

**SUMMARY OF FACTS AND STATEMENT OF OPINION  
F-16 MID-AIR ACCIDENT  
7 JAN 98**

1. **AUTHORITY:** Under the provisions of Air Force Instruction (AFI) 51-503, on 2 Feb 1998, the Twelfth Air Force Commander, Lieutenant General Lansford E. Trapp, Jr., appointed Lieutenant Colonel Mark G. Chauret to conduct an aircraft accident investigation after two F-16CGs aircraft, numbers SN 88-0449 and SN 88-0537 (Tab Y-2), had a mid-air collision over Utah Test and Training Range (UTTR) resulting in the crash of aircraft SN 88-0449 (Tab A-2, B-2). No damage was caused to private property (Tab P-2). The investigation was conducted at Hill Air Force Base, Utah, from 2 Feb 98 through 27 Feb 98. The technical advisors were Capt Andrew J. Chudy (operations), Mr. James G. McLaren (legal), Capt Daniel T. Smith (medical) and Capt John C. Mateer (maintenance) (Tab Y-3 thru 7).

2. **PURPOSE:** An aircraft accident investigation is convened under AFI 51-503. The investigation is intended primarily to gather and preserve evidence for claims, litigation, disciplinary and adverse administrative actions, and for all purposes other than mishap prevention. In addition to setting forth factual information concerning the accident, the board president is also required to state his opinion concerning the accident (if there is clear and convincing evidence to support that opinion), or to describe those factors, if any, that in the opinion of the board president, substantially contributed to the accident. This investigation is separate and apart from the safety investigation conducted under AFI 91-204. The report is available for public dissemination under the Freedom of Information Act (5 U.S.C. 552) and AFI 37-131. Accident board members were convened to investigate the Class A aircraft accident involving two F-16CG aircraft, numbers SN 88-0449 and SN 88-0537, from the 388th Fighter Wing, 421 Fighter Squadron, Hill AFB Utah, which occurred on 7 Jan 98 at 1321 (Local) hours / 2021 (Zulu) hours (Tab Y-2/B-3). The mid-air collision accident happened over Utah Test Range resulting in the crashing of aircraft SN 88-0449 on the Utah Test and Training Range. There were no casualties (Tab A-2). Total loss was \$17,245,430.15. Aircraft SN 88-0449 was totally destroyed upon impact with the ground resulting in a loss of \$16,539,200.15 (Tab M-2). Aircraft SN 88-0537 was damaged and its repair cost was \$706,230 (Tab M-7).

3. **SUMMARY OF FACTS:**

a. **History of Flight Activity:**

The purpose of the mission was to fly a 2 aircraft versus 4 aircraft (2v4) Tactical Intercept (TI) mission to prepare the squadron for an upcoming Combat Archer deployment. The mission briefing was accomplished in a thorough and professional manner (Tab V-3.4). The six aircraft mission consisted of Spider flight, a flight of 2 aircraft (Spider 1 and 2), and Nail flight, a flight of 4 aircraft (Nail 1 thru 4). Nail 1 thru 4 took off from Hill AFB at 1232 L and Spider 1 and 2 took off at 1238 L from Hill AFB. Takeoff and entry into the South UTTR were uneventful. Spider 2 (Capt Hertzberg) was the mishap pilot of aircraft SN 88-0449 which was totally destroyed. Nail 3 (Capt Hufford) was the mishap pilot of aircraft SN 88-0537 which was damaged (Tab J-10, V-5.6, V-5.7) (see fig. 1, 2, 3 and 4 on pg. 2 and 3).

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NUCLEAR REGULATORY COMMISSION

Docket No. \_\_\_\_\_ Official Exh No. 197  
In the matter of PPS  
Staff ✓ IDENTIFIED ✓  
Applicant ✓ RECEIVER ✓  
Intervenor ✓ 2/1/02  
Cont'g Off'r ✓ 2/1/02  
Contractor ✓ Witness 2/1/02  
Other 2/1/02  
Reporter 2/1/02

