru V-15.8) The flight brief, which was a WIC-level (very in-depth) briefing, started at 1445L and finished at 1545L (15 minutes prior to step time). (Tabs V-18.8 thru V-18.9) The MP used his personal BFM briefing guides, covering all items required by AFI 11-2F-16V3. (Tabs V-18.8 thru V-18.9, AA-3 thru AA-12) Once the MP finished briefing, he and the MW discussed minor tweaks that could improve the MP's briefing in the future. At the conclusion of the brief, both the MP and MW fully understood the mission profile. (Tab V-18.9)

**c. Preflight**

After putting on their flight gear, the MF went to the 422 TES operations desk on time and received a step brief from the Top 3. The following items were covered in the step brief: active runway, current weather, NOTAMS, bird status, and range restrictions. (Tabs V-18.10, AA-13) The Top 3 also examined the ORM worksheet, made sure that the MF had the appropriate media for the sortie, and remained available to coordinate with outside organizations if needed. (Tab V-2.3) After receiving the step brief, both pilots stepped to their respective aircraft and performed preflight safety inspections. No aircraft anomalies were found. The MF started their aircraft at 1620L IAW the flight briefing and completed all normal ground operating procedures without incident. (Tab V-18.10)

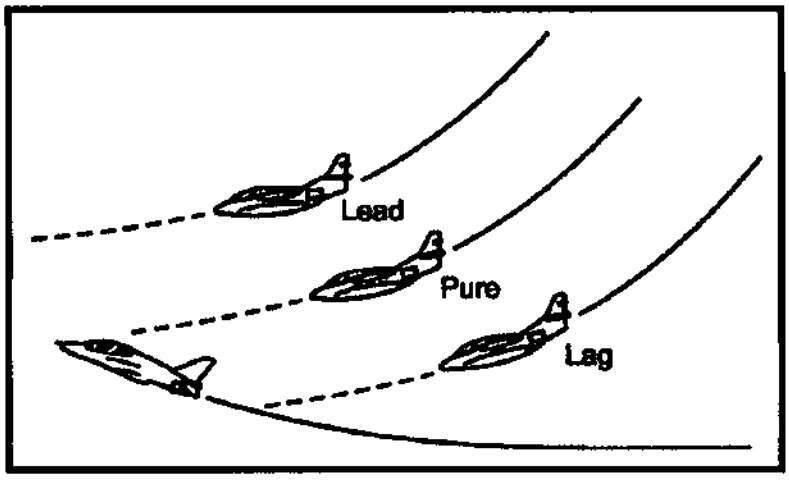
**d. Summary of Accident**

At 1635L, the MF taxied to runway 21 (the active runway). At 1650L, the MF took off from Nellis AFB and departed on a "Dream 2" departure. (Tabs K-5, V-18.10) "Dream 2" is a standard departure procedure that aircraft follow en route to the Caliente Military Operating Area (MOA), the airspace assigned to the MF that day. (Tabs K-3, K-11 thru K-12) At 1701L, the MF

was established in the Caliente MOA and performed a G warm up. (Tab N-3) This maneuver is a 90 degree turn involving 4 to 5 Gs, and is used to ensure that the G-suit, pressure breathing equipment, and the inflatable bladder in the Combat Edge Helmet are working properly. Immediately following the G warm up, the MF completed a G awareness maneuver. This is a 180 degree turn that involves flying the aircraft to body or aircraft G limits (the 422 TES standard is 6 to 7 Gs). While the G warm up is used to test the operation of Anti-G equipment, the G awareness maneuver gives the pilot the chance to practice the Anti-G Straining Maneuver (AGSM). (Tabs BB-5 thru BB-6, BB-9) The AGSM is a muscle-tightening and breathing procedure employed by pilots during high G maneuvers to ensure sufficient blood flow to the brain to maintain consciousness. (Tab DD-8) Following the G warm up and the G awareness exercises, neither member of the MF reported any Anti-G system or body related G force problems. (Tab V-18.7)

The mission for the day involved four engagements:

The first engagement of the day was a 9K offensive BFM set for the MF and began at 1704L. This fight was started at 18,000 feet Mean Sea Level (MSL), with the MP's aircraft 9,000 feet (9K) behind the MW's aircraft. After the fight, the MP debriefed the fight over the radio. He talked about being stuck in "lag" without enough airspeed to continue an effective attack on the MW. (Tabs N-3 thru N-4) Lag pursuit occurs when the nose of the offensive aircraft points behind the defensive aircraft.




The second engagement was a 6K offensive BFM set for the MP and began at 1708L. The fight started at approximately 18,000 feet MSL, with the MP's aircraft 6,000 feet (6K) behind the MW's aircraft. After the fight, the MP pilot debriefed the fight over the radio. The MP talked about achieving a gun track on the MW and mentioned that the second fight went better than the first. (Tabs N-4 thru N-5)

The third engagement was a high aspect BFM set and began at 1712L. This set started with both aircraft pointing at each other at approximately 16,000 feet MSL. During the fight, the MP lost sight of the MW and decided to terminate the fight and reset the engagement. (Tabs N-5 thru N-6) The term "knock it off" is commonly used to terminate a BFM engagement.

The fourth engagement was the mishap engagement and began at 1716L. This set was also a high aspect BFM set and started at approximately 18,000 feet MSL. (Tab N-6) After the aircraft passed each other, the MW lost sight (momentary loss of sight in this type of engagement is not abnormal) of the MA. After scanning the sky where he expected to see the MA (aft and slightly low), the MW felt that something had gone wrong and began looking low and high. Approximately 25 seconds after the two aircraft merged, the MW saw a bright flash below him, which was the MA impacting the ground. In an attempt to determine whether the impact was the MA or some other training in the Test Range, the MW made multiple "status" calls. The term "status" is a request for information on the location of the other aircraft. The MW received no response from the MP. (Tabs V-18.10 thru V-18.11)

**e. Simulator Analysis of Mishap Engagement**

Because the MA's flight data recorders were destroyed in the accident, the AIB lacked detailed objective data on the MA's flight parameters during its final seconds of flight. However, the AIB was able to estimate these parameters based upon information from the MW's Digital Video Recorder (DVR) and the MP's previously briefed high aspect BFM game plan. The AIB sought to improve the fidelity of this estimate by re-enacting the final sequence of events via flight simulation. The AIB conducted the following re-enactment using an F-16 simulator at Nellis AFB. The AIB pilot member simulated the MP, flying a profile based upon the briefed high aspect BFM game plan, resulting in a G-Induced Loss of Consciousness (G-LOC) profile (G-LOC is defined below in Section 11, Human Factors). In this profile, the AIB pilot member passed the merge point, selected afterburner and entered a slightly descending 7 to 8 G turn for 5 seconds, then over rotated 60 degrees nose low, increasing to 9 Gs (the MP's briefed game plan). The AIB pilot member then selected military power (based on post impact engine analysis) and released the control stick as if he had lost consciousness. Each time, after control stick release, the simulated MA accelerated in a nose-low attitude and impacted the ground. (Tab J-16) The following approximate parameters resulted from the simulation:

Speed: 650+ knots
Pitch Attitude: 85 degrees nose low
Time of Impact: 17:16:20L

In this scenario, the simulated MA's starting parameters were very close to the actual MA's airspeed, altitude, attitude, location, and time reported in the accident.

