DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR COMBAT COMMAND
LANGLEY AIR FORCE BASE, VIRGINIA

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SEP 2 2009

MEMORANDUM FOR ACC/JA

SUBJECT: Accident Investigation Board Report: F-16CM, T/N 89-2108, 421 FS, 388 FW, Hill AFB, UT, 22 June 2009

I have reviewed the Accident Investigation Board Report regarding the F-16CM, T/N 89-2108, that impacted the ground during controlled flight at the Utah Test and Training Range, approximately 100 nautical miles southwest of Hill AFB, UT on 22 June 2009. The report prepared by Brigadier General Russell J. Handy complies with the requirements of AFI 51-503 and is approved.

ROGER A. BINDER
Major General, USAFR
Vice Commander

Attachment:
Accident Investigation Board Report

EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION

F-16CM, T/N 89-2108
UTAH TEST AND TRAINING RANGE
22 JUNE 2009

On 22 June 2009 at approximately 2227 local time (0430 Greenwich Mean Time or Zulu time), an F-16CM aircraft, tail number 89-2108, assigned to the 421st Fighter Squadron, 388th Fighter Wing, Hill Air Force Base, Utah, impacted the ground during controlled flight on the Utah Test and Training Range, approximately 100 nautical miles southwest of Hill Air Force Base. The mishap pilot (MP) did not initiate a recovery nor attempt ejection and was fatally injured upon impact. The mishap aircraft was destroyed upon impact and there was no damage to private property.

The mishap occurred on a night close air support training sortie as part of the unit's preparation for an upcoming Air Expeditionary Force deployment. The flight was conducted in accordance with applicable service and unit guidelines, and the MP and mishap flight lead were current and qualified to perform the planned mission events. The MP had 1,571.9 total flying hours, but was considered inexperienced in the F-16, with 155.6 hours in that aircraft. He was a former T-6 instructor pilot and was on his first operational F-16 assignment. At the time of the mishap, he was attempting a simulated (no actual ordnance) night high-angle strafe (HAS) event with the aid of night vision goggles.

The board president found, by clear and convincing evidence, this mishap was caused by the MP's failure to recognize his altitude during a night HAS attack.

The board president also found the following five factors substantially contributed to the mishap:

1. Limited total experience: Despite the fact that the MP was current, qualified, and appropriately supervised, he had limited experience in this type of event.
2. Channelized attention: The MP channelized his attention on attempting to visually prosecute the attack, to the exclusion of visual and audible cues of a more immediate priority.
3. Breakdown in visual scan: MP failed to perform an effective visual scan of his flight instruments.
4. Expectancy: MP's mental expectation of his aircraft parameters was distinctly different from reality, making it difficult to mentally process data appearing contrary to what he was expecting, altering his perception of the target, ground cues, and altitude indications.
5. MP inability to distinguish terrain features: Low illumination conditions and lack of contrast made it difficult for the MP to visually distinguish terrain features and recognize his proximity to the ground.

SUMMARY OF FACTS AND STATEMENT OF OPINION
F-16CM, T/N 89-2108
22 JUNE 2009

TABLE OF CONTENTS

COMMONLY USED ACRONYMS AND ABBREVIATIONS

107 Dispositions	TO 00-25-107, Technical Assistance Request System
388 FW	388th Fighter Wing
388 OG	388th Operations Group
421 AMU	421st Aircraft Maintenance Unit
421 AMXS	421st Aircraft Maintenance Squadron
421 FS	421st Fighter Squadron
623	AF Form 623, On-the-Job-Training Record
797	AF Form 797, Job Qualification Standard Continuation
ACC	Air Combat Command
ADO	Assistant Director of Operations
AEF	Air Expeditionary Force
AF	Air Force
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AGE	Aerospace Ground Equipment
AGL	Above Ground Level
AIB	Aircraft Investigation Board
AIM-9 & AIM-120	Air Intercept Missile
ALO	Air Liaison Officer
ALOW	Altitude Low
AMU	Aircraft Maintenance Unit
AMXS	Aircraft Maintenance Squadron
AOR	Area of Responsibility
ARMS	Aviation Resource Management System
ART	Air Reserve Technician
ATC	Air Traffic Control
AUX	Auxiliary
B Course	Initial Formal F-16 Training Course
Bingo	Pre-Briefed Fuel State to Cease Maneuvering and RTB with Required Fuel
BSA	Basic Surface Attack
BSP	Baker Strong Point
CAF	Combat Air Force
CAMS	Core Automated Maintenance System
CANN	Cannibalization
CAP	Combat Air Patrol
CAS	Close Air Support
CCIP	Common Configuration Implementation Program or Continuously Computed Impact Point
Cert Ride	Certification Ride
Clover	ATC in the UTTR
CMR	Combat Mission Ready
CT	Continuation Training
DCA	Defensive Counter Air
DD	Delayed Discrepancy
DO	Director of Operations
DTC	Data Transfer Cartridge
ER	Exceptional Release
FAIP	First Assignment Instructor Pilot
FCR	Fire Control Radar
FLCS	Flight Control System
FLUG	Flight Lead Upgrade
FMC	Fully Mission Capable
G	Force of Gravity
GAAF	Ground Avoidance Advisory Function
G ex	G Warm-Up Exercise
GFC	Ground Force Commander
Goggles	Night Vision Goggles
HADB	High Altitude Dive Bomb
HAG	Helicopter Air to Ground
HARB	High Altitude Release Bomb
HAS	High-Angle Strafe
HMCS	Helmet Mounted Cueing System
HSD	Horizontal Situation Display
HSI	Horizontal Situation Indicator
HUD	Head-up Display
Illum	Illumination
ILS	Instrument Landing System
IMDS	Integrated Maintenance Data System
INS	Inertial Navigation System
IP	Instructor Pilot
IR	Infrared
JDAM	Joint Direct Attack Munition
JOAP	Joint Oil Analysis Program
Joker	Pre-Briefed Fuel State above Bingo at which Separation/Bugout/Event Termination should Begin
JTAC	Joint Terminal Attack Controller
L	Local Time
LANTIRN	Low Altitude Navigation Targeting IR for Night
LIS	Line-in-the-Sky
LOW AT or Low Alt	Low Altitude
LOX	Liquid Oxygen
LSS	Laser Spot Search
LST	Laser Spot Track
MA	Mishap Aircraft
MFD	Multi-Function Display
MFL	Mishap Flight Lead or Maintenance Fault Listing
mike mike	Millimeter
MOA	Military Operations Area
MOC	Maintenance Operations Center
MOS	Maintenance Operations Squadron
MP	Mishap Pilot
MQT	Mission Qualification Training
MS	Mishap Sortie
MSA	Minimum Safe Altitude
MSL	Mean Sea Level

MTC	Minimum Terrain Clearance
NAV	Navigation
NDI	Non-destructive Inspection
NITE	Nitrogen
NOGs	Night Vision Goggles
NOTAMs	Notices to Airmen
NVG	Night Vision Goggles
NVG Low	NVG Low Altitude
NVIS	Night Vision Imaging System
NM	Nautical Mile
OG	Operations Group
One Charlie	Operations Resource Managers
OP	Observation Point
OPR	Officer Performance Report
Ops Sup	Operations Supervisor or Top-3
ORM	Operational Risk Management
PCA	Permanent Change of Assignment
PCS	Permanent Change of Station
PEX	Patriot Excalibur
PGCAS	Predictive Ground Collision Avoidance System
Pipper	Aircraft Gun Aiming Reference
Pro Super	Production Supervisor
QA	Quality Assurance
RALT	Radar Altimeter
RAP	Ready Aircrew Program
Red Ball	Priority Maintenance Accomplished on an Aircraft after Engine Start
RESCAP	Rescue Combat Air Patrol
RTB	Return to Base
RTU	Replacement Training Unit
SAR	Search and Rescue
SARCAP	SAR Combat Air Patrol
SARM	Squadron Aviation Resource Management
SAT	Surface Attack Tactics
SCAR	Strike Control and Reconnaissance
SEAL	Sea, Air, Land
SEFE	Standardization Evaluation Flight Examiner
SELO	Standardization and Evaluations Liaison Officer
SIB	Safety Investigation Board
SOF	Supervisor of Flying
Stan/Eval	Standardization and Evaluation
T-6	USAF Primary Flight Training Aircraft
TCTO	Time Compliance Technical Order
TDY	Temporary Duty
TH	Thru-Flight
TISL	Target Identification System Laser
T/N	Tail Number
TO	Technical Order
TOP-3	Operations Supervisor
TOX	Toxicology
TTFACOR	Targets, Threats, Friendlies, Artillery Clearance Authority, Ordnance, Restrictions
TX	Transition
USAF	United States Air Force
UTTR	Utah Test and Training Range
Vol	Volume
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 23 June 2009, General John D.W. Corley, Commander, Air Combat Command (ACC), appointed Brigadier General Russell J. Handy to conduct an aircraft accident investigation of a mishap that occurred on 22 June 2009 involving an F-16CM aircraft at the Utah Test and Training Range (UTTR) (Tab Y-4). The investigation was conducted at Hill Air Force Base (AFB), Utah from 10-13 July 2009 and 23 July - 10 August 2009. Board members were Major James Crider (Medical), Captain Jonathan Leatherwood (Pilot), Captain Kathy Malowney (Legal), Chief Master Sergeant Gordon Drake (Maintenance), Master Sergeant Bryan F. Cawvey (Court Reporter), and Technical Sergeant Tonya Vallie (Recorder) (Tab Y-3).

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 (Tab V-1.1).

c. Circumstances

The accident investigation board was convened to investigate the Class A mishap involving an F-16CM, tail number (T/N) 89-2108, assigned to the 421st Fighter Squadron (421 FS), 388th Fighter Wing (388 FW), Hill AFB, Utah, which occurred during a training mission on 22 June 2009 (Tabs B-3, Y-3 through Y-4).

2. ACCIDENT SUMMARY

The mishap aircraft (MA), a Block 40 F-16CM, T/N 89-2108, departed Hill AFB, Utah for the UTTR at 2130 local time (L) (0330 Greenwich Mean Time or Zulu time (Z)) on 22 June 2009. The purpose was to conduct a night four-ship air-to-ground training mission, including multiple two-ship air-to-ground attacks in preparation for the 421 FS's Air Expeditionary Force (AEF) deployment (Tabs K-6, V-1.3). The mishap element, a two-ship flight, Hulky 11 and 12, was conducting close air support (CAS) training with joint terminal attack controllers (JTACs). JTACs are ground personnel responsible for directing air-strikes (Tab V-1.3). At approximately 2227L, during a simulated (no actual ordnance) night high-angle strafe (HAS), the MA impacted the ground 100 nautical miles (NM) southwest of Hill AFB (Tabs B-3, J-3, CC-13). The mishap pilot (MP), Captain George Houghton, was fatally injured (Tab B-3). Search and rescue operations were initiated by Hulky 11 and the JTACs and completed by personnel from Dugway Proving Grounds and the 388th Range Squadron, Detachment 1 (Tabs N-4, V-4.8, CC-8). The MA was destroyed upon impact; financial loss of the MA totaled $21,338,977 (Tab P-3). The accident caused no damage to private property (Tab P-11).

3. BACKGROUND

The MA's parent unit is the 421 FS, an ACC unit subordinate to the 388 FW, Hill AFB, Utah (Tab CC-16 through CC-20).

a. 388th Fighter Wing

The 388 FW operates and maintains the Air Force's largest fleet of combat-ready F-16 Fighting Falcons, ready to deploy and execute air-to-ground and/or air-to-air missions as tasked. The 388 FW also oversees the UTTR which provides testing and training opportunities for a variety of US forces and coalition partners (Tab CC-16 through CC-17).

The 388th Fighter Wing Symbol

b. 421st Fighter Squadron

The 421 FS is one of three fighter squadrons assigned to the 388 FW. Its mission is to conduct flying operations to maintain combat readiness of its assigned inventory of F-16 aircraft. The 421 FS has flown the F-16 Fighting Falcon since June 1980. This squadron prepares to deploy worldwide to conduct day/night air superiority and precision strike sorties employing laser-guided and inertially-aided munitions during contingencies and combat (Tab CC-18 through CC-20).