# AIR COMBAT MANEUVERING INSTRUMENTATION (ACMI) PRESENTATION

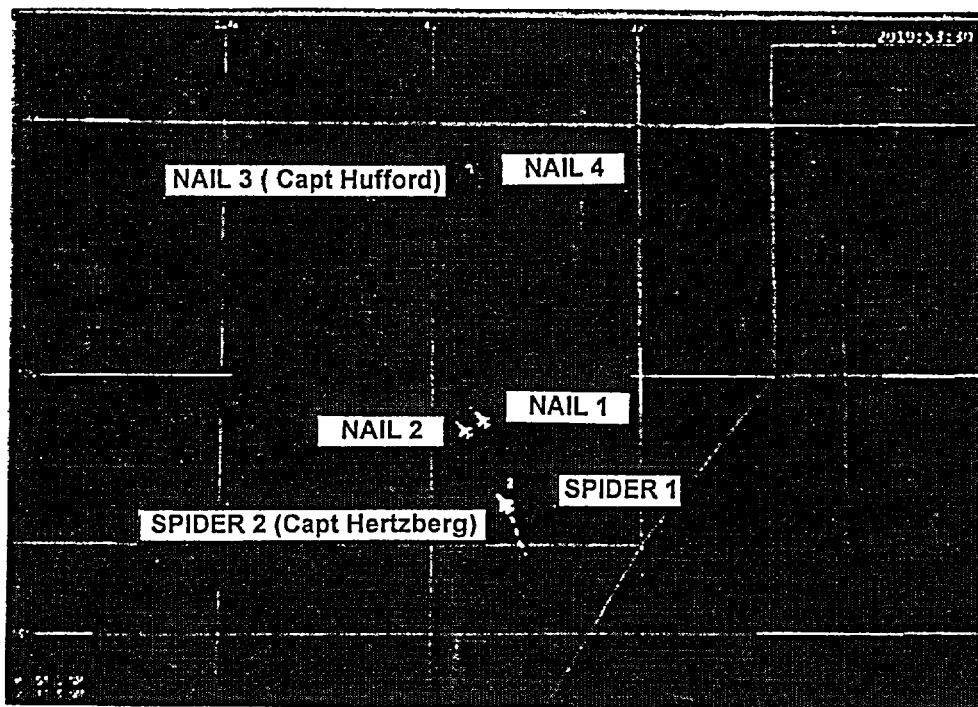


FIGURE 1 (ABOVE) - 20 NAUTICAL MILES (NM) APART

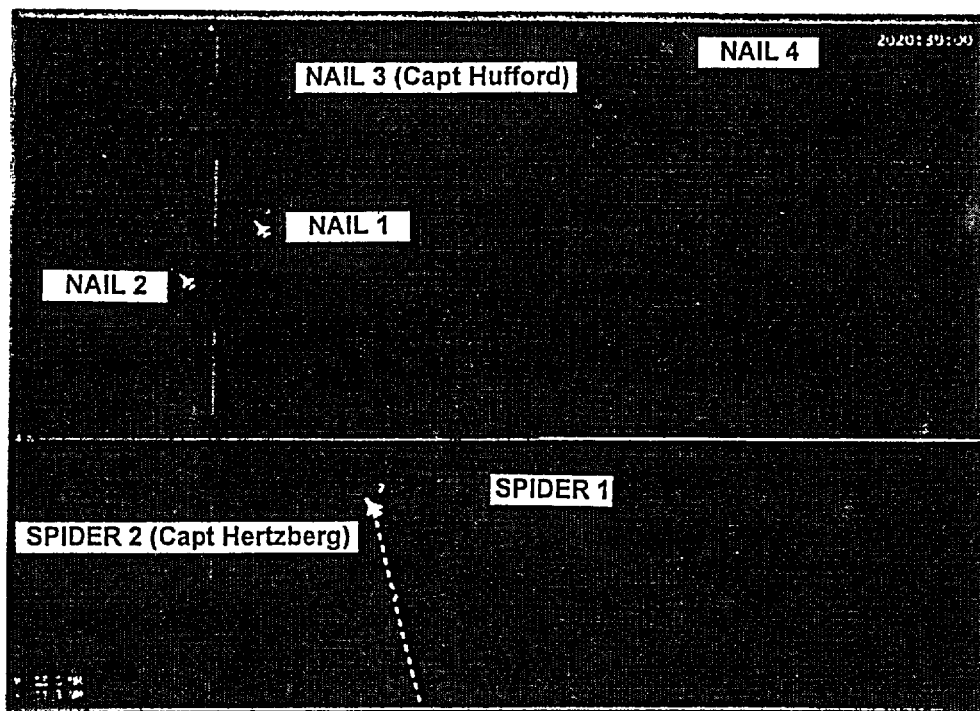


FIGURE 2 (ABOVE) - 7.6 NAUTICAL MILES (NM) APART  
SPIDER 2 (CAPT HERTZBERG) TALLY 2 (SAW NAIL 3 & 4) RADIO CALL

# AIR COMBAT MANEUVERING INSTRUMENTATION (ACMI) PRESENTATION

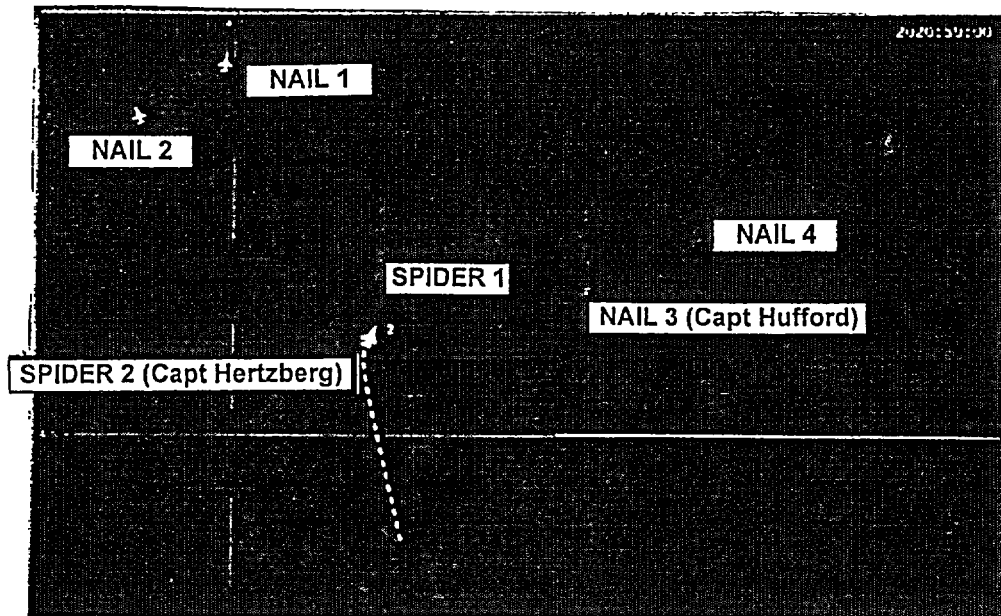


FIGURE 3 (ABOVE) - 3.5 NAUTICAL MILES (NM) APART  
NAIL 3 (CAPT HUFFORD CONVERTING - CLIMBING RIGHT TURN)  
SPIDER 2 (CAPT HERTZBERG - HARD DESCENDING RIGHT TURN)

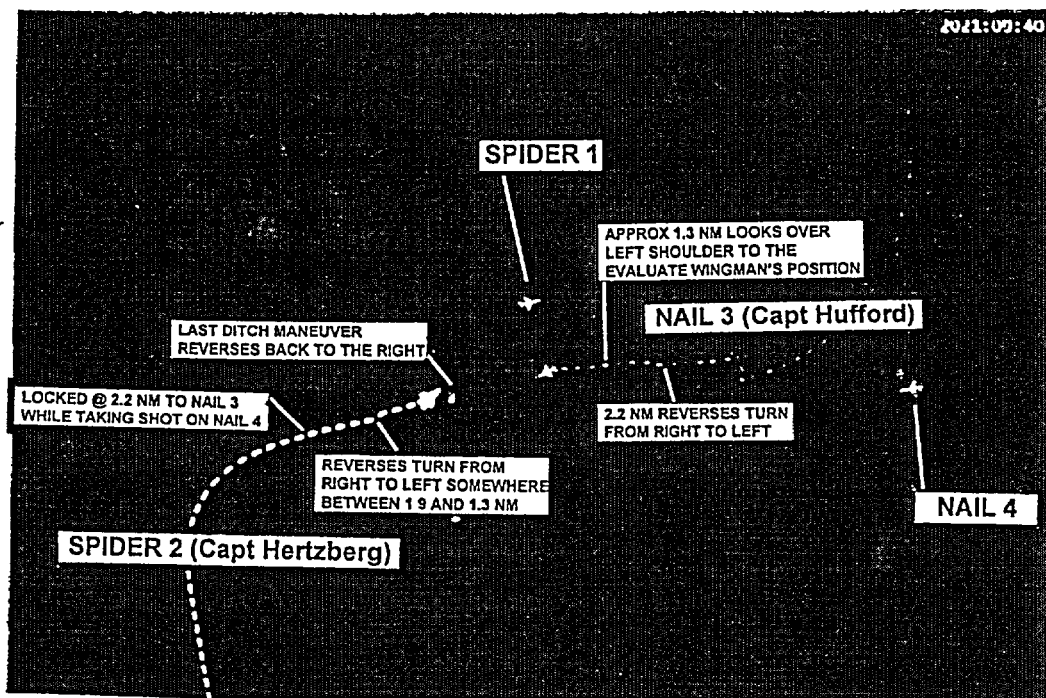


FIGURE 4 (ABOVE) - APPROXIMATELY 4300 FEET APART  
NAIL 3 (CAPT HUFFORD CLIMBING LEFT BANK)  
SPIDER 2 (CAPT HERTZBERG - DESCENDING LEFT BANK)  
SPIDER 2 (CAPT HERTZBERG) JUST STARTING TO REVERSE TURN TO THE RIGHT

(1) The intercepts began with Spider flight as the blue air (attackers) in the north and Nail flight as the four ship of red air (targets) in the south. Three intercepts were performed with the flights in these roles. After the third intercept, Spider 1 and 2 swapped roles with Nail 3 and Nail 4. On the fourth intercept (the mishap intercept), Nail 1, Nail 2, Spider 1, and Spider 2 (Capt Hertzberg) made up the four ship of red air (targets) and Nail 3 (Capt Hufford) and Nail 4 picked up the role as blue air (attackers) (Tab V-5.7) (see fig. 1 on pg. 2). The aircraft were equipped with Air Combat Maneuvering Instrumentation (ACMI) pods, which allowed each aircraft's position and maneuvering parameters to be recorded for playback. The playback can be displayed on large screens (overhead view or pilot view) to include aircraft attitude (bank/pitch), airspeed, Gs, etc. (examples: pg. 2, 3, Tab Z).