**f. Impact**

The geographic latitude and longitude coordinates of the mishap site were North 37 34.15 West 114 56.7, respectively. (Tab N-8) The MA impacted the ground in an unpopulated Bureau of Land Management wilderness area (Pahroc Valley, approximately 4 miles south of Highway 93) at approximately 1716L, 95 miles north of Nellis AFB, NV, creating a 35 foot wide, 5 foot deep circular crater. (Tabs N-6, M-9, P-4) A preliminary damage and contamination assessment was completed. No private property was damaged or destroyed in the accident. The team found minimal desert flora damage to the surrounding perimeter. There was possible soil contamination at the crash site due to soil contact with petroleum, oil, and lubricant products. Additionally, minimal damage to the desert floor was found, caused by "compression" from the

MA and vehicles/passage in and around the site. There was also minor fire damage on several bushes in the immediate vicinity of the impact site. (Tab P-4) The MP was killed upon impact and the MA was completely destroyed. (Tabs X-4, D-3) The primary wreckage field was within 1,000 feet of the impact crater, mostly in the crater itself and to the northwest and southwest of the crash site. A secondary debris field was located to the northeast, approximately 1,000-3,000 feet from the impact crater. (Tabs S-4 thru S-7)

At impact, the MA was configured with both a LAU-129 (Launch Adaptor Unit) missile launcher and a Nellis Air Combat Training Systems (NACTS) pod on station 1 (left wingtip); a centerline pylon on station 5 (centerline of the aircraft); and both a LAU-129 missile launcher and CATM-9M (Captive Air Training Missile) on station 9 (right wingtip). Additionally, 60 flares were on board. (Tabs U-4 thru U-5)

At impact, the aircraft was on a westerly heading, approximately 85 degrees nose low, with airspeed in excess of 650 knots (see Simulator Analysis section above). Structural breakup of the aircraft was severe, leaving only small pieces of wreckage. (Tab S-7) Testing shows that the nozzle position was approximately 15% open at ground impact, indicating a throttle position of at or near military power (full power without afterburner). The Augmentor Fuel Pump (AFP) is a boost pump that feeds extra fuel to the afterburner (AB) when AB is selected by the pilot. Inspection of the AFP revealed that the pump was not spinning, indicating that AB was not selected at the time of impact. (Tabs J-11 thru J-12, J-14, J-16)

**g. Egress and Aircrew Flight Equipment**

There was no evidence of an ejection attempt. (Tabs H-5 thru H-8, R-68, R-70) The MP was wearing the appropriate AFE for a daytime BFM mission. (Tabs V-6.3, V-18.7) However, AFE records indicate the MP's G-suit was overdue for a 120-day fit check. (Tab EE-6) The MP was wearing the CSU-13 B/P Anti-G suit. (Tab V-14.4, EE-6)

Performance and inspection of the 120-day fit check is not mandated by the Technical Order (TO). However, three major commands (MAJCOMS) do require a 120-day fit check. Those MAJCOMs are ACC, Pacific Air Forces, and United States Air Forces in Europe. (Tab EE-5) The MP was assigned to a unit within ACC, thus requiring the 120-day fit check.

The 120-day fit check is normally accomplished during a 120-day periodic inspection. The last recorded 120-day periodic inspection was accomplished on 31 May 2011. The last recorded 120-day fit check was 8 February 2011. (Tab EE-6) The periodic inspection includes a visual inspection of the entire G-suit, an operational test of all zippers, and a bladder leakage test. The leakage test ensures the integrity of the bladders during inflation. The fit check includes a visual check while the pilot is wearing the G-suit to ensure a proper fit.

The CSU-13B/P G-suit contains 5 air bladders that cover the legs and abdominal area (see below). The G-suit automatically inflates as needed with pressurized air through a hose connected to the aircraft. It assists the pilot in managing G forces by preventing blood from pooling in the legs under Gs. The suit starts to inflate at 2 Gs and increases pressure as the Gs

increase. The G-suit reduces the amount of blood flow to the legs, which helps maintain positive blood flow to the eyes and brain. This suit increases G tolerance by approximately 1 G.


**CSU-13 B/P Anti-G Garment**

The pilot accomplishes a pre-flight inspection as well. A visual check is done at the pilot's equipment locker and an operational/inflation check is accomplished in the aircraft prior to take off. The MP never mentioned a malfunction of the system prior to stepping to the aircraft, prior to taxi or during the flight. (Tab V-18.7)

All AFE technicians' training records applicable to this mishap were reviewed and all were qualified to perform applicable inspections on mishap equipment. AFE records were reviewed and all equipment had current inspection dates with the exception of the G-suit fit check. (Tab EE-3) Upon review of the records, it was discovered that the 120-day G-suit fit check had expired. The last fit check on record was 8 February 2011. Subsequently, according to the inspection record, the next inspection would have been due on 7 June 2011, approximately one week after the 120-day periodic inspection. (Tab EE-6) When a G-suit fit check is due, AFE technicians notify the crewmember in two ways. First, they e-mail the crewmember, and second, they place a laminated card on the crewmember's Flight Equipment locker saying the G-suit fit check is due. (TabV-10.2) Under normal circumstances, the crewmember meets with an AFE technician before the next flight and they accomplish the fit check together. (Tabs V-1.11, V-2.6, V-3.10, V-4.10, V-5.10, V-9.4, V-10.2, V-13.6, V-14.2, V-15.7). AFE records indicate the MP was briefed on fit check procedures by the AFE section during his in-processing brief. (Tab EE-7)

The MP's G-suit waist zipper was found at the mishap site. The two snaps were still snapped together and the bottom of the zipper was still engaged. This indicates that at the time of mishap, the waist zipper was properly closed. A G-suit comfort zipper in the closed position was also found; however it could not be determined whether it came from the left or right leg of the G-suit. Nevertheless, this indicated that the G-suit was worn properly during the flight. (Tabs H-10 thru H-11)

Habit evidence indicates that the G-suit was fit properly and the 120-day fit check was accomplished. (Tabs V-10.4, V-14.2) The MP flew seven sorties after the periodic inspection was performed on 31 May 2011. It is not uncommon for AFE technicians to remove flight equipment that is overdue for inspections, to include G-suits, from an aircrew member's locker and not return it until the inspection is completed face-to-face with the pilot. None of the 422 TES AFE technicians recalled such an occurrence with the MP's G-suit during the month of June. (Tabs V-10.4, V-14.2)

Additional evidence indicates the G-suit fit properly and the 120-day fit check was accomplished, but not documented. After the mishap, the MP's personal effects were quarantined in his locker. An inventory of the contents of the locker did not reveal the presence of a laminated card from an AFE technician identifying his G-suit fit check being due. (Tab V-14.4) This indicates the MP would have returned the card to the AFE technicians and performed the 120-day fit check. Circumstantial evidence indicates the discrepancy of the overdue date on the inspection card was a documentation error from the actual fit check date not being entered into the computer data tracking system as opposed to the fit check not being accomplished. (Tabs V-10.3, V-14.2)

As such, there was no evidence to suggest a malfunction in the MP's G-suit. All required maintenance and inspections had been performed with the exception of documentation of the 120-day fit check. Additionally, the MP made no mention of any G-suit issues. (Tab V-18.7)

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

The MW located the mishap site at approximately 1717L, and immediately assumed the role of on-scene commander. The MW contacted STRIKE flight, a two-ship of F-15Es, on the radio and asked for assistance. The MW had STRIKE flight contact the Supervisor of Flying (SOF) to request a SAR team. STRIKE flight contacted the SOF, then asked the MW for the coordinates of the accident site. The MW passed the coordinates to STRIKE flight, who relayed the information to the SOF. Due to fuel limitations, STRIKE flight did not fly to the crash site, but held over Dry Lake and relayed information via radio to the SOF to assist the MW. STRIKE flight also passed vital information to BLACKJACK (Nevada Test and Training Range Air Traffic Control). HOSS flight (a flight of two F-15Es) was waiting for takeoff at Nellis AFB at the time of the mishap. (Tab V-15.10) The SOF directed HOSS flight to proceed to the accident site to relieve the MW of on-scene commander duties. The SOF also coordinated to have SAR forces mobilized. The MW directed STRIKE flight to tell the SOF that he did not see a parachute or an ejection. At 1729L, STRIKE flight began their return to Nellis AFB due to fuel limitations. At this time, HOSS flight was airborne and began communicating with the MW. The MW told HOSS that he only had enough fuel to remain on station for 10 more minutes. At

1730L, SAR assets were notified that an aircraft had crashed on the Nevada Test and Training Range (NTTR) and began planning the SAR effort. At 1734, HOSS flight arrived overtop the mishap site and took over on-scene commander duties, allowing the MW to return to Nellis AFB. The original SAR plan involved 3 helicopters, 1 Combat Rescue Officer, 6 Pararescue Jumpers, 3 Security Forces personnel, and 2 Safety personnel. During preflight operations, one of the helicopters experienced maintenance problems, thereby causing the SAR forces to move to the other 2 helicopters. The first helicopter took off at 1955L. The second helicopter took off approximately 15 minutes later. The flight to the mishap site took slightly less than an hour. En route, the helicopters contacted HOSS 2 and received an updated briefing, including a detailed landing zone description, any hazards in the area, and current winds at the mishap site. HOSS 2 notified the SAR forces that the Lincoln County Sheriff's Department had posted vehicles approximately 1 kilometer south of the crash site, secured the area, and would remain on scene until the helicopters arrived. At 2045L, the first helicopter arrived on scene and offloaded ground personnel. Fifteen minutes later, the second helicopter landed and offloaded more ground team members. At 2205L, the ground team located and recovered sufficient remains, concluding their search at 2315L. The Safety Officer was tasked to maintain positive control of the remains throughout the flight. At 2335L, the SAR forces left the mishap site en route to Nellis AFB, landing at 0025L, and conducted a dignified transfer of the remains from the aircraft to the ambulance/mortuary affairs personnel. (Tabs N-6 thru N-12, AA-16 thru AA-17)