The 421st Fighter Squadron Symbol

c. F-16CM Fighting Falcon

The F-16CM Fighting Falcon is a single-seat, single-engine, multi-mission fighter with a maximum speed of Mach 2 and an unrefueled range of 2,000 miles (Tab CC-21 through CC-23).

F-16CM Fighting Falcon - T/N 89-2108

4. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was a combat mission ready F-16CM wingman. He had 1,571.9 hours of total military flying time but was categorized as an inexperienced F-16 pilot, based upon his limited F-16 time,

in accordance with Air Force Instruction (AFI) 11-2F-16, Volume (Vol) 1, *Flying Operations, F-16 Pilot Training*, dated 19 January 2007. The MP had 155.6 hours of primary F-16C/D time, with 19.6 of these hours flown with night vision goggles (NVGs). The MP's total time includes 1,140 hours in the T-6, with 968.5 of those hours as an instructor (Tab G-3 through G-13). All necessary flight currencies were up-to-date, and all required training for the planned mission was current in accordance with AFI 11-2F-16 Vol 1 (Tab G-17 through G-24).

On 5 March 2008, the MP completed his instrument qualification check in the F-16C, and he completed his initial mission qualification check on 6 March 2009. He was rated "Qualified, No Discrepancies" on both his instrument and mission check rides (Tab G-25 through G-31).

In accordance with the 421 FS AEF Spin-Up Tracker, the MP and mishap flight lead (MFL) planned the mishap sortie (MS) to accomplish AEF preparation which included night, low altitude HAS for the MP (Tabs G-142 through G-144, V-1.3, V-1.5).

On 19 May 2009, the MP accomplished his night vision goggle low-altitude (NVG Low) qualification (Tab G-145 through G-146). NVG Low qualifies a pilot to perform night tactical tasks down to a minimum of 1,000 feet above ground level (AGL) over the specific area/target he is flying, with the aid of NVGs, in accordance with AFI 11-2F-16 Vol 1. Without NVG Low qualification, pilots are restricted to an altitude providing a minimum terrain clearance over a broad geographic area. This altitude, called the "minimum safe altitude," was 13,200 feet mean sea level (MSL) for the MS (Tab K-31).

The 19 May 2009 sortie was the first and only time the MP had accomplished NVG Low training prior to the mishap (Tab G-24). Additionally, the mishap sortie was the first time the MP had attempted night HAS against a target illuminated with an infrared (IR) marker (Tabs G-143, V-1.7). The MP did have previous day and night HAS training and NVG training. Prior to the mishap sortie, the MP had flown a total of 20 F-16 sorties at night, with 18 of those flown using NVGs. He had documented accomplishing HAS on a total of 5 night sorties and 16 day sorties (Tab T-6).

The MP was known in the 421 FS as an average to slightly above-average wingman and had recently been awarded the distinction of 421 FS Wingman of the Quarter by his peers and squadron leadership (Tabs G-158 through G-187, V-2.3, V-5.2). He had a reputation in the squadron as an extremely motivated, disciplined, hard working, and professional officer, with a strong work ethic, who seized every possible opportunity to improve his knowledge and skills (Tabs V-1.4, V-1.26, V-3.6, V-5.4, V-6.6, V-7.16, V-8.5, V-9.11, V-10.7, V-11.9, V-13.3). There were no areas of his flying noted as particularly strong or particularly weak. He was not under additional supervision by squadron leadership as would be the case if he had a noted weakness in his training (Tabs V-3.5, V-7.5). The MP's recent flight history prior to the MS was (Tab G-7):

	HOURS	SORTIES
LAST 30 DAYS	13.8	9
LAST 60 DAYS	27.7	19
LAST 90 DAYS	52.3	33

b. Mishap Flight Lead

The MFL was an experienced F-16CM flight lead with 613.0 hours in F-16C/D aircraft, and 859.7 hours of total military flying time (Tabs G-3, G-5 through G-6). The MFL was a current and qualified four-ship flight lead, described as very strong in this role (Tabs G-3, V-11.12). He was recertified as a four-ship flight lead on 3 April 2009, after arriving from a non-flying assignment and being previously qualified as a four-ship flight lead in the F-16 at Misawa Air Base, Japan (Tabs T-3 through T-4, V-1.2). The MFL's recent flight history prior to the MS was (Tab G-5):

	HOURS	SORTIES
LAST 30 DAYS	10.0	7
LAST 60 DAYS	15.1	10
LAST 90 DAYS	29.2	20

5. SEQUENCE OF EVENTS

a. Mission

The mishap mission was a four-ship unopposed surface attack tactics (SAT) sortie that split into two, two-ship elements to conduct AEF preparation training. The MP was number two of the four-ship and was conducting CAS training with JTACs. The mission took place at the Baker Strong Point (BSP) target complex on the UTTR (Tabs K-6, K-33, V-1.3).

The mishap element, callsign Hulky 11 flight, departed Hill AFB at approximately 2130L (0330Z) followed immediately by the Hulky 13 two-ship element (Tab K-6). The two elements flew together as Hulky 11 flight to the UTTR, checked in with the controlling agency, and performed a G-awareness warm-up maneuver (Tab V-2.5 through V-2.6). To complete flight lead upgrade training for Hulky 13, Hulky 11 flight accomplished a night simulated (no actual ordnance) four-ship air-to-ground attack (Tab V-2.6). Upon completion of the attack, the four-ship split into two, two-ships, callsigns Hulky 11 flight and Hulky 13 flight (Tabs K-6, V-2.6). Hulky 13 flight transitioned to NVG Low training and was not in contact with Hulky 11 until the search and rescue operations had begun (Tab V-3.4). Hulky 11 flight stayed in the BSP target complex area and checked in with the JTACs to conduct CAS training (Tabs V-2.6, V-1.3).

To accomplish AEF preparation training, the MFL planned to complete multiple air-to-ground attacks including using his Sniper targeting pod's IR marker to illuminate ground targets assigned by JTACs. To attack the IR illuminated ground targets, the MP would then execute simulated night HAS down to a minimum of 1,000 feet AGL. Upon completion of the AEF preparation training, Hulky 11 element planned to return to base as a two-ship (Tabs K-28, V-1.7 through V-1.8).

The 421 FS Operations Supervisor (Top-3) authorized the mission with the authority of the 421 FS Commander (Tab K-6).

b. Planning/Briefing

The MP and Hulky 13 conducted the majority of the detailed pre-mission planning on 22 June 2009, beginning at 1430L and lasting approximately 2 hours (Tab V-2.2). The MFL

completed the 388/419 FW Risk Matrix Worksheet, and the 421 FS Top-3 on duty reviewed it (Tabs K-26, V-1.8 through V-1.9, V-6.3 through V-6.4). As a result of his lack of recent night sorties and relative inexperience leading four-ships at night, the MFL assessed the highest risk on the night of the mishap to be mid-air collision, but he also recalled dedicating substantial briefing emphasis, in his two-ship briefing, to the HAS events (Tab V-1.9). The MFL conducted the administrative portion of the flight brief and the four-ship air-to-ground attack brief (Tab V-2.3). The flight then split into two elements to conduct their respective two-ship briefs (Tab V-2.3).

The MFL briefed the MP to execute the night HAS event using both visual and instrument references, and he planned to illuminate the target using his IR marker so it could be seen through NVGs. The MFL directed the MP to execute the event from a box pattern, establishing a base altitude of no less than 6,000 feet AGL and a distance from the target from 2.4 to 3.0 NM (Tab V-1.11 through V-1.12). The MFL also referenced the 388 FW standard HAS attack card, depicting 5,800 feet AGL as the minimum altitude to achieve 10 seconds of track time (time after roll-in to prosecute the attack and initiate recovery as briefed) (Tab CC-15). The MFL briefed the MP to execute his HAS attack by maneuvering the MA to between 20 and 30 degrees nose low, establishing a 20-30 degree "wire" (trajectory to the target). The MP and MFL also discussed an alternative technique outlined in a recent 388 FW paper recommending more emphasis on instrument references while performing HAS, but the MP stated he would prefer to execute the HAS using the techniques he had previously been trained on, with more emphasis on setting parameters visually (Tab V-1.11 through V-1.12).

When low altitude maneuvering is anticipated, mission preparation includes determining and briefing altitudes to be used in the Block 40 F-16CM's three altitude warning systems that can be manipulated by the pilot from the cockpit prior to or during flight (Tab V-1.34). These three systems are line-in-the-sky (LIS), predictive ground collision avoidance system (PGCAS), and altitude low (ALOW) (Tab J-11 through J-15).

LIS provides an "ALTITUDE-ALTITUDE" voice message when the aircraft descends through the entered MSL altitude (Tab J-12). The 388 FW standard setting for LIS is 10,000 feet MSL; however, the MFL briefed to set the LIS to 13,200 feet MSL, an altitude providing a minimum specified terrain clearance over the entire southern portion of the UTTR (Tabs J-12, K-31, V-1.35, V-2.7).

PGCAS is pilot selectable (on/off) and provides advisories to the pilot when the digital terrain system determines that a ground collision is imminent (Tab J-12 through J-13). The MFL briefed the use of PGCAS with a setting of 700 feet; however, regardless of the brief, during strafe operations, the aircraft overrides the pilot input minimum terrain clearance (MTC) height and sets 50 feet AGL as the MTC height (Tabs J-12 through J-14, V-1.13 through V-1.14).

ALOW, a function of the aircraft's radar altimeter, provides an "ALTITUDE-ALTITUDE" voice message and flashing visual cue in the head-up display (HUD) whenever the aircraft descends below the ALOW setting (Tab J-12). The 388 FW standard ALOW setting is 500 feet (J-12). AFI 11-2F-16, Volume 3, *Flying Operations, F-16--OPERATIONS PROCEDURES,* dated 30 September 2005, states in paragraph 3.31.2 "Set the ALOW

function of the radar altimeter at either the briefed minimum altitude or the command-directed minimum altitude, whichever is higher." Per AFI 11-214, *Flying Operations, AIRCRAFT RULES AND PROCEDURES,* Change 1, dated 22 December 2005, paragraph 3.8.3, with high illumination conditions, the MP's minimum altitude with NVGs was 1,000 feet AGL (Tab G-145 through G-146). Although the MFL could not recall if he briefed 700 feet or 1,000 feet for the ALOW setting, he did brief the MP to recover from all HAS passes by 1,000 feet AGL (Tab V-1.14 through V-1.16).

All other portions of the pre-flight briefing were conducted in accordance with AFI 11-2F-16 Vol 3 (Tabs V-1.5 through V-1.17, V-2.3).

c. Preflight

After a step brief, including a weather, NOTAMs (notices to airmen), and aircraft status update, the mishap flight stepped to their respective aircraft to make their scheduled 2130L takeoff time (Tabs K-6, V-6.3). The MP accomplished a preflight walk-around and started the aircraft normally (Tab V-24.2). The MA had a faulty caution light that required the MP to shutdown the aircraft for maintenance assistance (Tab V-18.2 through V-18.3). The faulty light was repaired, and the MP restarted the MA with no further problems (Tab V-18.2 through V-18.3). The mishap flight taxied to make the scheduled takeoff time, and there were no other significant events to report prior to takeoff (Tab V-2.5).

d. Summary of Flight

Takeoff, departure, and entry into the UTTR were uneventful (Tab V-2.5 through V-2.6). The G-warm-up maneuver and four-ship air-to-ground attack were flown as briefed and were also uneventful (Tab V-2.6). Hulky 13 element departed the BSP target complex to the east as briefed to accomplish their NVG Low training, and Hulky 11 element remained in place and checked-in with the JTAC, callsign Punisher (Tabs N-3, V-2.6, CC-13). As directed by their JTAC, the MFL (Hulky 11) and MP (Hulky 12) completed one simulated, simultaneous joint direct attack munition (JDAM) attack without incident (Tab V-4.4, CC-13).