(2) The mishap intercept began with Nail 3 (Capt Hufford) and Nail 4 in the north as the attackers. The four ship of targets, Nail 1 and 2 and Spider 1 and 2, were in the south in a 5 NM lead-trail formation (Tab Z-3). Prior to the midair collision, both Spider 2 (Capt Hertzberg) and Nail 3 (Capt Hufford) saw each other (Tab N-6, N-11). During the merge of the flights, Nail 3 (Capt Hufford), the leader of the attacking flight collided with Spider 2 (Capt Hertzberg), the trail wingman in the target formation (Tab A-2) (see fig. 3 and 4 on pg. 3).

(3) The impact occurred at 1321 L (Tab Z-39 thru 40.1). Spider 2 (Capt Hertzberg) lost 40% of his right wing and the aircraft immediately started to spin to the right. Spider 2 ejected from his aircraft at 1321 L (Tab N-11, V-1.7). After doing a controllability check, Nail 3 (Capt Hufford) safely landed at Michael Army Air Field at 1333 L (Tab O-13, V-3.13).

(4) Air Combat Command handled questions about the accident through the 388th FW Public Affairs (PA) office at Hill AFB, Utah. The Public Affairs representative was Lt James R. Wilson. He coordinated responses through Ogden Air Logistics Center (OO-ALC/PA). There was significant media interest after the accident, which increased because of a second F-16 accident which occurred the following day. Lt Wilson, 388th FW/PA, received inquiries from all local television stations and numerous local newspapers. The accident was reported in local TV news reports and several articles appeared in Utah newspapers. A list of those media sources which requested information is found in Tab V-22, as is a representative sample of newspaper reports on the accident.

**b. Mission.** The purpose of the mission was to fly a 2 aircraft versus 4 aircraft (2v4) Tactical Intercept (TI) mission to prepare the squadron for an upcoming Combat Archer deployment. The mission content and execution were based on published Special Instructions (SPINS), designed to enhance the squadron's proficiency in accomplishing single and multi-group visual identification intercepts (Tab O-28 thru 34).

**c. Briefing and Preflight:** The mishap pilots' crew rest was within established regulations (V-1.3, V-3.2). The mission briefing was accomplished in a thorough and professional manner. All six pilots interviewed attested to a clear and understandable presentation by the mission briefers (Tab V-1.4, V-3.3, V-5.4, V-6.2, V-7.2, V-8.2). Mission preparation began about one and one half hours prior to the mass brief with each element informally discussing their respective TI techniques (Tab V-3.4). The formal briefing procedures began with a mass brief

of all of the flyers. Spider 1, Lt Col Grace, gave the coordination brief using his briefing guide for both Spider and Nail flights (Tab AA-9). Nail 1, (Capt Heiser) then gave a red air coordination brief to the six ship (Tab V-3.3). Testimony showed that the coordination brief was very professional and covered all of the applicable training rules in detail (Tab V-1.4, V-3.3, V-5.4, V-6.2, V-7.2, V-8.2). The briefing covered altitude blocks to be used: blue air had 0-4s (10,000 to 14,000 feet, 20,000 to 24,000 feet, 30,000 to 34,000 feet) and red air had 5-9s (15,000 to 19,000 feet, 25,000 to 29,000 feet, 35,000 to 39,000 feet) (Tab 0-29). After the six ship brief, Nail flight broke off for a quick four ship red air brief and Nail 1 briefed with Spider 1 and 2 for their red air portion. Each element then broke off to discuss their respective blue game plans. Testimony revealed that this type of 2v4 TI sortie had been briefed and flown by several other flights on the day prior and was considered to be a normal squadron training sortie (Tab V-3.20).

d. Flight Activity:

(1) The flight plan was a local standard (stereo) flight plan, which stated the route to and from the South UTTR. Nothing out of the ordinary was noted and all communications between the mishap pilots and Ground Control Intercept (GCI) were clear and understandable (Tab N-2 thru 13). No navigational difficulties were noted (Tab V-6.5).

(2) Nail and Spider flights' departure from Hill AFB and entry into the South UTTR were uneventful. Both flights checked in with "Clover" (GCI) and were given the current altimeter setting. Each flight performed a separate G-Awareness exercise and no one in the two flights reported any problems with G-Tolerance (Tab V-5.6, V-5.7).