**i. Recovery of Remains**

On 28 June 2011 the 99th Force Support Squadron (FSS) at Nellis AFB assembled the Search and Recovery Team (SART) following the report of an aircraft mishap. (Tabs X-23 thru X-24) The SART consisted of 19 individuals from the 99 FSS Mortuary Affairs in cooperation with Air Force Medical Operations Agency and the Air Force Medical Examiner's office. The scene was initially surveyed and secured by Pararescue and the 99th Security Forces Squadron on the evening of 28 June 2011. A two-man SART advanced party arrived on scene at 0813 on 29 June 2011 to begin the recovery organization and effort. (Tab X-24) The full SART arrived on scene at 1645 that afternoon. (Tab X-25) At 2200 on 29 June 2011 the United States Armed Forces Forensic Anthropologist and Medical Examiner arrived from Maryland at the Mike O'Callaghan Federal Hospital's Pathology department to begin confirmation of the remains. (Tab X-23) On the morning of 30 June 2011 the Forensic Anthropologist and the Medical Examiner arrived on the mishap scene to aid in the search and recovery. (Tab X-27) The SART searched a radius of 1,000 feet from the impact crater. (Tab X-27 thru X-29) Excavation of the crater revealed no human remains. All remains were found northwest of the impact crater. On 1 July 2011, the Anthropologist and Medical Examiner returned to Nellis AFB to identify the remains found. (Tab X-23 thru X-28) The SART concluded their search on 4 July 2011. (Tab X-30)

## 5. MAINTENANCE

### a. Forms Documentation

#### (1) Summary

The total airframe operating time at the time of the mishap, including the mishap flight time, was 5,564.6 hours. The Mishap Engine (ME) was a Pratt & Whitney F100/220 engine, serial number (S/N) 703471, and was installed into the MA on 20 November 2010. It had 7,747.9 hours total engine operating time with 2,298.7 hours Engine-Flight Time (EFT). (Tabs D-3, U-17, U-19 thru U-21)

A detailed review of active and historical Air Force Technical Order (AFTO) Form 781 series aircraft maintenance forms, AFTO Form 95 series significant historical data forms, and Jet Engine Intermediate Maintenance historical data revealed no discrepancies indicating engine, mechanical or flight control anomalies existed on the MA. (Tab U-3) A thorough review of the active AFTO 781 forms and AFTO 781 historical records for the time period 90 days preceding the mishap revealed no evidence of mechanical, structural or electrical failure. The Integrated Management Data System (IMDS) historical records for 90 days prior to the mishap were used to validate and confirm all form entries. (Tab U-3) None of the open Time Compliance Technical Orders (TCTO) in the active forms restricted the MA from flying; a review of the historical records showed all TCTOs had been accomplished in accordance with applicable guidance. (Tab D-200) There is no evidence that compliance with AFTOs, TCTOs, or maintenance historical records were a factor in this mishap.

The MA flew a total of 62 flights in the 90 days prior to the mishap. Fifty-nine of those flights were classified as Code 1 (no significant maintenance problems noted), two were Code 2 (aircraft has some degraded system performance, but is still flyable), and one was Code 3 (significant problems that require repair before the aircraft can fly again). (Tab U-3) The MA's single Code 3 discrepancy is identified below:

> 14 April 2011 – Emergency Power Unit (EPU) run light burned out. Maintenance replaced the bulb. (Tab U-17)

None of the in-flight discrepancies issues were determined to be a factor in the mishap.

#### (2) Major Maintenance

There was major maintenance performed on the MA in the preceding 30 days, but the AIB determined that none of the major maintenance actions contributed to the mishap. (Tab D)

#### (3) Recurring Maintenance Problems

Maintenance personnel indicated no recurring problems with the MA. A review of the MA AFTO 781 FORMs and IMDS data also revealed no recurring problems. (Tab U-3)

**(4) Open Write-ups**

The MA AFTO Form 781A had three non-grounding open write-ups at the time of the mishap. These open write-ups were minor discrepancies not affecting the airworthiness of the MA that had not yet been corrected. The non-grounding open write-ups were: (1) 12 month recovery parachute assembly repack due; (2) 12 month Advanced Concept Ejection System (ACES) II survival kit inspection and repack due; (3) "Job created to order part." (Tabs D-21 thru D-22)

The two open write-ups for the 12 month recovery parachute assembly repack and the 12 month ACES II survival kit inspection and repack are Time Change Items (TCIs) that must be accomplished before the due date. Both of these items were due on 14 July 2011. The write-ups were originally documented on 27 June 2011 by Aircraft Maintenance Unit (AMU) technicians. Egress technicians removed and replaced both the recovery parachute and the survival kit on 28 June 2011. The Egress technicians created their own write-ups with separate job control numbers in the MA's forms, and signed these write-ups off after replacing the items. Typically, if the AMU writes up Egress TCIs, Egress technicians will sign off the AMU's write-ups after creating and signing off their own write-ups. In this case, neither Egress technicians nor AMU technicians signed off the AMU's write-ups after the Egress technicians had replaced both items. This left the AMU's two original write-ups open in the forms when the MA flew on 28 June 2011. Because both inspections were accomplished correctly, this is a documentation-only error. The two open write-ups for the recovery parachute and the survival kit were not relevant to the mishap. (Tab U-8 thru U-9)

The open write-up that stated, "Job created to order part" was a documentation error by an AMU technician. The part that was placed on order was a Head's Up Display (HUD) Electronic Unit for aircraft 85-1418, and the technician who documented the write-up in the forms on 27 June 2011 mistakenly entered it in the MA's forms. The write-up did not reflect a condition on the MA, and was a documentation error only. (Tabs U-10 thru U-11)

**(5) AFTO 781K Write-ups**

The MA AFTO Form 781K had no overdue inspections. (Tab D-5 thru D-6)

**(6) Pre-flight Operational Checks**

The MA AFTO Forms 781A for the period 27-28 June 2011 indicated all pre-flight servicing checks were completed prior to the flight on 28 June 2011. (Tabs U-18 thru U-19) Liquid Oxygen (LOX) was verified at 3.0 liters and the fuel load at 7,200 lbs. (Tab U-19)

**b. Inspections**

**(1) Mishap Aircraft**

Phase inspections are regularly scheduled maintenance inspections performed on Air Force aircraft at specific flying hour intervals. The Block 25 F-16C has a 300-hour phase inspection cycle. The last phase inspection accomplished on the MA was started on 4 November 2010 at

5,386.5 airframe hours. The aircraft had approximately 122.4 airframe hours remaining before its next phase inspection due date. (Tab D-3)

On 27 June 2011, the MA's crew chief conducted a Basic Postflight/Preflight (BPO/PR) inspection on the MA. This type of inspection is valid for 72 hours, and was still valid when the MA took off for its first sortie of the day. (Tab U-18)

On 28 June 2011, the MA flew two sorties prior to the mishap sortie. Between those two prior sorties, the only maintenance action that was accomplished was hot pitting. Hot-pitting is a process wherein a pilot taxis to a specified area following a sortie, and maintenance technicians, as part of a hot-pit crew, service the aircraft with fuel while the engine remains running. Prior to fuel servicing, the hot pit crew checks the aircraft for hot brakes, de-arms all munitions systems, safes the landing gear and EPU, and visually inspects the aircraft for damage or leaks. Following fuel servicing, the hot-pit crew unpins and re-arms the aircraft before launching it out for its next sortie. Hot-pitting is accomplished when an aircraft will immediately accomplish a turnaround or continuation sortie. Between its first two sorties on 28 June 2011, the hot pit crew noticed nothing abnormal about the MA. Two 57 MXG Quality Assurance (QA) inspectors were present and observed the hot pit crew's actions while certifying one of the crew members. The QA inspectors witnessed no discrepancies with the hot pit crew's work, and noticed nothing abnormal about the MA. (Tabs U-12, U-19)