Following the JDAM attack, the MFL and MP established a 3 to 5 NM orbit over the target area in the altitude block of 12,000 to 16,000 feet MSL (Tabs M-13, CC-13). The MFL directed Hulky 11 element into "roam ops" (a means of deconflicting two aircraft operating in the same airspace by differentiating altitude) (Tab V-1.11). The MFL directed the MP into the 14,000 to 16,000 feet MSL block, and the MFL flew in the 12,000 to 13,000 feet MSL block (Tab CC-13). The JTAC then passed the MFL and MP a situation update advising them of a north to south oriented convoy requiring a HAS attack (Tabs N-3, CC-13). After confirming the MP was visually deconflicted from the MFL, the MFL climbed into the 14,000 to 16,000 feet MSL block and directed the MP into the 12,000 to 13,000 feet MSL block (Tab N-3). The MFL then redirected the MP into the 10,000 to 13,000 feet MSL block (Tab N-3). The MFL advised the JTAC that the MP would be the attacking flight member and then passed control of the radios to the MP (Tab N-3). The JTAC passed Hulky 11 element target data and targeting instructions, and they were read back correctly by the MP in accordance with Joint Publication 3-09.3, Change 1, *Close Air Support,* dated 3 September 2003 (Tabs N-3, BB-3 through BB-8).

To confirm he had acquired the correct target, the MP described over the radio the target area he was seeing, which was the northern most vehicle in a linear convoy of stationary vehicles located on the west side of a road (Tabs N-3, S-5). At that time, the MFL's targeting pod experienced a temporary degradation of performance which impaired his ability to see the target area in his targeting pod display (Tab N-3). After attempting laser spot-search (a targeting pod function which allows one aircraft to position its laser and the other aircraft's targeting pod to acquire the position at which that laser is impacting the ground) and with the assistance of the MP, the MFL positioned his IR marker to identify the target (Tab N-3). Through the use of both aircrafts' targeting pods, the MFL and MP were able to "match sparkle" (position both IR markers at the same point on the ground visually) and confirm the location of the target (Tabs N-4, V-4.6 through V-4.7).

After visual acquisition and confirmation of the target, at 22:26:29L, 50 seconds prior to impact, the MA was 6,200 feet AGL, still within the briefed parameters to execute the briefed HAS attack (Tabs M-9 through M-12, N-3 through N-4, V-1.11 through V-1.12). At 22:26:50L, the MP declared he would be "inbound in 30 seconds," establishing his intent to roll-in for his attack in approximately 30 seconds (Figure 1) (Tab N-4).

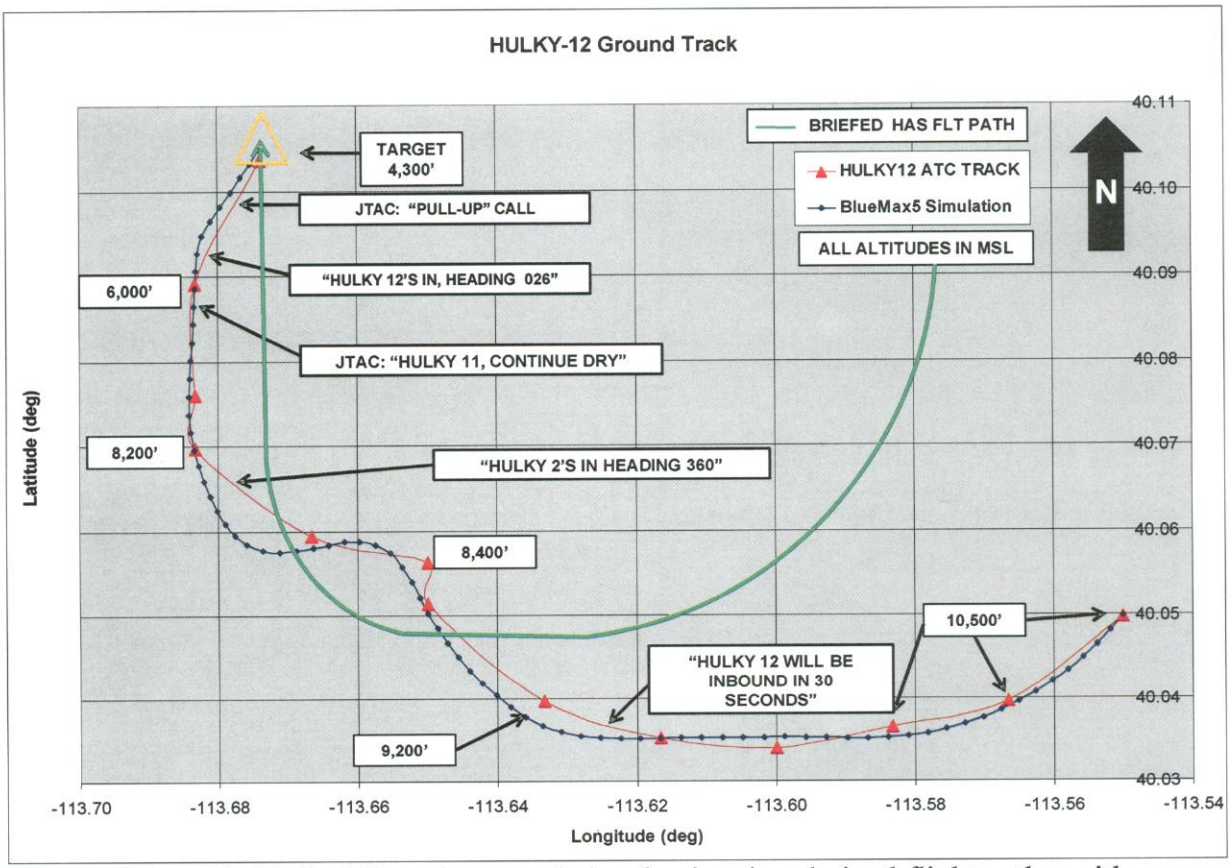

Figure 1: Hulky12's radar-recorded and animation-derived flight paths, with associated altitudes and radio transmissions, compared to his briefed HAS flight path (Tabs M-10 through M-11, N-4, CC-14).

At this time, the MP's aircraft was positioned further from the target than briefed (Tabs M-9 through M-11, V-1.11 through V-1.12). Prior to rolling-in, the MP turned toward the target and descended slightly (Tabs M-10 through M-11, CC-9 through CC-10). He then turned away from the target momentarily before executing an almost level turn to the north, and at 22:27:07L the MP called "Hulky 2's in, heading 360" from an altitude of approximately 8,300 feet MSL (4,000 feet AGL) (Tabs M-10 through M-11, N-4). At that point, the MP commenced another shallow descent, setting himself up to commence his HAS attack more than 2,000 feet lower than the briefed minimum altitude (1,800 feet below the minimum stated on his attack card) (Figure 2) (Tabs M-10 through M-11, CC-15).

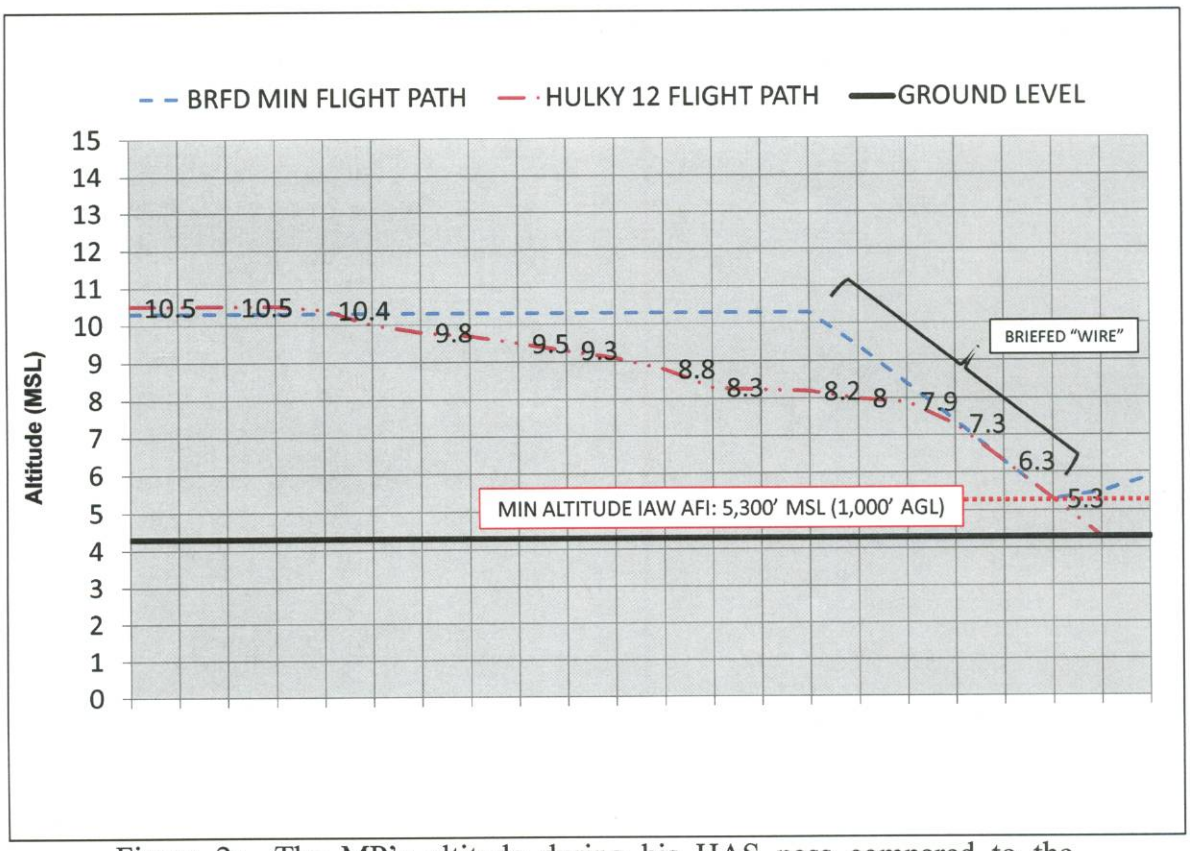

Figure 2: The MP's altitude during his HAS pass compared to the briefed minimum altitude for a HAS pass (Tabs M-10 through M-11, V-1.11 through V-1.13, CC-9 through CC-10).

At this time, the MFL was illuminating the MP's intended target with his IR marker, limiting his time available to monitor the MA (Tabs N-3 through N-4, CC-9 through CC-10). Testimony and multiple simulations indicated it would have been difficult for the MFL to visually assess the MP's precise altitude from his position in the CAS pattern (Tabs M-9 through M-11, CC-9 through CC-10).

Approximately 1.7 NM from the target, the MP's visual references indicating his angular trajectory to the target matched what he was briefed to execute (20 to 30 degrees below the horizon), so he turned slightly toward the target and lowered the nose of the MA (Tabs M-10

through M-11, CC-9 through CC-10). At 22:27:13L, the JTAC transmitted "Hulky 11, continue dry," the expected transmission for the MP to continue his attack, with the exception of the JTAC using the wrong callsign--using Hulky 11 instead of Hulky 12 (Tabs N-4, BB-3 through BB-8). At 22:27:15L the MP initiated a transmission of "Hulky 12's in, heading 026" (Tab N-4). At 22:27:18L, the JTAC initiated a directive call over the radio of "pull-up, pull-up, pull-up, pull-up" (Tab N-4). The JTAC observed no further change in the aircraft's trajectory through impact (Tab V-4.7).

e. Impact

The MA impacted the ground on 22 June 2009 at 22:27:19L (Tab C-3). The location of the impact site was N 40 06.178 W 113 40.452 (Tab J-18). The MA impacted the ground along its attack axis, approximately 50 meters short of the target the MP was assigned to attack (Tabs J-18, S-5, V-4.7 through V-4.8).

At the time of the impact, the MA was carrying two inert AIM (air intercept missile)-120 training missiles, one inert AIM-9 training missile, one acceleration monitoring device pod, two external fuel tanks, a Sniper targeting pod, and two weapons pylons (Tabs J-4, K-42). Estimated fuel remaining at the time of the mishap was 5,500 pounds (Tab J-19). Engineering analysis of the wreckage estimated the MA's trajectory at impact was 20 to 30 degrees low relative to the horizon (Tab J-4).

f. Life Support Equipment, Egress, and Survival

Aircrew flight equipment (AFE) was recovered in an area within 0.25 miles of the impact site. AFE records were reviewed, and all equipment had current inspection dates. AFE technician training records show that all those involved were trained and certified. All recovered AFE was disassembled and inspected, and it was confirmed that the equipment components functioned as designed. The MP accomplished F-16 egress training in March 2009, and he was current in accordance with AFI 11-301, Volume 1, *Flying Operations, AIRCREW FLIGHT EQUIPMENT (AFE) PROGRAM,* dated 25 February 2009 (Tab H-3).