(3) The intercepts began with Spider flight as the blue air (attackers) fighters in the north and Nail flight as the four ship red air (targets) in the south. Three intercepts were performed with the flights in these roles. After the third intercept, Spider 1 and 2 swapped roles with Nail 3 (Capt Hufford) and 4. On the fourth intercept, Nail 1, Nail 2, Spider 1, and Spider 2 (Capt Hertzberg) made up the four ship of red air (targets) and Nail 3 (Capt Hufford) and 4 picked up the role as blue air (attackers) (Tab Z-3) (see fig. 1 and 2 on pg. 2). Testimony revealed that the role swap went smoothly and each flight flowed in their appropriate directions (Tab V-5.7).

(4) The mishap intercept began with Nail 3 and 4 in the north. Nail 1 and 2 and Spider 1 and 2 were in the south (Tab Z-3) (see fig. 1 and 2 on pg. 2). The four ship target presentation was two groups with a five mile range split in the 25,000-29,000 (ft) block and wingman in a line abreast formation. Nail 1 and 2 were in the front of the presentation in the high part of the block and Spider 1 and 2 were the trailing group in the lower half of the 25,000-29,000 block. The wingmen, Nail 2 and Spider 2, were located on the west side of the formation and both groups, as per the coordination brief, were non-maneuvering on a heading of 320 degrees (Tab V-5.7, Z-3, and N-10) (see fig. 1 and 2 on pg. 2).

(5) After the "fight's on" call, the groups began to maneuver towards each other. The targets maneuvered to a 320 degree heading in the 25,000-29,000 block with the prebriefed

formation. The attackers, Nail 3 (Capt Hufford) and Nail 4, initially maneuvered toward the south. After the commit, Nail 4 moved to a 6,000 - 9,000 foot line abreast formation and was on the east side of Nail 3 (Tab Z-3) (see fig. 1 and 2 on pg. 2).

(6) As the intercept began, Clover (GCI) accurately portrayed the red-air formation and Nail 3, in accordance with the prebriefed plan, used his radar to monitor the movement of the lead group (Nail 1 and Nail 2). Because of the red-air formation and Visual Identification (VID) situation required prior to shooting, Nail 3 (Capt Hufford) and Nail 4 had to bypass the lead group and engage the trail group (Tab V-3.10 thru 3.11). At 10 miles from the lead group, Nail 3 (Capt Hufford) told his wingman to monitor the trail group with his radar (Tab N-5). About the same time and just prior to losing radar contact of the lead group off the right side of his (Capt Hufford) radar scope, Nail 3 (Capt Hufford) told Clover (GCI) to monitor the lead group (Tab N-5) (see Fig. 2, on pg. 2).

(7) When Spider 2 was 7.6 miles away from Nail 3, Spider 2 (Capt Hertzberg) obtained the tally (visual sighting) on both Nail 1 and 2 (Tab Z-7 and N-11). Shortly after this, Spider 1 called tally two (Tab N-11). As per the coordination brief, Spider flight was required to have tally-two and 3/9 o'clock passage (passing the wingline) before they could react (Tab O-30) (see fig. 2 on pg. 2).

(8) At 5.6 miles from Spider flight, Nail 3 (Capt Hufford) called "engaged" and told his wingman to deploy to the prebriefed weapons employment zone (wez)-in-depth (1.5 to 3.0 NM trail) formation (Tab Z-8 and V-3.11). Nail 3 (Capt Hufford) then began his conversion to intercept (right turn) and identify Spider 1 and 2 flight. As Nail 3 (Capt Hufford) passed Spider flight's 3 o'clock position (4.5 miles away), Spider 1 directed Spider flight to break right (turn hard to the right) (Tab Z-10). At the time of the hard right break turn, Spider 1 and 2 testified that they saw both Nail 3 and 4. Also, Nail 3 (Capt Hufford) saw both Spiders (Tab V-1.6, V-3.11, V-5.7). The Spiders began the break turn from a line abreast formation and as a result of the maneuver (approximately 90 degrees), Spider 2 (Capt Hertzberg) was now 5,600 feet in trail of his flight lead, Spider 1. During this maneuver Spider 2 lost altitude and left his altitude block (below 25,000); however, he saw both members of the opposing flight. Both flights (Nail 3-4 and Spider 1-2) were now high aspect (approximately 180 degrees) to one another (head-to-head) and remained head-to-head until the mishap occurred. (Tab Z-11) (see fig. 3 and 4 on pg. 3).