A Thru-Flight (TH) inspection must be accomplished between flights when a turnaround or continuation sortie is scheduled and a BPO is not required. (A TH inspection is not required when aircraft are hot-pitted and immediately accomplish a turnaround or continuation sortie.) A TH inspection was the last minor scheduled inspection on the MA on 28 June 2011. The crew chief completed and documented the TH inspection, which included engine intake and exhaust inspections, after the MA's first two flights on 28 June 2011, approximately 1.5 hours before the mishap flight. During the TH inspection, the crew chief identified that the MA's nose landing gear tire required replacement. He accomplished the tire change prior to the mishap sortie. (Tabs U-18, D-27 thru D-28)

The Exceptional Release, the process that releases the aircraft from maintenance to operations or the pilot, was accomplished and documented. (Tabs U-18, D-29)

The last maintenance technicians to look at the aircraft prior to takeoff were the End of Runway (EOR) crew. The EOR crew's job is to unpin any munitions loaded on the aircraft, and check for any obvious discrepancies such as open doors/panels or incorrect hydraulic systems pressures. All EOR crew members stated that they noticed nothing abnormal about the MA. (Tabs U-13 thru U-15)

Investigation revealed no overdue airframe inspections.

**(2) Mishap Engine**

The most recent inspection accomplished on the ME was a 100-hour borescope inspection, which occurred on 5 April 2011. (Tab D-3) Prior to that, the engine was inspected during the 200/400-hour phase inspection at 7,585.6 engine hours. (Tabs D-3, U-16) All engine work packages were reviewed for accuracy to include information from IMDS, Joint Oil Analysis Program (JOAP) and Comprehensive Engine Management System to determine serviceability of the ME. No discrepancies were noted. (Tab U-3)

**(3) Egress and Aircrew Flight Equipment**

The AIB reviewed all maintenance records for physiological, ejection, escape, and survival systems for the MA and MP. (Tab EE-8) Post-mishap drug tests revealed that the contractor technician who installed the parachute and survival kit had traces of tetrahydrocannabinol (THC) in his system. (Tab EE-9) An attempt to verify the technician's training records was unsuccessful; on 5 July 2011 the technician resigned and was given his training records. The Egress Section did not maintain an archived copy of these records (Tab H-5 thru H-8). The maintenance performed by the contractor technician pertained to components that would be activated after a successful ejection. Actuation of the recovery parachute and survival kit occur after the ejection seat leaves the aircraft. These items do not affect the ejection sequence, and the work performed would not pose any threat to or cause any failure of ejection initiation. (Tab H-5) Additionally, the contractor technician's work was inspected and verified by a more experienced contractor technician who had 8 years experience on F-16 Egress systems. (Tab V-16.1) No discrepancies were discovered during post-maintenance inspections. (Tab V-16.3) The AIB determined that the presence of THC in the contractor technician's system did not contribute to the mishap. There were no overdue Egress system inspections on the MA, and all components were in serviceable condition at the time of the mishap. (Tab EE-8)

**c. Maintenance Procedures**

All aircraft forms and maintenance records were reviewed and showed that maintenance was conducted IAW applicable TOs. The AIB discovered one procedure that was not IAW AFI guidance. Changes to aircraft configurations are required to be documented on an AF Form 2407, "Weekly/Daily Flying Schedule Coordination." The signed weekly schedule showed the MA's configuration would be one CATM-120 missile on each wingtip, and one NACTS pod installed on station 8 of the right wing. Early in the morning on 27 June 2011, AMU weapons technicians discovered that they were unable to load CATM-120 missiles on the MA's wingtips because the MA did not meet capabilities required for that configuration. The AMU coordinated with Operations later that morning to leave the MA's configuration for the week as one CATM-9M missile on the right wingtip, one NACTS pod on the left wingtip, and a centerline pylon, but did not initiate an AF Form 2407 to document the change. Per ACCI 21-165, the configuration changes should have been documented on an AF Form 2407. The AIB determined that the lack of an AF Form 2407 to document the MA's configuration change did not contribute to the mishap. (Tabs U-4 thru U-7)

No major discrepancies were found in maintenance records, but the AIB found some inconsequential minor errors on some entries, such as several AFTO 781A Forms write-ups not cross-referenced, and the three previously mentioned open write-ups that should not have been in the MA's forms (recovery parachute, survival kit, and "job created to order part").

No evidence was found that any maintenance procedure, practice, or performance contributed to the mishap.

**d. Maintenance Personnel and Supervision**

Interviews conducted with maintenance personnel indicated all preflight activities were normal and all personnel involved in the preflight and launch of the MA were experienced and qualified. (Tab U-3) Training records of all maintenance personnel who serviced and maintained the MA revealed no evidence of training deficiencies that contributed to the mishap. All personnel involved in servicing or inspecting the MA prior to the 28 June 2011 mishap sortie were qualified and proficient in the performance of their duties. Investigation revealed that AMU Supervision was actively engaged in maintenance operations. (Tab U-3)

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

Fuel samples were taken and tested post-accident from Fuel Truck 05L-075, Fuel Storage/Issue Tank #1, and Fillstand #1, all of which were used to refuel the MA on 28 June 2011. All fuel samples tested were within limits and were free from contamination, IAW TO 42B-1-1. (Tabs D-203 thru D-206)

LOX samples were taken post-accident from LOX Tank #1 and LOX Cart #27, both of which were used to service the MA prior to the mishap. The samples tested were within limits and were free of any contaminations IAW TO 42B6-1-1. (Tabs D-207, U-22)

Hydraulic fluid samples were taken post-accident from the hydraulic servicing carts and test stands that serviced the MA prior to the mishap. The test stand and one hydraulic servicing cart tested within limits and were free of any contamination. The sample from the second hydraulic servicing cart was free from contamination but failed the test due to the presence of two separate types of hydraulic fluid: MIL-PRF-5606 hydraulic fluid with a trace of MIL-PRF-83282 hydraulic fluid. However, per TO 42B2-1-3, Table 10-1, both types of hydraulic fluid are identified for use and may be used together in the F-16C. (Tabs D-208 thru D-210, D-212 thru D-213) Engine oil was analyzed after the first two flights of the day, just prior to the mishap flight, showing acceptable limits per the mandated JOAP. (Tab D-211)

No fluid samples were obtained post-accident from the MA. No evidence was found that servicing equipment contributed to the mishap.

**f. Unscheduled Maintenance**

Unscheduled maintenance was performed on the MA the day of the mishap, after the TH inspection had been accomplished. The MA's nose landing gear tire was removed and replaced

after the first two flights on 28 June 2011 due to wear. The torque links were disconnected to tow the aircraft to a hangar for the tire replacement, and then reconnected after towing it back to the parking ramp. (Tabs D-28 thru D-29) Evidence indicated all unscheduled maintenance performed on 28 June 2011 was completed IAW applicable TOs. Furthermore, the MA flew the first two flights of the day on 28 June 2011 with no discrepancies. (Tab U-3) Unscheduled maintenance actions were determined to not be a factor in the mishap.