Multiple components of the egress system were recovered and turned over to an ejection seat specialist at Hill AFB. Portions of the ejection handle, bellcrank assembly, JAU-8/A25 mechanically activated initiators, inertia reel gas generators, M-53 gas activated initiators and the unfired CKU-5C/A rocket catapult were found (Tab J-63 through J-67).

When an ejection is initiated in an F-16CM by pulling the ejection handle, a bellcrank is rotated, activating the JAU-8/A25s, which then activates the inertia reel gas generators and M-53 gas activated initiators. The inertia reel gas generators and the M-53 gas activated initiators receive the first gas inputs from the JAU-8/A25 initiators. Analysis of the recovered bellcrank shows that the connection rod was bent, the cable was in the track, and there were witness marks from the impact of the connection rod on the bellcrank. This evidence suggests that the ejection handle was not pulled. Additionally, the inertia reel gas generator and both M53 gas activated initiators were unfired, confirming that no ejection attempt was made (Tab J-61 through J-67).

g. Search and Rescue

At 22:27:27L, the MFL declared an in-flight emergency with Clover Control, the air traffic control facility responsible for the airspace including the BSP target complex (Tab N-4).

Clover Control notified the 388th Operations Group (388 OG) supervisor of flying (SOF) of the mishap via telephone, and the SOF ran the corresponding checklists to include notifying the 388 OG Commander (Tabs V-2.7, V-8.2 through V-8.3). The JTAC team immediately began moving toward the mishap site by sport utility vehicle (Tab V-4.8). Hulky 13 element was notified of the mishap by radio and proceeded to the mishap site to assist (Tab V-2.6 through V-2.7). Hooter flight, an additional flight of two 421 FS F-16s, was also notified of the mishap by Hulky 13 and moved into position over the mishap site (Tab V-2.7). After arriving on scene, Hulky 14 reached a fuel state requiring him to return to base, and he provided no further search and rescue assistance (Tab V-2.7). Shortly thereafter, Hulky 13 determined he could be of no further assistance and also returned to base (Tab V-2.7).

The JTAC team entered the range complex, proceeded to the mishap site with navigational assistance from the MFL, and secured the area (Tab V-4.6 through V-4.8). Despite deep mud and standing water at the mishap site, the JTAC team positioned themselves to provide any assistance required (Tab V-4.8). The MFL and Hooter flight remained on station until they were required to return to base (Tabs V-1.32 through V-1.33, V-10.4). Helicopters from Salt Lake City, Utah were launched in response to the mishap, but were 10 to 15 miles away from the mishap site when the last F-16s (Hooter flight) left the mishap site (Tab V-8.3 through V-8.4). A handoff of applicable information concerning the mishap occurred between Hooter flight and the responding helicopters (Tab V-8.4). Fire rescue vehicles and personnel from Dugway Proving Grounds and the 388th Range Squadron, Detachment 1 were dispatched to and arrived at the mishap site (Tabs CC-8). There was no evidence to establish the time the rescue vehicles arrived at the mishap site (Tab CC-8). Upon arrival at the mishap site, the Dugway Proving Grounds fire chief took control of the mishap site from the lead JTAC (Tab V-4.8).

h. Recovery of MP

Personnel from the 75th Air Base Wing, Hill AFB, under the supervision of 75th Mortuary Affairs personnel, recovered the remains of the MP. Supervision was subsequently handed off to Mortuary Affairs personnel from Dover AFB (Tab CC-6). The remains were transferred to the Salt Lake City Medical Examiner's office where an Armed Forces Institute of Pathology Medical Examiner performed the autopsy (Tab X-3). Mortuary affairs protocols were completed by the 75th Air Base Wing (Tab CC-6).

6. MAINTENANCE

All maintenance actions were found to be completed in accordance with the proper Technical Data. There is no evidence to suggest that maintenance issues contributed to the mishap (Tab U-5).

a. Forms Documentation

The Air Force Technical Order (AFTO) 781 series of forms collectively provide maintenance, inspections, servicing, configuration, status, and flight records. When AFTO 781 forms are removed from the aircraft's active forms binder at the end of the flying period, they are kept in a jacket file along with all other aircraft historical data. A thorough review of the AFTO 781 forms and jacket file for the MA from 90 days preceding the mishap revealed no evidence of mechanical, structural, or electrical failure. The active AFTO 781 forms for the day of the

mishap indicated the MA was inspected and prepared for the flight in accordance with applicable technical orders (Tab D-5 through D-26).

b. Inspections

Prior to the MS, the MA had 6,192.5 flight hours (Tab D-7). The MA's last major inspection was a phase inspection accomplished at 6,185.2 flight hours and completed from 20 May 2009 through 2 June 2009 (Tab U-3 through U-4). The phase inspection is completed by a dedicated inspection team composed of highly trained crew chiefs and specialists, and it consists of removing panels and components and inspecting aircraft structure and sub-systems for damage, wear, and correct operation. There were no discrepancies revealed other than normal expected wear (Tab U-5). The F-16 requires a phase inspection every 400 flight hours; the next phase inspection was scheduled at 6,600 hours (Tab D-21). The MA's last minor inspection, a thru-flight (TH), was completed on 22 June 2009 at 1958L (Tab D-7). A crew chief performs a TH inspection, between flights on the same flying day, consisting of a visual verification of proper fuel, fluid, and pneumatic servicing, and a physical inspection of the external airframe structure, to include flight controls, landing gear, and canopy. The TH inspection performed immediately preceding the mishap did not highlight any issues with the MA. The MA had seven non-mission related equipment Time Compliance Technical Orders (TCTOs) identified on the AFTO Form 781K as pending but not overdue (Tab D-22). There were no open discrepancies identified on the AFTO Form 781K that would have affected the airworthiness of the MA (Tab D-24). The Integrated Maintenance Data System (IMDS) is the electronic system used for maintenance data collection, maintenance management, and trend analysis. IMDS data for the MA from 90 days preceding the mishap was reviewed. No overdue inspections, time-change items, or TCTOs were found and no negative maintenance trends were discovered (Tab U-5).

c. Maintenance Procedures

The 421st Aircraft Maintenance Unit (421 AMU) maintenance procedures and practices were reviewed and found to be conducted in accordance with Air Force Instructions, procedures, and directives (Tab U-5).

d. Maintenance Personnel and Supervision

On 22 June 2009, 421 AMU crew chiefs performed the pre-flight and TH inspections and serviced the MA (Tab D-7 through D-20). A weapons load crew verified the proper installation of munitions prior to flight (Tabs D-11, D-13), and the production supervisor determined the MA was properly configured and released it for flight by signing the exceptional release (Tab D-7). A thorough review of the Air Force Form 623, Air Force Form 797, Special Certification Roster, and associated maintenance documentation was accomplished (Tab U-5). Records indicate maintenance personnel assigned to maintain the MA were properly trained and possessed the necessary skill level, qualifications, and expertise required to perform their assigned tasks (Tab U-5). IMDS records showed that unit ancillary training was effective and no overdue training tasks were identified. Maintenance supervision was actively engaged in daily aircraft maintenance practices (Tabs V-17, V-22 through V-23).

e. Fuel, Hydraulic, and Oil Inspection Analysis

After the first flight on the day of the mishap, the MA's engine oil sample was taken, processed, and reported as acceptable for continued service (Tab D-42). Due to the nature of the mishap, no engine oil, hydraulic fluid, or fuel samples were obtained for testing from the MA wreckage

(Tab U-5). Immediately following the mishap, the aerospace ground equipment and refueling trucks that were most recently used to service the MA were impounded (Tab V-15). All samples taken were analyzed and found to be within acceptable serviceable range (Tab D-43 through D-65).

f. Unscheduled Maintenance

The MA flew a total of 23 sorties and 35.5 flying hours in the 90 days preceding the mishap. A thorough review of historical IMDS records and the aircraft forms jacket file for this same time period was conducted. Pilots documented 12 discrepancies with the MA in the 90 days preceding the mishap, all of which were found to be properly resolved (Tab U-4). On the first sortie of the day on the day of this mishap, a minor discrepancy with the nose wheel steering system was documented but due to the nature of the discrepancy and affected system, it was not troubleshot or repaired prior to the MS and would not have affected the airworthiness of the MA (Tabs D-17, V-15.6, V-18.4). All maintenance actions were completed in accordance with the proper technical data.

7. AIRCRAFT AND AIRFRAME

a. Condition of Systems

The MA was destroyed upon impact and the ensuing fire. The wreckage was recovered from a 0.3 by 0.61 mile fan-shaped debris field (Tab Z-3). The MA's electrical and mechanical systems appear to have been fully functional and operating normally prior to impact (Tab J-6 through J-11). The post-mishap analysis and testing of the MA components did not reveal any internal damage or anomalies that could have contributed to the mishap (Tab J-6 through J-11).

Despite a diligent and labor-intensive search effort, the crash survivable flight data recorder and signal acquisition unit were not recovered (Tab U-5). Pieces of the data transfer cartridge, seat data recorder, digital flight control computer, modular mission computer, digital video recorder, and programmable display generator were recovered but were all severely damaged to the extent that no data could be retrieved (Tab J-5).

b. Testing

Lockheed Martin Aeronautics Company conducted post-mishap analysis of recovered MA systems, control surfaces, and integrated servo actuators. This in-depth analysis did not reveal any anomalies, malfunctions, or preexisting internal/external damage (Tab J-15 through J-16).

The Air Force Petroleum Laboratory conducted detailed analysis of fuel and liquid oxygen samples taken from equipment that was used to service the MA and found all samples to meet specification requirements (Tab D-63 through D-65).

The 388th Equipment Maintenance Squadron, Non-Destructive Inspection Section, conducted spectrometric analysis of oil samples taken from oil servicing carts used to service the MA engine and found them to meet all specification requirements (Tabs D-55, D-59).

8. WEATHER

a. Forecast Weather

The forecast weather for the UTTR was clear skies with 7 miles of visibility and surface winds out of the north-northwest (340 degrees) at 10 knots gusting to 18 knots (Tab F-5). Winds aloft were forecast light and variable below 10,000 feet MSL and from the southwest at 35 knots at 15,000 feet MSL (Tab F-5). Sunset was 2104L and moonset was 2128L (Tab F-4). End evening nautical twilight was 2224L (Tab F-6). Forecast illumination was high (greater than 2.2 millilux) at 2200L and 2300L, then becoming low (less than 2.2 millilux) at 2315L (Tab F-5 through F-6).

b. Observed Weather

At the time of the mishap, the observed weather at Hill AFB was clear skies with 10 miles of visibility, surface winds out of the east at 4 knots, and a temperature of 17 degrees Celsius (Tab F-8). Due to the lack of meteorological reporting stations at the location of the mishap, no recorded meteorological data of the actual weather at the mishap site exists (Tab W-3). Observed weather in the area surrounding the mishap was sky clear (Tab V-2.7). There was sky glow in the west from the setting sun, and the illumination was observed high, but approaching low at the time of the mishap (Tabs V-2.7 through V-2.8, V-3.5). The MFL testified he was able to distinguish terrain features through his NVGs from his position, above 15,000 feet MSL (Tabs M-8 through M-12, V-1.18 through V-1.19).

c. Space Environment

Not applicable.

d. Conclusion

The mission was flown in compliance with weather requirements, AFI 11-202, Volume 3, *Flying Operations*, *GENERAL FLIGHT RULES*, dated 5 April 2006, and AFI 11-214.