(9) During the conversion turn, Nail 3 (Capt Hufford) turned right and pointed his aircraft toward Spider 1 so he could pass close aboard. As Nail 3 (Capt Hufford) approached Spider 1, and when he (Nail 3) was at 2.2 miles from Spider 2, Nail 3 (Capt Hufford) started to reverse his turn to the left (Tab Z-18, Z-18.1). Spider 2 (Capt Hertzberg), after completing a descending right break turn, pointed his aircraft at Nail 4 in an attempt to get a boresight radar lock. Because Nail 4 was 2 miles directly in trail of Nail 3 (Capt Hufford) and because of the search pattern of the boresight mode, the radar locked onto Nail 3 (Capt Hufford) not to Nail 4 (Tab Z-10 thru Z-18.1). Spider 2 (Capt Hertzberg) testified that he took a no-lock boresight AIM-9 shot (simulated) on Nail 4 when he was 2.2 NM from Nail 3 (Capt Hufford) (Tab V-2.4). This was the same range that Nail 3 (Capt Hufford) reversed his turn direction to the left in an attempt to pass to the south of Spider 2 (Capt Hertzberg). After the shot (simulated),

Spider 2 (Capt Hertzberg) began a climbing turn to the right in an attempt to pass to the south of Nail 3 (Capt Hufford); i.e., Spider 2 (Capt Hertzberg) maneuvered right in an attempt to lag Nail 3's expected flight path (Tab V-1.6). Spider 2 (Capt Hertzberg) testified that he was just outside of 1.5 miles from Nail 3 (Capt Hufford) when he started this maneuver to the south (Tab V-2.4). By doing this, Spider 2 (Capt Hertzberg) put Nail 3 (Capt Hufford) under his nose and out of view. Just prior to this, Spider 2 (Capt Hertzberg) thought he saw Nail 3 (Capt Hufford) in a climbing right hand turn. Since Spider 2 (Capt Hertzberg) was focusing his attention on taking his shot (simulated) on Nail 4, he may have not recognized that Nail 3 (Capt Hufford) who was directly in front of him, had reversed his turn direction to the left. Spider 2 (Capt Hertzberg) testified that he anticipated that Nail 3 (Capt Hufford) would continue turning right. At the start of Spider 2's (Capt Hertzberg's) maneuver, Air Combat Maneuvering Instrumentation (ACMI) data shows that Spider 2 (Capt Hertzberg) was 5 degrees nose low and in 48 degree right bank. ACMI lost track of Spider 2 (Capt Hertzberg) when he was 1.9 miles from Nail 3 for about 0.6 NM. However, when ACMI regained track on Spider 2 (Capt Hertzberg), the track was a zero filter (excellent) ACMI track. Even though the zero track was only for a moment the data was reliable and accurate. The track then converted to a one filter track, which is still good data with some positional drift [i.e., the aircraft attitude (bank angle/pitch) airspeed, Gs, etc are still good] (Tab V-19.3, Z-2.2). At the zero filter track, Spider 2 (Capt Hertzberg) was 1.3 NM from Nail 3 (Capt Hufford), who was also on a zero filter track. ACMI showed that Spider 2 (Capt Hertzberg) had only changed his heading by two degrees from 1.9 NM to 1.3 NM and now he was in a left hand turn; i.e., he had reversed his turn directly towards Nail 3 (Capt Hufford). The ACMI also showed, that Spider 2 (Capt Hertzberg) had lost 213 feet of altitude during his maneuver (Tab V-2.3 and Z-20 thru 26.1). Capt Hertzberg testified that after leveling off from his initial turn away from Nail 3 (Capt Hufford), he started a bank to the left and a slight unload to check Nail 3's position (Tab Z-25, Z-25.1). This fact is substantiated by ACMI with Spider 2 (Capt Hertzberg) in a 35 degree left bank (Tab Z-25, Z-25.1) (see fig. 3 and 4 on pg. 3).

(10) Nail 3 (Capt Hufford) testified after making a hostile call, "I do a quick check to my 7 o'clock to see where my wingman is; Bryan (Nail 4) is kind of a new guy and we've been trying to work on his wez-in-depth" (Tab V-3.12, Z-25, Z-25.1). After locating his wingman, Nail 3 (Capt Hufford) looked forward, went to air combat mode (ACM) on his radar and thought about taking a boresight lock on Spider 2 (Capt Hertzberg) (Tab V-3.12). ACMI data showed that Nail 3 (Capt Hufford) was 1.3 miles from Spider 2 (Capt Hertzberg) after the hostile call. ACMI data also showed the closure velocity between Spider 2 (Capt Hertzberg) and Nail 3 (Capt Hufford) to be 1,021 NM per hour (1,725 feet per second). According to these parameters, the collision would occur in approximately 4.5 seconds. Human reaction time studies show this approaches the minimal reaction time required to avoid the collision (Tab DD). Nail 3 (Capt Hufford) looked away from Spider 2 (Capt Hertzberg) at approximately 1.3 NM. Nail 3 (Capt Hufford) was still in slight climb and still in a left bank, approximately 180 degrees aspect (head to head) with Spider 2 (Capt Hertzberg). ACMI data also confirms an apparent attempt to take a boresight lock with a zero/zero (accurate data) track, showing an unload maneuver when Nail 3 (Capt Hufford) is 1.2 NM from Spider 2 (Capt Hertzberg) (Tab Z-27 thru 31.1, V-19.2). Nail 3 (Capt Hufford) realized he was too close for a lock-on and "bails on the concept of getting a lock" (Tab V-3.12) (see fig. 3 and 4 on pg. 3).