## 6. AIRFRAME SYSTEMS

### a. Condition of Systems

The MA was destroyed on impact. Post mishap analysis of several components was completed by Lockheed Martin Aeronautics Company and Pratt & Whitney. (Tabs J-5 thru J-18)

### b. Testing

The Crash Survivable Memory Unit was the only Crash Survivable Flight Data Recording System component recovered. No data could be retrieved from the memory chips due to the severity of the crash and condition of the memory chips. (Tab Q-7)

Several pieces of the MA engine were recovered at the crash site and analyzed. The damage sustained by the engine hardware and major rotating parts was consistent with an engine that was operating at high speed upon impact. (Tabs J-5 thru J-16)

Several flight control components were analyzed. Two of the eight Leading Edge Flap (LEF) actuators were recovered and measured, indicating that they were near full up position. However, due to the lack of witness "trap" marks and the inability to measure the remaining six LEF actuators, it could not be determined with a high degree of confidence that this was the position they were in at impact. Additionally, two of the five Integrated Servo Actuators were recovered at the crash site, but the witness marks were inconclusive and could not be used to determine status of the flight control system. (Tabs J-17 thru J-18)

The MA had the following ground collision avoidance systems installed: Ground Avoidance Advisory Function (GAAF), Combined Altitude Radar Altimeter Altitude Low (CARA ALOW), Line-in-the-Sky (LIS), Descent Warning After Takeoff (DWAT), and Ground Collision Avoidance System (GCAS). All systems provide an "Altitude-Altitude" voice warning if the aircraft drops below the system's pre-set altitude limit. (Tab BB-13)

Based on the major debris field to the north-northwest of the impact site, and the impact angle of the CATM-9M missile and the NACTS pod at the crash site, the aircraft impacted approximately 85 degrees nose low. Based on previous F-16 mishaps, this type of damage indicated an impact speed of at least 650 knots. (See Simulator Analysis, Section 4.e of this report)

## 7. WEATHER

### a. Forecast Weather

At takeoff time, weather for Nellis AFB was forecast to be few clouds at 25,000 feet with no significant weather. Visibility was forecast to be 7 statute miles. Winds were projected to be from the southwest at 25 knots, with gusts up to 35 knots. Surface temperature was forecast to be 106 degrees Fahrenheit (F). Local weather watches and warnings included a possible 35 knot wind warning and a possible observed Fighter Index of Thermal Stress (FITS) danger. This limits the allowable time for aircrew to be outside of an air conditioned facility. (Tab F-5)

On 28 June 2011, weather for the NTTR airspace was forecast to be scattered clouds from 25,000 feet to 31,000 feet. Visibility was forecast to be 7 statute miles. The wind at 14,000 feet MSL was forecasted to be from the southwest at 55 knots. (Tabs F-11 thru F-12)

### b. Observed Weather

Nellis AFB: The mishap flight took off from Nellis AFB at 1650L. (Tab K-12) Weather observations were taken at 1655L and 1755L, approximately 21 minutes prior to and 39 minutes after the mishap. Both observations were approximately the same. The observations revealed clear skies, visibility of 10 statute miles, winds from the southwest at 24 knots with gusts up to 33 knots, and a temperature of 106 degrees F. (Tab F-3)

### c. Space Environment

Not applicable.

### d. Operations

The temperature was 106 degrees F at the time of step/preflight, resulting in FITS danger. (Tab F-5)

## 8. CREW QUALIFICATIONS

### a. Mishap Pilot

#### (1) Training

The MP completed Undergraduate Pilot Training as a member of the 80th Flying Training Wing at Sheppard AFB, Texas, and earned his United States Air Force aeronautical rating on 17 December 2004. (Tab T-3) Soon thereafter, he joined the 88th Flying Training Squadron and completed the Introduction to Fighter Fundamentals (IFF) course, learning BFM and Basic Surface Attack in the T-38, a training aircraft. After graduating from IFF on 15 August 2005, the MP transferred to Luke AFB, AZ, where he attended the F-16 Basic Course, flying Block 25 F-16s. At Luke AFB, he completed the basic course (F-16 qualification training) as a member of the 309th Fighter Squadron, part of the 56th Fighter Wing. (Tabs T-4 thru T-6) His first operational assignment soon followed.

**(2) Experience**

The MP accepted a remote assignment as a member of the 35th Fighter Squadron, part of the 8th Fighter Wing, stationed at Kunsan Airbase, Republic of Korea. (Tab T-7) Following Korea, the MP moved to Spangdahlem Airbase, Germany, flying Block 50 F-16s with the 23rd Fighter Squadron, part of the 52nd Fighter Wing. (Tab T-8) The MP joined the 422 TES in November 2010 (Tab T-9). The MP's accepted qualifications when he entered the 422 TES were as follows: experienced F-16 instructor pilot, Low Altitude Step Down Training (LASDT) CAT 1 (cleared down to 500 ft above ground level (AGL)), Night Vision Goggle (NVG) Flight Lead, Targeting Pod, Suppression of Enemy Air Defenses, JHMCS Instructor, and Functional Check Flight pilot. (Tabs T-11 thru T-12) While a member of the 422 TES, the MP completed multiple upgrades in the following sequence: egress instructor, test upgrade, LASDT CAT 2 (cleared down to 300 feet AGL), NVG Low (cleared down to 500 ft AGL at night), NVG night IP, mission commander, and global cruise (cleared to chase cruise missiles). (Tab T-13 thru T-30) While a member of the 422 TES, the MP was also selected for WIC. (Tab T-31 thru T-32)

At the time of the mishap, all of the MP's currencies required for a BFM mission were up to date. The MP had current check ride dates, signed off all required Flight Crew Information Files (FCIFs), had a current Critical Action Procedure (CAP) worksheet (listed as boldface in supporting documents), and all Go/No-Go items were verified. (Tabs T-33 thru T-41, G-23 thru G-24, G-14 thru G-17)

The MP had a total of 1,319.2 flight hours, including 1,010.3 hours in the F-16, and 303.9 combat hours. (Tabs G-6 thru G-7)

The MP's flight time during the 90 days before the mishap is as follows:

| | Hours | Sorties |
|---|---|---|
| Last 30 Days | 14 | 7 |
| Last 60 Days | 27.2 | 16 |
| Last 90 Days | 44.8 | 32 |

(Tab T-42)

**b. Mishap Wingman**

**(1) Training**

The MW was a current and qualified experienced F-16 instructor pilot and a WIC graduate. The MW was up to date on all currencies required for a BFM mission. The MW had current check ride dates, all FCIFs signed off, a current CAP worksheet (listed as boldface in supporting documents), and his Go/No Go items were verified. (Tabs T-33 thru T-37, T-44 thru T-49, V-18.2)

**(2) Experience**

At the time of the mishap, the MW had 3,044.8 flight hours in the F-16 with 51.3 combat hours. (Tabs T-43, T-50)

The MW's flight time during the 90 days before the mishap is as follows:

| | Hours | Sorties |
|---|---|---|
| Last 30 Days | 3.8 | 2 |
| Last 60 Days | 15.5 | 11 |
| Last 90 Days | 18.8 | 14 |

(Tab T-42)

Crew qualifications were not a factor in this mishap.

## 9. MEDICAL

### a. Qualifications

At the time of the mishap, the MP was fully medically qualified for flight duty without medical restrictions. The MP carried an indefinite waiver for Disorder of Refraction (near-sightedness) that was granted in 2002. The MP's most recent flight physical on 29 April 2011 determined he was medically qualified for flight duties and qualified for worldwide military duty. (Tab X-18) The MP displayed no physical or medical limitations prior to the mishap. (Tab X-17)

At the time of the mishap, the MW's most recent flight physical was on 17 May 2010 and his AF Form 1042 was valid until 17 August 2011. (Tab X-19) Since the mishap the MW had his annual flight physical on 7 July 2011. He was medically qualified for flight and for worldwide military duties. The MW carries no waivers. The MW displayed no physical or medical limitations prior to the mishap. (Tab X-17)

The MA Crew Chief (Airman A.L.) had his annual physical performed on 23 June 2011. He had no issues or concerns and was medically cleared for duty. (Tabs X-21 thru X-22) Additionally, all ground maintenance crew members were medically qualified for duty at the time of the mishap. Physical and medical qualifications were not factors in the mishap.

### b. Health

The AIB's medical member reviewed the medical and dental records of the MP and MW, as well as the MW's and the MA crew chief's 72-hour and 14-day history. (Tabs X-9 thru X-16) Records revealed all individuals were in good health and had no recent performance-limiting illnesses prior to the mishap. Review of the Preventative Health Assessment (PHA) and Individual Medical Readiness, Armed Forces Health Longitudinal Technology Application and Composite Healthcare System showed that the MP, MW and A.L. had current PHAs. After interviewing the A.L., and thoroughly reviewing the MW's and A.L.'s medical records, there was no evidence that any medical condition contributed to this mishap. (Tabs V-6.2 thru V-6.3, X-17, X-21)

The AIB's medical member reviewed the MP's medical examiner's autopsy report. The MP died instantly from injuries sustained when his aircraft impacted the ground. (Tabs X-5 thru X-6)

**c. Pathology**

Immediately following the mishap, commander-directed toxicology testing for all personnel involved in the flight and the launch of the MA. Blood, tissue and urine samples were submitted to the Armed Forces Institute of Pathology (AFIP) for toxicological analysis. This testing included carbon monoxide, cyanide and ethanol levels in the blood/tissue and drug testing of the urine/tissue.