9. MEDICAL

a. Qualifications

The MP was medically qualified for flying duties at the time of the mishap in accordance with AFI 48-123, Volume 3, *Medical Evaluations and Standards-Flying and Special Operational Duty*, 5 June 2006. The MP's annual flight physical and dental exams were accomplished in January 2009, and he was medically fit for flying duties. His vision and hearing were both within standards for flying. He had a current flying class II waiver for a benign medical condition that was valid through 12 July 2012; this condition would not have impacted his ability to perform flying duties. He had a current AF Form 1042, *Medical Recommendation for Flying or Special Operational Duty*, which was dated 4 March 2009 and was valid through 31 July 2010 (Tabs V-25.1 through V-25.2, CC-4).

The MFL was medically qualified for flying duties at the time of the mishap in accordance with AFI 48-123 Vol 3. He had an annual flight physical in November 2008 and was medically fit for flying duties. His vision and hearing were both within standards for flying. He had a current AF Form 1042 which was dated 16 June 2009 and was valid through 30 November 2009 (Tab CC-5).

b. Health

The MP had no known medical or psychological issues or problems (Tab V-25.1 through V-25.2). Per his medical records and his 72-hour and 14-day histories provided by his spouse, he took no medication and had no recent illnesses or injuries (Tab CC-3 through CC-4).

The MFL had no current medical problems that would have impacted flying. A post-mishap medical examination revealed no medical issues or problems (Tab CC-5).

c. Pathology

The MP was fatally injured upon impact. An autopsy was performed by an Armed Forces Institute of Pathology Medical Examiner, and the results were submitted in an Autopsy Examination Report (Tab X-3). Toxicology reports for the MP, the MFL, flight members, and all associated maintenance personnel indicated they were not under the influence of alcohol or drugs at the time of the mishap (Tab CC-7).

d. Lifestyle

According to the MP's 72-hour and 14-day histories, as well as testimony by his flight commander and other squadron associates, he had no unusual work, home, or lifestyle stressors, and did not have any unusual habits or behaviors. Interviews suggest he had a stable personal life and a strong marriage (Tabs V-1.4, V-1.25, V-2.9, V-3.6, V-5.5, V-6.7, V-7.16, V-8.5, V-9.12, V-10.8, V-11.9, V-13.4, V-14.5, V-25.1 through V-25.2, CC-3). There is no evidence to suggest lifestyle issues or problems contributed to this mishap.

e. Crew Rest and Crew Duty Time

AFI 11-202 Vol 3, defines crew rest as a minimum 12-hour non-duty period prior to the designated flight duty period. The flight duty period is defined as the period that starts when an aircrew reports for a mission, briefing, or other official duty and ends when engines are shut down at the end of the mission. Fighter aircrew are limited to a maximum flight duty period of 10 hours when night operations are conducted per AFI 11-202 Vol 3, ACC Supplement, paragraph 9.8.4 (Tab BB-9 through BB-10).

A review of the MP's 72-hour history and testimony of other flight members indicate that he reported for duty at 1430L on the day of the mishap, well within crew rest and flight duty period requirements (Tabs CC-3, V-1.24, V-2.10). The 72-hour history reported that he slept well the night before with greater than 8 hours uninterrupted sleep and displayed no evidence of acute fatigue. Other flight members observed nothing to suggest the MP was fatigued (Tabs V-1.25, V-2.9). The 14-day history reveals no evidence of cumulative fatigue (Tab CC-3).

10. OPERATIONS AND SUPERVISION

a. Operations

At the time of the mishap, the 421 FS was preparing to deploy in support of Operation Enduring Freedom (Tabs V-5.3, CC-25). The originally scheduled date for deployment was 15 June 2009 and had been delayed (Tab CC-25). The 421 FS commander's training focus was on preparation for the types of combat operations most anticipated at the deployed location, primarily unopposed SAT and CAS (Tab V-5.3). Of the 777 training sorties flown by the squadron in the

2 months preceding the mishap, 543 involved unopposed SAT and/or CAS, many including HAS (Tab CC-26). In April 2009, the squadron participated in GREEN FLAG East, an exercise designed to focus on CAS (Tab V-7.6). Regular academics and ground training focused on these missions/events (Tab V-9.6). The 421 FS was also focused on increasing proficiency in night operations (Tab V-5.4). Of the 777 training sorties flown by the squadron in the 2 months preceding the mishap, 165 were at night, 70 of those in the last 2 weeks (Tab CC-26). Witnesses described the operations tempo as average or normal for the wing and the operational F-16 community and commensurate with a squadron preparing to deploy. None asserted operations tempo factors that negatively affected their ability to perform the mission (Tabs V-8.5. V-9.5, V-11.9 through V-11.10).

b. Supervision

Squadron supervision was engaged and involved in the training plan for the squadron and in monitoring qualifications and proficiency of squadron pilots (Tabs V-6.14 through V-6.15, V-11.7 through V-11.8). The MP's flight commander, who was also the MFL, was a new flight commander and had limited supervisory exposure to the MP (Tab V-1.3 through V-1.4). The MFL was a F-16 four-ship flight lead, current and qualified in all events required to lead the mission (Tab G-3). The 421 FS Director of Operations, a qualified F-16 instructor pilot, was a member of the mishap four-ship (Hulky 14) and supervised the conduct of the initial portion of the flight brief and four-ship execution from his position in the flight (Tabs G-3, K-6, V-3.2 through V-3.3). A qualified squadron supervisor (Top-3) participated in the mass briefing for the flight and handed Top-3 responsibilities over to another qualified squadron supervisor, who briefed the flight on all applicable items regarding their mission prior to "step" (Tabs V-6.2 through V-6.4, V-7.2). The MFL conducted an analysis of operational risk factors specific to this mission in accordance with applicable directives and completed the 388/419 FW Risk Matrix Worksheet prior to "step," which was reviewed and validated by the Top-3 (Tabs K-26, V-1.8 through V-1.10, V-6.3 through V-6.4). There was a qualified wing SOF on duty in the Hill AFB control tower (Tab V-8.2).

11. HUMAN FACTORS

AFI 91-204, *Safety Investigations and Reports,* 24 September 2008, 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 human factors were relevant to this mishap.

Misperception of Operational Conditions

Misperception of operational conditions is when an individual misperceives or misjudges altitude, separation, speed, closure rate, road/sea conditions, or aircraft/vehicle location within the performance envelope or other operational conditions and this leads to an unsafe situation.

At 22:26:29L, the MP was at 6,200 feet AGL and began a series of maneuvers, presumably in an attempt to visually position himself for the HAS, during which time he continuously descended (Tabs M-4 through M-11, M-13 through M-14). By the time of the MP's call "Hulky 2's in heading 360," he had descended to 4,000 feet AGL (Tab M-14). This was 2,000 feet lower than the briefed minimum altitude (and 1,800 feet lower than the minimum published on the 388 FW attack card) (Tabs V-1.13, CC-15). During his positioning maneuvers, roll-in, and HAS he gave

no indication, either verbally or via changes in the MA trajectory, that indicated he was aware of his altitude (Tabs N-4, V-4.7). Passing approximately 1,000 feet AGL, the altitude by which he should have already completed his recovery, the MP transmitted "Hulky 12's in heading 026," in a clear, calm, and coherent manner (Tabs M-11, N-4, CC-28). The MP potentially misperceived his altitude as being higher that it actually was.

Limited Total Experience
Limited total experience is relevant when a supervisor selects an individual who has performed a maneuver, or participated in a specific scenario, infrequently or rarely.

This mishap occurred while the MP was performing night HAS down to a minimum of 1,000 feet AGL, using an IR marker transmitted from the MFL's targeting pod to identify the target, a mission he was qualified to perform (Tab G-145 through G-146). According to the MP's flight records, he had a total of 155.6 hours in the F-16 (Tab G-7). Prior to the MS, the MP had flown HAS on 21 sorties, 5 of which were at night (Tab T-6). Only one of these night sorties involved HAS recovering as low as 1,000 feet AGL--his 19 May 2009 NVG Low qualification sortie (Tab G-145 through G-146). Additionally, the MP had never executed a night HAS event employing an IR marker from another aircraft (Tab V-1.7).

Channelized Attention
Channelized attention is when an individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others of a subjectively equal or higher or more immediate priority, leading to an unsafe situation. It may be described as a tight focus of attention that leads to the exclusion of comprehensive situational information.

The MS was the first time the MP had attempted a HAS event using an IR marker to identify the target (Tab V-1.7). During the HAS pattern, the MP made several radio calls with the MFL confirming that he had visually acquired the IR marker and that it was on the correct target (Tab N-4). Analysis of the MFL's Link16 recording, along with position and altitude data from Clover radar control then showed the MP descending prior to roll-in for his HAS attack. The MP subsequently performed several maneuvers to correct his pattern position, during which he continued to descend (Figure 3) (Tab M-4 through M-11). At the time of the MP's call "Hulky 2's in heading 360," he was approximately 4,000 feet AGL, 2,000 feet lower than the briefed minimum altitude (Tabs M-14, N-4, V-1.13). When he made this turn, the MP delayed lowering his nose to the target (Tab M-4 through M-11). These maneuvers, combined with the MA's diminishing altitude, could suggest that the MP was channelized on visually establishing the correct angular trajectory through his NVGs to the exclusion of cross checking his altitude indications throughout the mishap sequence.

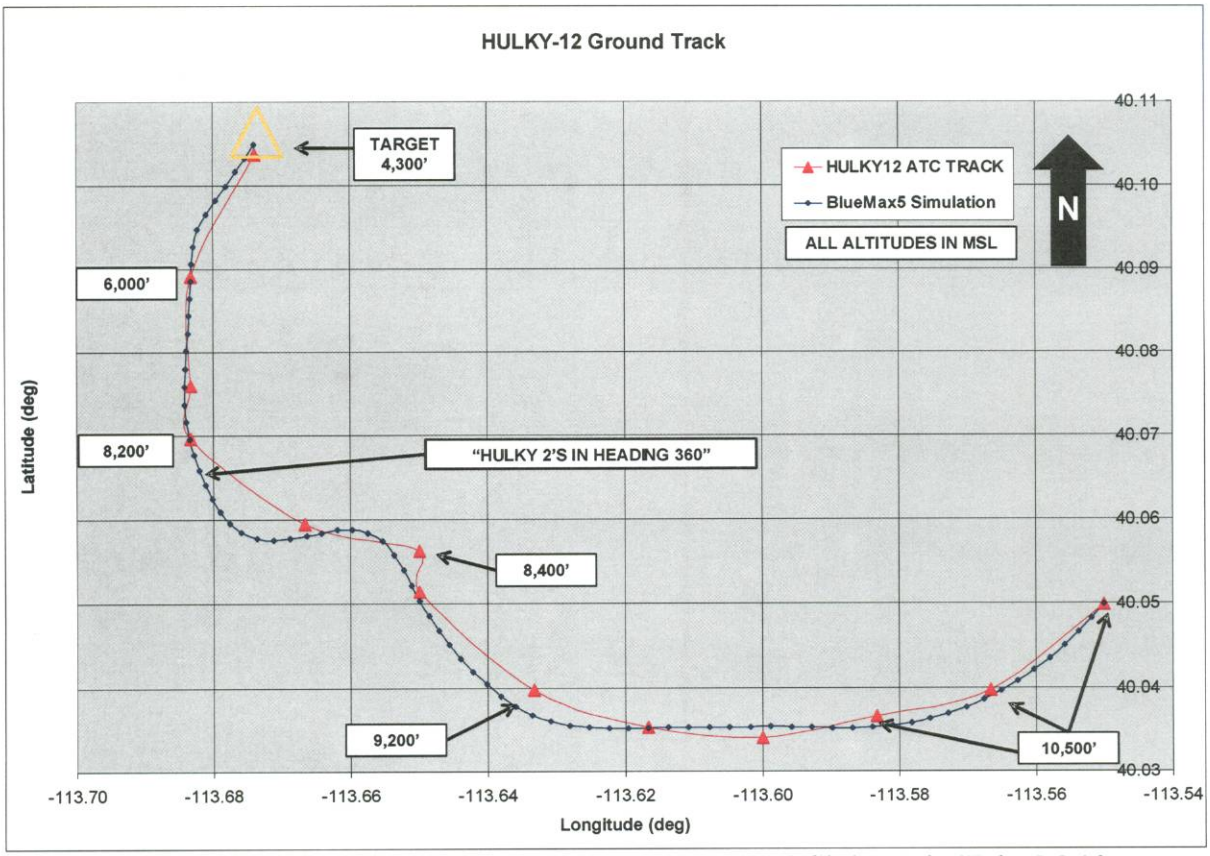

Figure 3: The MP's ATC and animation derived flight path (Tabs M-10 through M-11, CC-14).