(11) Spider 2 (Capt Hertzberg) continued to bank slightly nose low to the left, and was looking left (9-10 o'clock) for Nail 3 (Capt Hufford). Spider 2 (Capt Hertzberg) was maneuvering his aircraft towards Nail 3 without seeing him. ACMI showed Nail 3 (Capt Hufford) was slightly low and directly in front of Spider 2 (Capt Hertzberg) (Tab Z-26, Z-26.1) (see fig. 4 on pg. 3).

(12) Nail 3 (Capt Hufford), after aborting his attempt to lock Spider 2, noticed that there was no line of sight movement in the HUD (meaning that they are on a collision course) (Tab V-3.12). Nail 3 (Capt Hufford) testified that he "basically froze" because he thought if he maneuvered hard left or right, it may have matched Spider 2's (Capt Hertzberg's) collision avoidance maneuver. Capt Hufford's (Nail 3) continued testimony adds, "About two-seconds prior to impact, I realize he is not doing anything and there is absolutely no line of sight in my HUD. So at that point I roll to about a 120 degrees of bank (to the left) and I see basically the belly of his aircraft, his centerline bag passes over my head" (Tab V-3.13) (see fig. 4 on pg. 3).

(13) As Spider 2 (Capt Hertzberg) regained the tally on Nail 3, he expected to see Nail 3 (Capt Hufford) going by to the north (left side), instead, he "saw an F-16 coming straight uphill at me" (Tab V-1.7). Spider 2 (Capt Hertzberg) saw the imminent collision and reacted by selecting full afterburner and "pulling as hard as I could (to the right)" (Tab V-1.7). By turning right, Spider 2 (Capt Hertzberg) reversed his turn and ended up moving in the same direction as Nail 3's last-ditch collision avoidance maneuver (see fig. 4, pg. 3).

(14) At the time of the collision, Spider 2 (Capt Hertzberg) was in a right hand pull, belly-up to Nail 3 (Capt Hufford). The impact occurred on the right wing of each aircraft (Tab Z-39 thru 40.1). Nail 3 (Capt Hufford) lost his missile, part of his missile rail, and there was a gash in his right wing (Tab S-5 thru 8). After doing a controllability check, Nail 3 (Capt Hufford) safely landed at Michael Army Air Field (Tab V-3.13).

(15) Spider 2 (Capt Hertzberg) lost 40% of his right wing and the aircraft immediately started to spin to the right. Spider 2 (Capt Hertzberg) attempted to recover the aircraft by performing the out-of-control critical action procedures (J-11). The aircraft descended rapidly and continued spinning to the right in a 70 degree nose low attitude. As the 16,000 foot cloud deck approached, Spider 2 (Capt Hertzberg) wisely ejected from his aircraft (Tab V-1.7).

#### **e. Impact.**

(1) The time of the mid-air collision was at 1321 hours (hrs) local (2021 Zulu) on 7 Jan 98 at 4001 46" N and 11341 05" W (Tab 0-36) at 23,800 feet Mean Sea Level (MSL). Aircraft SN 88-0449 impacted the ground at 4001 N and 11339 W (Tab B-3) at approximately 1322 hrs local just after the pilot ejected (Tab N-11). Photographs show a relatively small impact area indicating a steep nose low impact (Tab S-2, S-3). Because the Signal Acquisition Unit (SAU) was destroyed and the Crash Survivable Memory Unit (CSMU) was not recovered from the crash site, aircraft SN 88-0449 airspeed and angle of attack are unknown at ground impact; however, due to the nature of the mishap (mid-air collision) information about the ground impact would provide little if any pertinent information to this investigation (Tab J-9). Aircraft

SN 88-0537 recovered and landed at Michael Army Air Field (Tab A-2).

(2) At the time of the mid-air collision the aircraft were passing right to right, with aircraft SN 88-0449 in a slight nose high attitude (approximately 13 degrees) with a roll attitude of approximately 53 degrees right wing down. Aircraft SN 88-0537 was also in a slight nose high attitude (approximately 9 degrees) with a roll attitude of approximately 82 degrees left wing down. Aircraft headings were approximately 071 degrees for SN 88-0449 and 249 degrees for SN 88-0537. Aircraft airspeeds were approximately 325 knots for SN 88-0449 and 360 knots for SN 88-0537 (Tab J-10).