The carbon monoxide and cyanide levels were unable to be performed on the samples provided from the MP. (Tab X-7) Testing was also performed on the MW and associated maintenance crew members. All results were normal. (Tabs X-8, X-31)

AFIP examined the tissue for the presence of ethanol at a cutoff of twenty milligrams per deciliter. AFIP detected no ethanol in the MP's tissue. (Tab X-7) Ethanol results were also negative for the MW and associated maintenance crew members. (Tabs X-8, X-31)

Furthermore, AFIP screened the MP's, MW's and maintenance crew members' urine/tissue for amphetamine, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates and phencyclidine by immunoassay or chromatography. AFIP detected none of these drugs in the MP or MW. (Tabs X-7 thru X-8) One civilian egress contractor tested positive for cannabinoids. (Tab EE-9) All other maintenance members tested negative. (Tabs X-20, X-31)

**d. Lifestyle**

On 27 June 2011 the MP was informed of his grandfather's death. The occurrence was not a surprise to the MP but was still met with grief and sadness. He had the insight that this news affected his judgment and concentration. (Tabs R-19, R-32 thru R-33, V-1.4) Therefore, he removed himself from flying for that day. (Tabs V-1.4 thru V-1.5, V-4.3) On 28 June 2011, the date of the mishap, the MP returned to work and informed his Division Commander that he was ready to fly. In all accounts from his friends and squadron mates he appeared focused and without distractions. (Tabs R-13, R-19 thru R-20, R-28, R-37, R-45 thru R-46, V-1.4, V-1.6, V-2.3, V-2.5, V-3.4, V-3.7, V-4.3 thru V-4.5, V-4.8, V-5.6 thru V-5.8, V-11.2 thru V-11.4, V-13.3 thru V-13.4, V-15.5 thru V-15.6, V-18.3) Besides this occurrence there is no evidence that any behavior, stress, distractions or unusual habits displayed by the MP, MW or maintenance crewmembers had any contribution to the mishap. Witness testimonies, as well as review of 72-hour histories of the MW and pertinent maintenance crewmembers, revealed no substantial evidence or abnormal behaviors that would be contributory to the mishap. (Tabs X-9 thru X-16)

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

Air Force Instructions require pilots have proper "crew rest," as defined in AFI 11-202, Volume 3, *General Flight Rules*, 22 October 2010, prior to performing flying duties. AFI 11-202, paragraph 9.4.5 defines normal crew rest as a minimum 12-hour non-duty period before the Flight Duty Period begins. Its purpose is to ensure the aircrew member is adequately rested before performing flight or flight related duties. Crew rest is free time, and includes time for

meals, transportation, and rest. Rest is defined as a condition that allows an individual the opportunity to sleep.

The MP's wife stated that the MP had good sleep the night before and had normal nutrition and hydration the morning of the mishap. (Tabs R-5, R-9, V-5.7) The 72-hour histories and duty cycles of the MW and crew chief leading up to the mishap indicated that both had adequate rest. (Tabs X-9 thru X-16) The MP did not suffer from excessive stress, pressure, fatigue or lack of rest prior to or during the mishap sortie.

## 10.OPERATIONS AND SUPERVISION

### a. Operations

The 422 TES is a highly experienced squadron compared to most, consisting entirely of instructor pilots and multiple WIC graduates. Operations tempo for the squadron was normal at the time of the incident. (Tabs G-3, V-15.5 thru V-15.7, V-4.3)

### b. Supervision

The mission was authorized by the 422 TES Top 3 on an ARMS Fighter Flight Authorization Form. (Tab K-7)

## 11.HUMAN FACTORS

Human factors are features of people's tools, tasks and working environment that systemically influence human performance. When human performance suffers and either an incident or mishap occurs, human factors must be broken down into logical subsets to investigate the cause of the failure. These failures are designated as either latent or active. *Latent failures* or *conditions* are errors that exist within the organization or in the chain of command that affect the sequence of events characteristic of a mishap. Latent failures encompass *Preconditions for Unsafe Acts*, *Unsafe Supervision* and *Organizational Influences* that contribute to the mishap. *Active failures*, traditionally referred to as errors, are the actions or inactions of operators that are believed to cause the mishap (AFI 91-204, *USAF Safety Investigation and Reports*, Attachment 5, Department of Defense Human Factors Analysis and Classification System (DODHFACS) 24 September 2008).

The board considered all of the latent and active human factors elements contained in AFI 91-204, *USAF Safety Investigation and Reports*, Attachment 5, DODHFACS 24 September 2008, and analyzed them to identify potentially relevant factors that may have contributed to this mishap.

The AIB found no evidence of maintenance or egress crew complacency, overconfidence, low motivation, distraction, disruption, supervisory pressure, channelized attention, uncharacteristic mistakes or other degradation that may have led to the accident. (Tabs U-3, V-6.2 thru V-6.3, V-16.2 thru V-16.3, EE-8) The AIB found no indications of latent failures, but did identify active failures. The AIB found the Operations supervision to be effective, proficient and professional and not causal to this mishap.

**a. Effects of G Forces (G-LOC, etc)**

"The Effects of G Forces" are defined by DODHFACS as factors wherein the individual experiences G-LOC, greyout, blackout or other neuro-circulatory affects of sustained acceleration forces. The brain is extremely sensitive to oxygen deprivation. Oxygen is delivered to the brain through normal blood flow. If the brain is deprived of oxygen for 4-6 seconds it is unable to continue normal function. (Tabs DD-4, DD-22) If the rate of G onset is not too rapid, the body will experience warning signs of decreased blood flow to the eyes. Individuals will experience "tunnel vision," a dimming of their central vision (greyout), or a complete loss of vision (blackout). (Tabs DD-5, DD-28 thru DD-30) If the rate of onset of Gs is high, G-LOC can occur before any other symptoms are noticed, including visual manifestations. (Tabs DD-6, DD-30) The MP's fourth engagement in his sortie was a high aspect BFM set. He was planning to execute a lift vector low to intercept the MW. This maneuver would cause the MA to point at the ground during the high G pull. It would also place a large amount of G force on the MP's body, approximately 8 or 9 Gs. (Tabs DD-12, V-15.5, V-18.6 thru V-18.7) The MA was in a clean configuration (minimal external stores), thereby decreasing its drag and causing the rate of G onset to be incredibly fast during this maneuver. If the MA's rate of G onset was 6 Gs per second or higher, it could have caused the MP to G-LOC within 4 seconds, without any visual warning signs to precede it.

G-LOC incapacitation has been divided into two time periods: absolute incapacitation (unconsciousness) and relative incapacitation (confusion/disorientation). The average absolute incapacitation lasts for approximately 12 seconds (range of 2-38 seconds). The average relative incapacitation that follows is approximately 15 seconds (range of 2-97 seconds). A pilot would be unable to control his aircraft during either of these phases. The average total incapacitation time, therefore, is approximately 28 seconds (range of 9-110 seconds). (Tabs DD-6, DD-30 thru DD-31) Recent studies performed at Wright-Patterson AFB shows that these times may be even longer. This study showed that cognitive performance degrades on average 3.2 seconds prior to rapid acceleration induced G-LOC and does not return to normal until 55.6 seconds later. (Tabs DD-25 thru DD-26) This would leave the pilot incapacitated for nearly 1 minute without aircraft control. Evidence recovered from the MA revealed that the MP was leaning forward in his seat consistent with being unconscious, his right shoulder further forward than his left. (Tabs H-19 thru H-23) Part of the control mechanism for the ejection seat was recovered and showed that no attempt was made to eject. (Tabs H-5 thru H-8) Two eye witnesses reported seeing no attempts being made to recover the MA from its dive, again indicating that the MP was unconscious at the time of the mishap. (Tabs V-7.2 thru V-7.3, V-8.2 thru V-8.3)