The MA impacted the ground along its attack axis approximately 50 meters short of the target (Tab S-5). Through multiple simulations utilizing the same attack parameters as the MA, it was only possible to impact short of the target by not pulling up prior to impact (Tab CC-9 through CC-10). This again suggests that the MP had no recognition of his low altitude and made no attempt at recovery. These actions are consistent with the MP being channelized on target acquisition of the IR marker to the exclusion of recognizing his decreasing altitude.

Given the MP's trajectory and the mechanization of F-16 low-altitude warning systems, it is highly likely the MP received a repeating auditory warning of "PULL UP, PULL UP" from the PGCAS along with a continuously displayed large, flashing "X" visual cue in the HUD by at least 900 feet AGL and 3 seconds prior to impact (Figure 4). In strafe mode, this is designed to allow the pilot a delay of 1 second to recognize the warning and 1 second to initiate a 5G recovery to remain above 50 feet AGL. If the PGCAS is turned off or not functioning, the MP would have received a repeating "PULL UP, PULL UP" warning and a continuous HUD "X" from the ground avoidance advisory function (GAAF), also by 900 feet AGL (Tab J-11 through J-15). During multiple simulations of the MS, pilots of various experience levels were consistently able to process these warnings, perform an instrument cross-check to confirm altitude and slant range, and initiate a recovery in time to avoid impacting the ground, with all pilots recovering by at least 450 feet AGL. A timely response to either of these warning systems

would have allowed sufficient time to recover the aircraft prior to ground impact (Tab CC-9 through CC-10). The lack of attempted recovery is consistent with channelized attention making it unlikely the MP mentally processed the warnings.

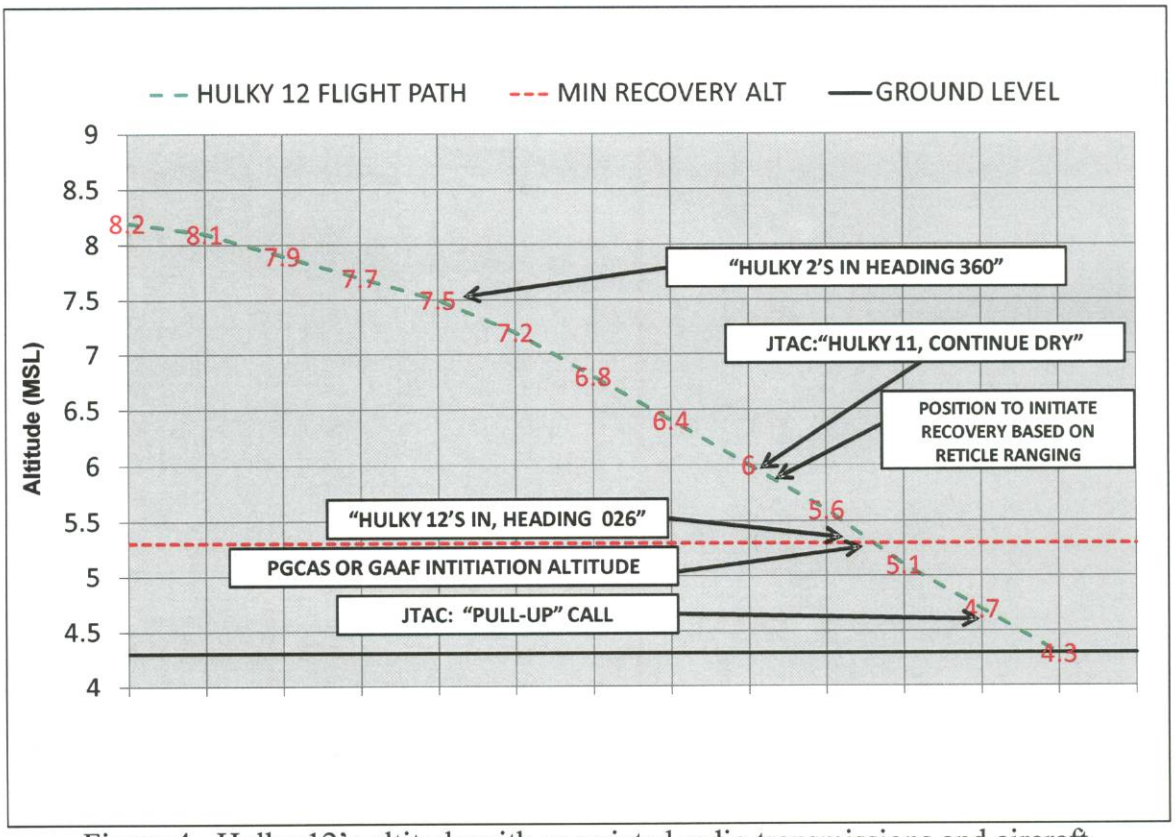

Figure 4: Hulky 12's altitude with associated radio transmissions and aircraft warnings (Tabs J-11 through J-15, M-10 through M-11, N-3 through N-4, CC-9 through CC-10).

Breakdown in Visual Scan

Breakdown in visual scan is when the individual fails to effectively execute learned/practiced internal or external visual scan patterns leading to an unsafe situation.

Anytime during the last 50 seconds of the HAS pattern, a visual scan of the MA's altitude indication(s) would have alerted the MP that his aircraft was significantly lower than briefed (Tabs M-4 through M-12, V 1.13, CC-27). Although the briefed minimum altitude for roll-in was 6,000 feet AGL, the MP was at 4,000 feet AGL on roll-in (Tabs M-14, V-1.13). There is no evidence, either by radio communication or by a change in aircraft trajectory, to indicate the MP was aware of his decreased altitude (Tabs M-14 through M-15, V-4.7). In the F-16CM, the radar altimeter display on the HUD (indicating height AGL) is preceded by an "R" and is directly below the barometric altimeter display (indicating height above MSL) (Tab CC-27). It is possible the MP mistook the barometric altimeter reading for radar altimeter throughout the mishap sequence giving him the false impression he was 4,300 feet higher than he actually was. It is also possible he simply failed to reference either altitude reading in a timely manner during the HAS pattern. Additionally, when the reticle is placed on the target it gives a range to the

target in feet. This was briefed as the primary means for the MP to assess his correct distance to the target (Tab V-1.12). The MP's actions are consistent with a breakdown in visual scan resulting in the MP failing to observe his altimeter and other instruments.

Expectancy

Expectancy is a factor when an individual expects to perceive a certain reality and those expectations are strong enough to create a *false perception* of the expectation.

During the entire mishap sequence, the MP continued the pattern without correcting his altitude, despite being substantially lower than his briefed minimum altitude (Tabs M-14 through M-15, V-1.13). The communication from the MP gave no indication that he was aware of his diminished altitude and compressed range (Tab N-3 through N-4). If the MP had flown the HAS as briefed, he would have rolled in using a 120 degree bank turn and placed the aiming reference, or "pipper," 20 to 30 degrees below the horizon near the target (Tab V-1.11 through V-1.13). This would have put the MA on the briefed "wire." Once on the "wire" with the pipper near the target, the MP was trained to use reticle ranging (the range generated by the aircraft system measuring the line-of-sight distance through the pipper) as his primary cue for his distance to the target (Tab V-1.12). Had the MP been on the briefed "wire" at roll-in, the first reticle range he would see would have been at least 12,000 feet (Figure 5) (Tab CC-9 through CC-10).

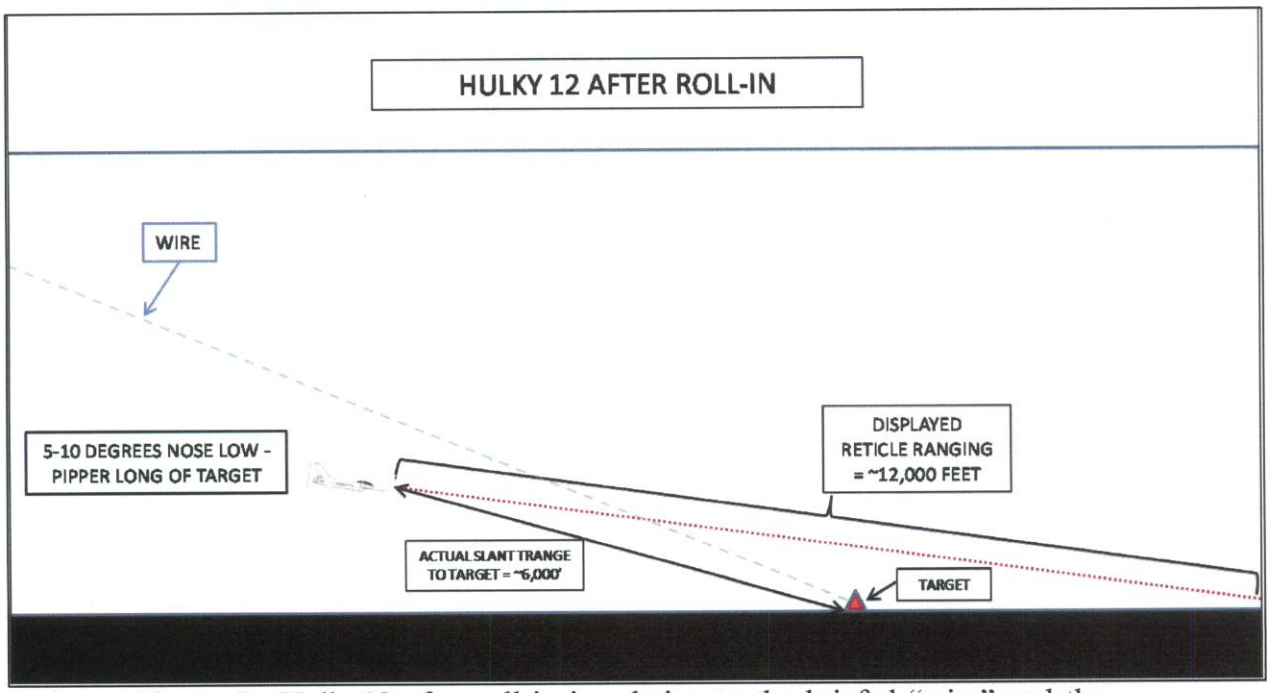

Figure 5. Hulky12 after roll-in in relation to the briefed "wire" and the associated reticle ranging (Tab CC-9 through CC-10).

On the MS, the MP was initially below the briefed 20 to 30 degree "wire" and delayed lowering the MA's nose until reaching the "wire" (Tab M-4 through M-11). Under these conditions, since the MA was pointed long of the target, simulations indicated the reticle would probably still have displayed a range of over 12,000 feet, when the actual distance was less than 6,000 feet (Tab CC-9 through CC-10). This misleading reticle range could have corresponded to the

ranging the MP expected to see and reinforced his false perception that he was higher and farther from the target than he actually was. This expectancy could also have altered his perception of the target, ground cues, and possibly altimeter readings in the final seconds and made it difficult to recognize his proximity to the ground.

Vision Restricted by Meteorological Conditions

Vision restricted by meteorological conditions is relevant when weather, haze, or darkness restricts the vision of the individual to a point where normal duties were affected.