**b. Inadequate Anti-G Straining Maneuver**

"Inadequate AGSM" is defined by DODHFACS as a factor wherein the individual's AGSM is improper, inadequate, poorly timed or non-existent, leading to adverse neurocirculatory effects. The AGSM is a two part muscle contraction and breathing procedure employed by pilots and aircrew during high G maneuvers that increases blood flow to the eyes and brain to assist in maintaining sight and consciousness in high stress environments. The muscle contraction consists of maximal straining of the legs, thighs, buttocks and abdomen. The breathing element consists of a maximal inspiration of air prior to the onset of Gs. Repetitive sharp, quick air exchanges are made every 3 seconds. This maneuver is maintained until after the G forces on the body have returned to normal (1 G). (Tab DD-8) The MP was an experienced and seasoned pilot who had many engagements in a high G environment, although, as stated in the discussion on G-LOC, if the rate of G onset is high, G-LOC can occur rapidly without any visual warning signs. (Tabs DD-6, DD-29 thru DD-30) During the MP's final engagement he performed a maneuver that would place his body under high Gs and would have resulted in a high G onset rate. A pilot not anticipating such a high G onset may succumb to G-LOC. (Tabs V-3.6, V-15.5, V-18.6 thru V-18.7, DD-6, DD-8, DD-9, DD-22)

**c. Excessive Motivation to Succeed**

"Motivation to Succeed – Excessive" is defined by DODHFACS as a factor when the individual is preoccupied with success to the exclusion of other mission factors, leading to an unsafe situation. This was the MP's last sortie and the last high aspect BFM engagement that he would perform prior to starting WIC. (Tabs R-7, V-1.2 thru V-1.4, V-1.7 thru V-1.8, V-2.5, V-3.8, V-4.6, V-4.8, V-5.3 thru V-5.5, V-5.8, V-5.14, V-9.3, V-9.5, V-11.4, V-12.3, V-15.4, V-17.3, V-18.2, V-18.4 thru V-18.7) It is likely that he was highly motivated to perfect this engagement. The MP had attempted to perform a lift vector low maneuver during his third engagement of the sortie. During that engagement the MP lost sight of the MW. The MP was not satisfied with his performance and ended the engagement early. (Tab V-18.5) After a brief discussion with the MW, the MP decided to attempt that same scenario again. (Tab V-18.5) The MP was focused on success and may have positioned his body and/or head in such a way as to keep the MW in sight. (Tab H-19 thru H-23) This may have placed him in a less optimal position to effectively counteract the G forces he was about to endure.

**d. Emotional State**

"Emotional State" is defined by DODHFACS as a factor when the individual is under the influence of a strong positive or negative emotion and that emotion interferes with duties. The MP received the news of the death of his grandfather the day prior to the mishap. He had been scheduled to fly on 27 June 2011, but removed himself from the schedule due to the emotional impact that news had on him. (Tabs V-1.4 and V-4.3) Witnesses reported that the MP was so preoccupied by the news of his grandfather that he did not exit the freeway at the proper exit on his way to work that day. (Tabs R-19, R-32 and V-1.4) By the day of the mishap, the MP appeared to be in better spirits and was coping well with the death of his grandfather. By all

witness accounts he was back to his normal countenance/mindset and appeared focused. (Tabs R-9, R-13, R-20, R-28, R-37, R-45 thru R-46, V-1.6, V-2.3, V-2.5, V-3.4, V-3.7, V-4.3 thru V-4.5, V-4.8, V-5.7, V-11.2 thru V-11.4, V-13.3 thru V-13.4, V-15.5 thru V-15.6, V-18.3) He told his division commander that he was ready to fly. During his sortie, he showed clarity of thought and excellent clear, concise and directive communications to the MW. He had no lapses of thought and made no incorrect radio calls. (Tabs N-3 thru N-6, V-18.4) After reviewing all witness testimonies and the MW's HUD tape, the AIB assessed the MP's emotional state to have been a minor factor, at most, for cause of the accident. By all accounts he appeared ready to fly.

**e. Physical Fatigue**

"Physical Fatigue" (over-exertion) is defined by DODHFACS as a factor when the individual's diminished physical capability is due to overuse (time/relative load) and it degrades task performance. It includes the effects of prolonged physical activity, or the effects of brief but relatively extreme physical activity, either of which taxes a person's physical endurance or strength beyond the individual's normal limits. On 28 June 2011 the temperature at the time of the preflight inspection was 106 degrees F, resulting in FITS danger. (Tab F-5) The AIB assessed physical fatigue as a minor factor at most to this mishap. Witness testimonies all indicate the MP was rested and ready to fly. (Tabs R-5, R-9, V-5.7) It is possible that after his third training engagement, the MP was slightly fatigued. Most F-16 G-LOCs occur on the third or later engagement due to fatigue. (Tabs DD-8, DD-13 thru DD-14, DD-32)

There is no evidence of MP inattention, confusion, complacency, over-aggressiveness, overconfidence, distraction, hypoxia, special disorientation, motivational exhaustion, disruption, task oversaturation, external pressure, channelized attention, medication or alcohol misuse, pre-existing physical illness, uncharacteristic mistake or other degradation as causes of the accident. The AIB evaluated all available evidence, such as witness testimonies, radio transmissions and the MW's HUD tape. The evidence of the engagement – a high G and high rate G onset maneuver, the MP's body position at time of impact as revealed by shoulder harness markings, his lack of communication, eye witness testimony of the impact, and evidence supporting no ejection effort – suggests that the MP suffered rapid onset G-LOC and did not regain consciousness prior to the impact of the MA. (Tabs H-5 thru H-8, H-19 thru H-23, DD-7, DD-14, V-3.6, V-15.5, V-18.6 thru V-18.7)

## 12. GOVERNING DIRECTIVES AND PUBLICATIONS

**a. Primary Operations Directives and Publications**

1. Air Force Instruction (AFI) 11-202, Volume (Vol) 1, *Aircrew Training*, 22 Nov 10
2. AFI 11-202, Vol 2, *Aircrew Standardization/Evaluation Program*, 13 Sep 10
3. AFI 11-202, Vol 2, ACC Supp, *Aircrew Standardization/Evaluation Program*, 30 Jun 11
4. AFI 11-202, Vol 3, *General Flight Rules*, 22 Oct 10
5. AFI 11-202, Vol 3, ACC Supp, *General Flight Rules*, 27 Feb 07, incorporating Change 1, 28 Apr 08

6. AFI 11-2F-16, Vol 1, *F-16 Pilot Training*, 19 Jan 07
7. AFI 11-2F-16, Vol 2, *F-16 Aircrew Evaluation Criteria*, 10 Dec 09
8. AFI 11-2F-16, Vol 3, *F-16 Operations Procedures*, 18 Feb 10
9. AFI 11-205, *Aircraft Cockpit and Formation Flight Signals*, 19 May 94
10. AFI 11-214, *Air Operations Rules and Procedures*, 22 Dec 2005, incorporating Change 2, 2 Jun 09
11. Air Force Manual (AFMAN) 11-217, Vol 1, *Instrument Flight Procedures*, 22 Oct 10
12. AFMAN 11-217, Vol 2, *Visual Flight Procedures*, 22 Oct 10
13. AFMAN 11-217, Vol 3, *Supplemental Flight Information*, 23 Feb 09
14. AFI 11-290, *Cockpit/Crew Resource Management Training Program*, 11 Apr 01
15. AFI 11-290, ACC Supp, *Cockpit/Crew Resource Management Training Program*, 16 Jul 10
16. AFI 11-301, Vol 1, *Aircrew Flight Equipment (AFE) Program*, 25 Feb 09
17. AFI 11-301, Vol 1, ACC Supp, *Aircrew Flight Equipment (AFE) Program*, 23 Apr 10
18. AFI 11-401, *Aviation Management*, 10 Dec 10
19. AFI 11-403, *Aerospace Physiological Training Program*, 20 Feb 01
20. AFI 11-403, ACC Supp, *Aerospace Physiological Training Program*, 18 Aug 09
21. AFI 11-418, *Operations Supervision*, 21 Oct 2005, incorporating Change 1, 20 Mar 07
22. AFI 11-418, Nellis AFB Supp, *Operations Supervision*, 21 Oct 05
23. AFI 11-421, *Aviation Resource Management*, 13 Dec 10
24. AFI 51-503, *Aerospace Accident Investigations*, 26 May 10
25. Air Force Tactics, Techniques and Procedures (AFTTP) 3-3, F-16, *Combat Aircraft Fundamentals*, 5 May 08
26. Technical Order (T.O.) 1F-16C-1, *Flight Manual, USAF Series*, 15 Jul 10, with Supp 4, dated 22 Nov 10

**b. Maintenance Directives and Publications**

1. AFI 21-101, *Aircraft and Equipment Maintenance Management*, 26 Jul 10
2. AFI 21-101, Air Combat Command, United States Air Forces in Europe and Pacific Air Forces Supp, *Aircraft and Equipment Maintenance Management*, 28 Dec 10
3. AFI 21-124, *Oil Analysis Program*, 8 Dec 10
4. ACCI 21-165, *CAF: Aircraft Flying and Maintenance Scheduling Procedures*, 22 Apr 08
5. T.O. 00-20-1-WA-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures*, 15 Jun 11
6. T.O. 33-1-37-WA-1, *Joint Oil Analysis Program Laboratory Manual, Volumes I, II, and III*, 1 Aug 10
7. T.O. 42B-1-1, *Quality Control of Fuels and Lubricants*, 15 Jun 11
8. T.O. 42B6-1-1, *Quality Control of Aviator's Breathing Oxygen*, 16 Aug 10

**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**

Not applicable.