AFI 11-214 specifies illumination requirements to ensure aircrew have sufficient reference to the horizon and terrain features during NVG operations. The illumination at the time of the mishap was 5.74 millilux, above the 2.2 millilux required to conduct NVG Low operations (Tabs F-9, CC-11). However, analysis of the mishap site by Air Force Research Laboratory personnel revealed that the illumination data, while valid at an altitude above the mountain ranges where the sky glow from recent sunset was available, is different than the illumination in the area of the ground shaded by the mountain ranges. Although there was no direct measurement of low altitude illumination available to the mishap flight, it is possible the MP experienced as low as 0.22 millilux, provided by ambient starlight. In addition, the ground surface was flat with few terrain features, creating a low-contrast background. These factors could have created a "black hole" effect around the area of the target, giving the MP few cues to allow him to visually recognize his proximity to the ground (Tab CC-11 through CC-12). Additionally, NVGs restrict the wearer's field of view from 180 degrees to 40 degrees, thus blinding the pilot to peripheral terrain cues that could be used to judge altitude. The MP's vision could have been restricted to the point that, without referencing his instruments, it was difficult or impossible to judge proximity to the ground.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications

1. AFI 11-2F-16, Volume 1, *Flying Operations, F-16 Pilot Training*, 19 January 2007
2. AFI 11-2F-16, Volume 3, *Flying Operations, F-16--Operations Procedures,* 30 September 2005
3. AFI 11-202, Volume 3, *Flying Operations, General Flight Rules*, 5 April 2006
4. AFI 11-202 Volume 3, ACC Supplement, *Flying Operations, General Flight Rules*, 27 February 2007
5. AFI 11-214, *Air Operations Rules and Procedures*, *Air Operations Rules and Procedures,* 22 December 2005
6. AFI 11-301, Volume 1, *Flying Operations, Aircrew Flight Equipment (AEF) Program*, 25 February 2009
7. AFI 48-123 Volume 3, *Aerospace Medicine, Medical Evaluations and Standards-Flying and Special Operational Duty,* 5 June 2006
8. AFI 51-503, *Law*, *Aerospace Accident Investigations*, 16 July 2004
9. AFI 91-204, *Safety Investigations and Reports*, 24 September 2008

b. Primary Maintenance Directives and Publications

1. AFI 21-101, *Aircraft and Equipment Maintenance Management, Air Combat Command, United States Air Forces in Europe, and Pacific Air Forces Supplement*, 24 April 2007
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. 1F-16CG-6WC-1-11, *Combined Preflight/Postflight, End-of- Runway, Thruflight, Launch and Recovery, Quick Turnaround, Basic Postflight, and Walkaround Before First Flight of Day Inspection Workcards,* 15 Jan 2009
5. T.O. 33-1-37, *Joint Oil Analysis Program Laboratory Manual, Volume I,* 1 July 2005 with Change 4 dated 7 December 2005, *Volume II*, 1 July 2005 with Change 4 dated 7 December 2005, *and Volume III*, 1 December 2004 with Change 37 dated 7 December 2005
6. T.O. 42B1-1-1, *Quality Control of Fuels and Lubricants*, 1 August 2004 with Change 1 dated 1 June 2005
7. T.O. 42B6-1-1, *Technical Manual -- Quality Control of Aviator's Breathing Oxygen*, 30 April 2004

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

There are no known or suspected deviations from directives or publications by crew members or others involved in the mishap mission.

13. NEWS MEDIA INVOLVEMENT

Headquarters 388 FW, Office of Public Affairs published four press releases. Media outlets immediately reported on this mishap, and on 23 June 2009 the 388 FW Commander hosted a press conference (Tab CC-24).

10 August 2009

RUSSELL J. HANDY, Brigadier General, USAF
President, Accident Investigation Board

STATEMENT OF OPINION
F-16CM, T/N 89-2108 ACCIDENT
22 JUNE 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 22 June 2009 at approximately 2227 local time (L) (0430 Greenwich Mean Time or Zulu time (Z)), F-16C aircraft tail number 89-2108, assigned to the 421st Fighter Squadron, 388th Fighter Wing (388 FW), Hill Air Force Base, Utah, impacted the ground during controlled flight on the Utah Test and Training Range (UTTR), approximately 100 nautical miles (NM) southwest of Hill Air Force Base. The mishap aircraft (MA) was destroyed upon impact and the mishap pilot (MP) was fatally injured.

The intent of the mishap sortie (MS) was to conduct a night four-ship air-to-ground training event and multiple two-ship air-to-ground events as part of the unit's preparation for an upcoming Air Expeditionary Force deployment. At the time of the mishap, the mishap element was conducting close air support (CAS) training with joint terminal attack controllers (JTACs). Following the mishap, search and rescue operations were initiated by Hulky 11 and the JTACs, and fire rescue vehicles and personnel responded from Dugway Proving Grounds and the 388th Range Squadron, Detachment 1.

I find, by clear and convincing evidence, this mishap was caused by the MP's failure to recognize his altitude during a night high-angle strafe (HAS) attack.

I also find the following five factors substantially contributed to the mishap: MP's limited total experience; channelized attention; breakdown in visual scan; expectancy; and inability to distinguish terrain features.

I developed my opinion by analyzing factual data from historical records; guidance and directives; engineering analysis; witness testimony; and information provided by technical experts. In addition, the board secured two animations, from separate sources, to replicate the mishap sequence of events. This evidence was used to conduct multiple flight simulations from two separate sources, with the assistance of technical experts and F-16 pilots with specified levels of experience.

2. BACKGROUND

The MP had 1,571.9 total military flying hours and 155.6 hours in the F-16C/D. He was considered an inexperienced F-16 pilot, based upon his limited flight hours in that specific aircraft. He was current and qualified in all events planned and executed on the night of the mishap. He had a reputation in the squadron as an extremely motivated, hard working, and professional officer, with a strong work ethic, who seized every possible opportunity to improve

his knowledge and skills. His supervisors, instructors, and peers characterized his skills as an F-16 wingman as average to slightly above average. His personal life was very stable, with a strong family relationship. There were no apparent on- or off-duty stressors indicated that would impact his ability to perform his duties. On the day of the mishap, he was well-rested, well-prepared, and motivated.

The mishap flight lead (MFL) was an experienced F-16 pilot, on his second operational F-16 assignment, with 859.7 total military flying hours and 613 in the F-16C/D. He was a current and qualified four-ship flight lead, described as very strong in this role. He was also the MP's flight commander, but was new in this job and had limited supervisory exposure to the MP.

Figures 1 and 2 depict the MP's HAS pattern geometry, in two dimensions, relative to the geometry of a pattern the MP would be expected to fly, based upon the mishap flight briefing, the MP's training, historical evidence of MP technique, and his pre-mission discussion with the MFL.

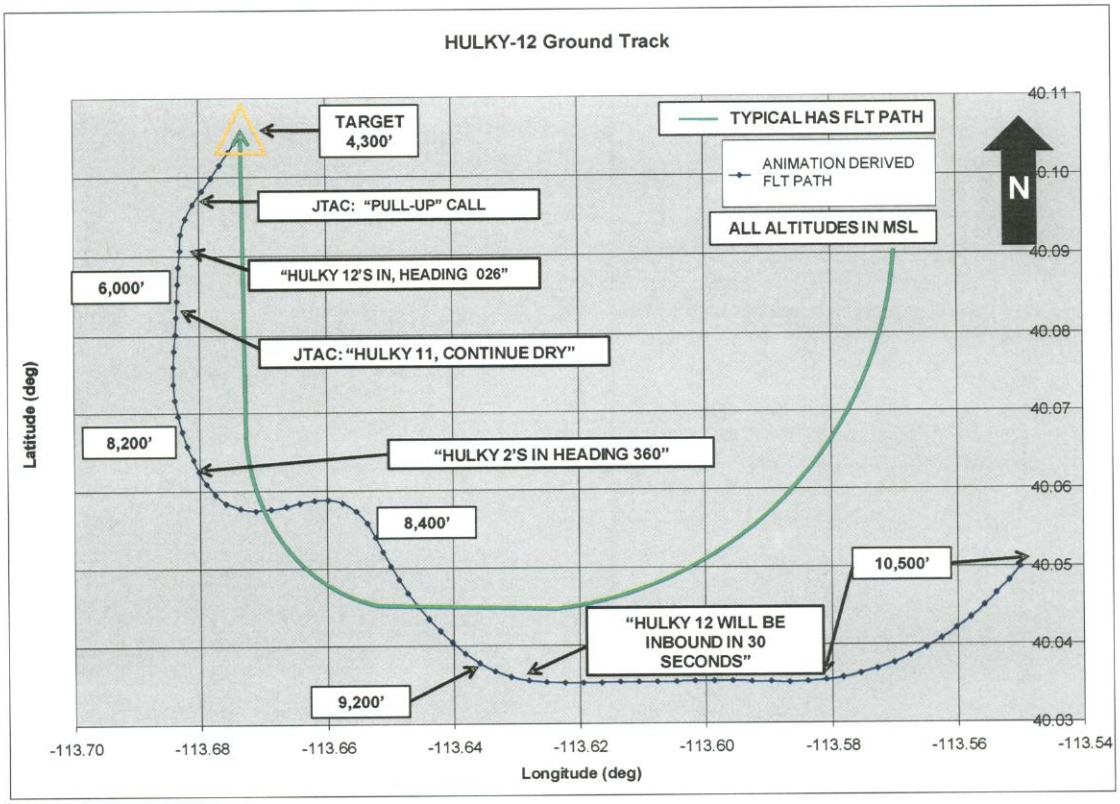

Figure 1: Ground Track Depiction

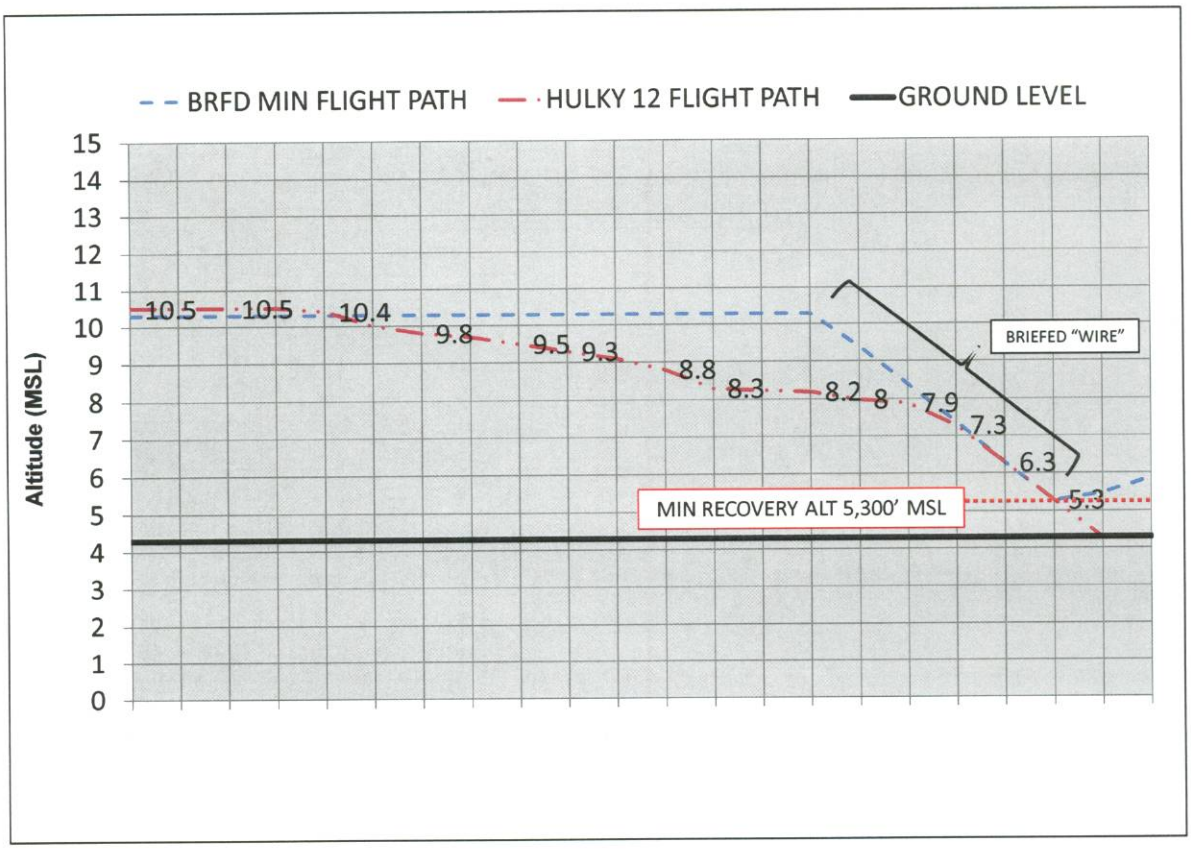

Figure 2: Elevation Depiction

3. CAUSE

At 22:26:29L, 50 seconds prior to impact, the MA was at 6,200 feet above ground level (AGL) (10,500 feet mean sea level (MSL)), still above at the briefed minimum roll-in altitude and in a position to execute a safe HAS attack. The MP had visually acquired the target through his night vision goggles (NVGs), with the aid of his and the MFL's targeting pod infrared (IR) marker. From that point, the MP began a descent below this altitude and performed a series of maneuvers toward the target so that, by the time he performed his roll-in turn to commence the HAS attack, the MA was at 4,000 feet AGL, 2,000 feet lower than the briefed minimum altitude (1,800 feet lower than the wing-established minimum published on the 388 FW attack card). It is highly likely the MP was focused on positioning himself visually for the attack and unaware of his low altitude. The MP then flew toward the target, nearly level, until 1.7 NM from the target, at which point the angular trajectory to the target matched what he was briefed to execute (20 to 30 degrees below the horizon), and he lowered the nose of the MA in an apparent maneuver to place his aiming reference near the target. The MP transmitted "Hulky 12's in heading 026," in a clear, calm, and coherent manner, passing approximately 1,000 feet AGL, the altitude by which he should have already completed his recovery. Four seconds later, the MA impacted the ground approximately 50 meters short of the target. Additionally, I concluded, from testimony and multiple simulations, the MFL could not have been expected to alert the MP of his precise altitude from his position. This evidence and the MP's historical reputation for disciplined

execution lead me to conclude the MP's failure to recognize his altitude during the night HAS attack. This caused the mishap.