## 13. ADDITIONAL AREAS OF CONCERN

No additional areas of concern contributed to this aircraft accident.

26 August 2011

DONALD J. BACON
Brigadier General, USAF
President, Accident Investigation Board

## STATEMENT OF OPINION

## F-16C, T/N 85-1413 ACCIDENT
## 28 JUNE 2011

*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

I find by clear and convincing evidence this accident was caused by a G-Induced Loss of Consciousness (G-LOC) experienced by the mishap pilot (MP). At 26 minutes into the training mission, during a maneuver involving a high-onset rate of high G forces, the mishap aircraft (MA) suddenly stopped maneuvering, entered a dive, and impacted the ground approximately 20 seconds later. This profile was consistent with an aircraft whose pilot was no longer making control inputs. I find by a preponderance of the evidence that during this maneuver the MP did not adequately perform a muscle tightening and breathing procedure known as the Anti-G Straining Maneuver (AGSM), which is required to maintain consciousness during high G maneuvers in the F-16. I find by clear and convincing evidence that the MP made no attempt to eject and put no pressure on the flight control systems. G-LOC created an inadequate blood supply to the brain, causing the MP to lose consciousness and remain incapacitated until impact with the ground.

# 2. DISCUSSION OF OPINION

### a. Cause

The mishap occurred during an F-16C basic fighter maneuvers (BFM) training mission involving simulated air-to-air engagements between the MP and the Mishap Wingman (MW), each in their own F-16C aircraft. This training profile required high levels of sustained G forces (up to 9 Gs) often at high G onset rates (greater than 6 Gs per second). Although the MA and its flight data recorders were totally destroyed in the impact, the Accident Investigation Board (AIB) was able to determine the accident sequence through recorded voice/data from the MW's aircraft, radar tracks, analysis of wreckage, witness interviews, and F-16 simulator analysis.

The MP stopped controlling the MA after initiating his fourth air-to-air training maneuver of this mission. The MW testified that he lost sight of the MP after making the initial high aspect pass and turn, and that, subsequently, the MP was not visible in the locations the MW anticipated. Approximately 25 seconds after the two aircraft passed, the MW witnessed the explosion of the MA impacting the ground. The MW stated the explosion indicated a near vertical impact of the MA. Two witnesses on the ground observed the MA flying straight towards the ground with wings steady until impact, and analysis of the wreckage revealed the MA impacted at an

approximate 85 degree angle. The MP's fourth air-to-air maneuver required a prolonged high G turn, and was one of the more challenging maneuvers, from a G load perspective, to accomplish. The AIB replicated this flight profile in an F-16 simulator, finding that when control inputs were stopped following the initial turn, the aircraft would strike the ground 20 seconds later, matching the approximate aircraft attitude, airspeed, and location assessed by analysis of the wreckage at the mishap site. The MP made no radio transmissions and made no attempt to eject during this period. Evidence from the wreckage and witness testimony indicated the MP was putting no pressure on the flight controls during the MA's descent. The AIB discovered no evidence of aircraft malfunctions that would have prevented pilot control inputs or radio transmissions. In short, this constitutes clear and convincing evidence that the MP stopped controlling his aircraft because he had lost consciousness due to G forces that resulted in an inadequate blood supply to the brain, a condition known as G-LOC.

Although a pilot can become unconscious for reasons other than G-LOC, in this mishap the AIB found no evidence of an existing medical condition that could have caused the MP to lose consciousness. The MP's communications and handling of the MA were normal up until the fourth air-to-air maneuver, with no evidence of physical duress. There was no evidence of a malfunction in the MA's aircrew flight equipment, oxygen or pressurization systems, although the G-suit fit check documentation was overdue. Since the MP's weight had not recently fluctuated, the G-suit fit would have remained effective. Furthermore, the MP did not note problems with the G-suit during the previous three air-to-air maneuvers or during the G-awareness tests earlier in the sortie. The MP was wearing the CSU-13 B/P G-suit (legacy) which affords up to 1 G protection. At the training altitude of 18,000 feet above sea level, it is unlikely that oxygen or pressurization system malfunction would produce a sudden loss of consciousness, when just 45 seconds prior to ground impact he was lucid in his communications and handling of the MA.

The MP likely sustained 8 to 9 Gs at a high onset rate during the final maneuver. Although this G load is typical for an F-16 maneuvering against a simulated adversary, it can cause a loss of consciousness if the pilot's G tolerance is lowered by physiological factors or if the pilot fails to properly perform the AGSM, a muscle-tightening and breathing procedure employed by fighter pilots to maintain sufficient blood flow to the brain. When G-LOC occurs, a pilot will remain significantly incapacitated for an average of approximately 28 seconds. Therefore, in this F-16 G-LOC incident, the MP was very likely still incapacitated when his F-16 impacted the ground 20 seconds after G-LOC.

I find by a preponderance of the evidence that the MP experienced G-LOC because the MP did not adequately perform an AGSM during the mishap maneuver. Proper application of the AGSM is the most important factor enabling a pilot to stay conscious during a quick-onset rate of high G forces. I note, however, the MP did not have a history of poor AGSM technique and was graded "average" during his two AGSM training classes. Also, I was able to eliminate several factors that could have negatively impacted the MP's overall G tolerance, to include his physical conditioning level, hydration, rest, and nourishment.

**b. Contributing Factors**

I find by a preponderance of evidence that each of the following factors substantially contributed to the MP's ineffective AGSM:

First, the MP had excessive motivation to succeed in executing a proper maneuver in response to the previous engagement that was not executed to the MP's satisfaction. The MP lost sight of the MW during his third engagement, and was focused on proper execution of the fourth engagement. This resulted in the MP not adequately performing an AGSM quickly enough.

Second, the MP was focused on accomplishing one more spin-up sortie before his Weapons Instructor Course (WIC) began, which was to occur the following week. Without this last sortie on 28 June 2011, the MP would have required a waiver to start WIC. Witness testimony states that he wanted one more BFM sortie before WIC, more for preparation vice concerns about the waiver. Self-induced pressure to fly for WIC preparation contributed to excessive motivation to succeed during the last engagement.

Third, the MA was a Block 25 airframe in a "clean" configuration, meaning there were minimal external stores attached to the wings. The MP typically flew either a Block 42 or 52 aircraft with external tanks. The clean configuration would have resulted in a MA with a higher G onset potential than what the MP was used to flying.

Finally, the mishap occurred 26 minutes into the mission, after the MP had already flown 3 high G engagements against the MW and after conducting preflight in 106 degree heat. This would have left the MP slightly more fatigued than at the beginning of the mission. In F-16 aircraft, G-LOC most frequently occurs during or after the third engagement.

## 3. CONCLUSION

I find by clear and convincing evidence this accident was caused by G-LOC experienced by the MP. I find by a preponderance of evidence that the G-LOC occurred due to the MP not adequately performing an AGSM during a high G maneuver, primarily due to an excessive motivation to succeed on his fourth engagement on his last sortie before WIC. Other factors were slight physical and mental fatigue, and increased aircraft responsiveness from what the MP was used to flying.

26 August 2011

DONALD J. BACON
Brigadier General, USAF
President, Accident Investigation Board