4. SUBSTANTIALLY CONTRIBUTING FACTORS

The following five factors substantially contributed to the mishap.

Limited Total Experience. Limited total experience is when an individual is selected to perform a maneuver or participate in a specific scenario that he or she has performed infrequently or rarely.

This mishap occurred while the MP was performing night HAS down to a minimum of 1,000 feet AGL, using an IR marker transmitted from the MFL's targeting pod to identify the target, a mission he was qualified to perform. Prior to the MS, the MP had flown HAS on 21 sorties, 5 of which were at night. Only one of these night sorties involved HAS recovering as low as 1,000 feet AGL--his 19 May 2009 NVG Low qualification sortie. Additionally, the MP had never executed a night HAS event employing an IR marker from another aircraft. Based upon his limited total experience in this environment, it is reasonable to conclude he was placed in an environment where he was exposed to conditions he was not thoroughly familiar with. Despite the fact that the MP was current, qualified, and appropriately supervised to perform this event, his limited total experience was a substantially contributing factor.

Channelized Attention. Channelized attention may occur when an individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others of a subjectively equal or higher or more immediate priority, leading to an unsafe situation. It may be described as a tight focus of attention that leads to the exclusion of comprehensive situational information.

The MS was the first time the MP had attempted a HAS event using an IR marker to identify the target. Identifying the target in this manner required focusing through the limited field of view of his NVGs, requiring a diversion of attention away from his flight instruments. The MP makes several radio calls during the pattern indicating he was diligently attempting to confirm the IR marker was on the correct target. Throughout the mishap sequence, the MP performed several maneuvers to correct his pattern position, during which he descended below the minimum roll-in altitude. When he makes his final roll-in turn, the MP delays lowering his nose to the target, indicating he was focused on visually establishing the correct angular trajectory through his NVGs to the exclusion of cross checking his altitude indication(s).

Additionally, given the MA trajectory and the mechanization of F-16CM low-altitude warning systems, it is highly likely the MP received an auditory warning of "PULL UP, PULL UP," along with a continuously displayed large, flashing "X" visual cue in the head-up display (HUD), from either the Predictive Ground Collision Avoidance System (PGCAS) or Ground Avoidance Advisory Function (GAAF), at a minimum of 900 feet AGL, 3 seconds prior to impact. In strafe mode, the F-16CM PGCAS system is mechanized to transmit the "PULL UP" warning and the "X" in time for the pilot to initiate a 5G recovery and remain above 50 feet AGL. It assumes a total of a 2-second delay--1 second for pilot recognition of the "PULL UP" warning and 1 additional second for the pilot to physically apply the recovery flight control input.

Simulations revealed F-16 pilots of a variety of experience levels were able to recognize and react much quicker than this. These pilots consistently recognized the "PULL UP" altitude warnings generated by PGCAS or GAAF, delayed recovery actions to validate other cues (i.e., range from the target, trajectory, altitude) and still safely recovered. Had the MP heard and processed the warnings, he should have either immediately initiated a recovery or, as a minimum, referenced his other instruments to validate his position with respect to the ground. Had he referenced his instruments, specifically reticle range or altitude, he would have been alerted to his dangerous proximity to the ground and initiated a recovery.

I believe the MP channelized his attention at attempting to visually prosecute the attack, to the exclusion of visual and audible cues of a more immediate priority, and this was a substantially contributing factor.

Breakdown in Visual Scan. Breakdown in visual scan may occur when an individual fails to effectively execute learned/practiced internal or external visual scan patterns leading to an unsafe situation.

The briefed minimum altitude for roll-in was 6,000 feet AGL. Had the MP processed his altitude any time during the last 50 seconds of the mishap sequence, he would have recognized he was dangerously low. In the F-16CM, the radar altimeter display (indicating height AGL) on the HUD is preceded by an "R" and is directly below the barometric altimeter display (indicating height above MSL). It is possible the MP mistook the barometric altimeter reading for radar altimeter throughout the mishap sequence giving him the false impression he was 4,300 feet higher than he actually was. It is also possible he simply failed to reference either altitude reading in a timely manner during the HAS pattern. Regardless of which of these occurred, it is clear that an effective visual scan of his flight instruments would have alerted the MP of his low altitude state prior to the roll-in. Breakdown in visual scan was a substantially contributing factor to the mishap.

Expectancy. Expectancy is a factor when the individual expects to perceive a certain reality and those expectations are strong enough to create a *false perception* of the expectation.

During the entire mishap sequence, the fact that the MP continued the pattern without correcting his diminishing altitude indicates he perceived himself to be at or above a minimum safe roll-in altitude. If the MP had flown this HAS attack as briefed, he would have rolled in using a 120 degree bank turn, placing the aiming reference (pipper) near the target, 20 to 30 degrees below the horizon. This would put the MA on what's referred to as the "wire." Once on the "wire" with the pipper near the target, the MP was trained to use reticle ranging (the range generated by the aircraft system measuring the line-of-sight distance through the pipper) as his primary cue for how close he was to the target. Had the MP been at the briefed altitude and position at roll-in, the first reticle range he would see would have been at least 12,000 feet (Figure 3).

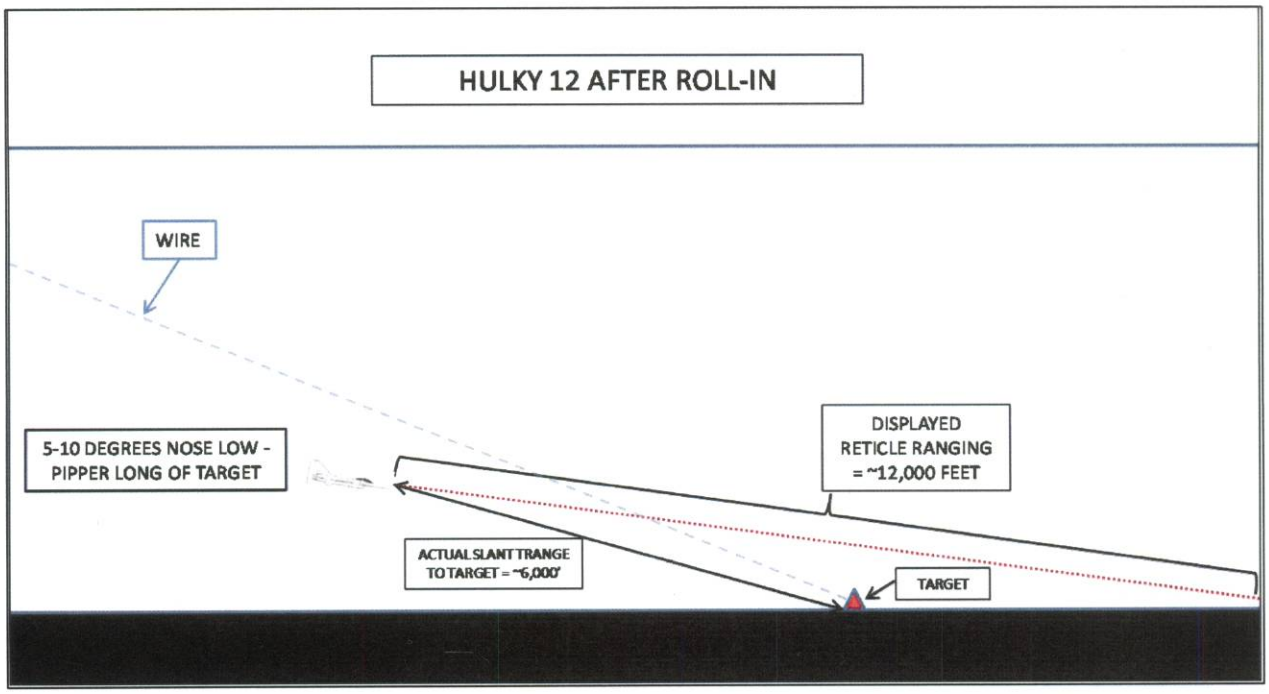

Figure 3

On the MS, the MP was much lower than expected, below the briefed 20 to 30 degree "wire." Assuming the MP thought he was at or above 6,000 feet AGL, it would now appear to him as if he were too far from the target laterally for that altitude, so he continued flying toward the target nearly level and delayed lowering the MA's nose until reaching the "wire." Since the nose of the aircraft was not pointed directly down at the target during this time, it is highly likely the reticle ranging was misleading, indicating 12,000 feet or more--the range he **expected** to see, vice his actual range, which at this point (5 to 7 seconds prior to impact) was less than 6,000 feet.

Based upon his training, past experiences, and probable misleading reticle range, the MP had a strong expectation he would have at least 10 seconds to prosecute the attack on final, when in reality, after he established his final HAS trajectory, he had approximately 1 second remaining to recover and remain above 1,000 feet AGL. The conflict between this expectation and reality could have made it difficult for him to process data appearing contrary to what he was expecting, altering his perception of the target, ground cues, and altitude indications. Expectancy was a substantially contributing factor.

Inability to Distinguish Terrain Features.

Illumination conditions and lack of IR contrast likely made it very difficult for the MP to visually distinguish features in the target area. To fly night HAS down to 1,000 feet AGL in this area, Air Force directives require illumination in the area to be "high" (defined as greater than 2.2 millilux) to ensure a pilot has sufficient reference to the horizon and terrain features through NVGs. On the night of the mishap, illumination conditions for the target area were forecast to be "high," in accordance with Air Force directives. This condition was confirmed in post-mishap analysis--illumination at the time of the mishap in the general area of the target was 5.74

millilux. However, analysis by technical experts revealed that the illumination data, while valid at an altitude above the mountain ranges where the sky-glow from recent sunset was available, was different than the illumination in the area of the ground shaded by the mountain ranges. Although there was no direct measurement of low altitude illumination available to the mishap flight, it is possible illumination at the altitude the MP began his final HAS attack was as low as 0.22 millilux, provided only by ambient starlight. In addition, the ground surface was flat with few terrain features, creating a low-contrast background. These factors would have created a "black hole" effect around the area of the target, giving the MP little visibility through his NVGs to allow him to visually recognize his proximity to the ground. NVGs also restrict the wearer's field of view from 180 degrees down to 40 degrees, thus blinding the pilot to peripheral terrain cues that could be used to judge altitude. This inability for the MP to clearly distinguish terrain features substantially contributed to the mishap.

5. CONCLUSION

The mishap flight was conducted in accordance with applicable service and unit guidelines. The MP and MFL were current and qualified to perform the planned mission events. There is clear and convincing evidence the MP failed to recognize his altitude during a night HAS attack, causing the mishap, complicated by the five substantially contributing factors discussed above.

10 August 2009

RUSSELL J. HANDY, Brigadier General, USAF
President, Accident Investigation Board