(3) The mid-air collision was nearly head on and the recovered debris indicates that the AMD pod and LAU-129 launcher on right side of aircraft SN 88-0537 struck the right wing of aircraft SN 88-0449 at approximately 5 feet from the outboard edge of the leading edge flap and ended approximately 6 feet from the outboard edge of the trailing edge of the wing (Tab J-11, J-3). This resulted in a loss of approximately 40% of the right wing surface on aircraft SN 88-0449 and a subsequent ejection by the pilot (Tab J-11, A-2).

(4) The right wing of Aircraft SN 88-0537 had a 3 inch cut completely through the leading edge flap (LEF) just outboard of the LEF #3 rotary actuator. The majority of the right wing tip LAU-129 launcher was missing and the wing tip AMD was missing. The forward fairing of station 8 launcher adapter was missing. The AIM-9 from the right wing, station 8, was missing and the outboard side of the AIM-9 launcher had many marks/scrapes. The aircraft sustained additional minor damage as well (Tab J-4).

f. **Egress System:** Capt Hertzberg (Spider 3) accomplished a successful Mode II or Mode III in-the-envelope ejection from his aircraft and everything with the seat functioned normally (Tab J-19). Capt Hertzberg testified the only difficulties he encountered were in locating the parachute's four-line jettison lanyards and during the descent the seat kit line wrapped around his right leg. Neither of these problems caused any injuries. The pilot remarked that his only injury was a small bruise on the back of his neck caused by his helmet nape strap during ejection (Tab V-1.8 thru 1.10).

g. **Personal and Survival Equipment:** Maintenance and life support records show all of the survival equipment inspections were properly performed and up-to-date. Capt Hertzberg testified that he consumed six flex packs of water and also successfully used several of the signaling devices packed in his survival kit. He initially used the PRC-90 radio to contact his flight members and after the radio contact, Capt Hertzberg used his chute as a signaling device to help them locate his position. Upon arrival of the rescue helicopter, Capt Hertzberg used his radio and the smoke end of his Mk 113 flare to assist them in finding his exact location (Tab V-1.7 thru 1.10).

h. **Rescue:** The time of the mid-air collision was 1321L (Tab B-3). Local time was Mountain Standard Time. The time of the aircraft crash (ground impact) was 1322 L which was shortly after the pilot ejected (Tab N-11). The downed pilot, Capt Hertzberg, initiated a mayday call from the ground by radio at approximately 1328L (Tab V-1.9). The rescue call was relayed to

the Army Aviation Support Facility Commander. Detachment 1, 189<sup>th</sup> Aviation Support Battalion, Salt Lake Airport #2, Utah, was tasked to initiate a rescue at approximately 1330L. The crew of the Army Blackhawk helicopter consisted of CW4 Lynn S. Higgins (pilot), CW3 Michael Richards (Trainee Pilot), Major Marshall F. Willis (Flight Surgeon), and SFC Bruce Olson (Crew Chief). The aircraft launched at approximately 1400L and located the mishap pilot at approximately 1440L (Tab V-20).

**i. Crash Response:**

(1) After Capt Hertzberg made the initial mayday call, he coordinated with Spider 1 (Lt Col Grace) until Spider 1 confirmed visual. Capt Hertzberg spread his parachute out. Spider 1 ran low on fuel and handed off the rescue efforts to Nail 1 (Capt Heiser). Later when Capt Heiser got low on fuel, he handed off the rescue efforts to Napa 1, a flight from the 34th Fighter Squadron (FS), 388th Fighter Wing (FW). Napa 1, in turn, handed off to Thud 1, from the 419<sup>th</sup> FW (USAFR, Hill AFB). Thud 1 did not obtain a visual on Capt Hertzberg until he popped a flare (Tab V-1.8). While these aircraft maintained an orbit over Capt Hertzberg, the rescue helicopter from the 189<sup>th</sup> Aviation Support Battalion launched and proceeded on a near direct route to the coordinates provided. Clover Control vectored the rescue helicopter to Capt Hertzberg's position. When within 30 miles of the site, CW4 Higgins made radio contact with Thud 1. When the helicopter was approximately four miles from the site, Thud 1 instructed Capt Hertzberg to pop the smoke end of his Mk-113 flare. CW4 Higgins saw the smoke, and circled the site once at approximately 100 feet AGL to locate the parachute and raft and then landed upwind from the site. Major Willis conversed with Capt Hertzberg and determined that he was uninjured. CW4 Higgins and SFC Olson recovered the parachute and raft. Capt Hertzberg boarded the helicopter and a near direct route was flown to Hill AFB. Capt Hertzberg was off loaded with the parachute and raft on the transient parking area adjacent to Operations (Tab V-20).

(2) CW4 Higgins reported that it was approximately 1 hour and 54 minutes between the 1330L call to the 189<sup>th</sup> and landing at Hill AFB (Press Notices V-22). Equipment taken to the crash site consisted of an aid bag, back board, blankets, burn trauma kit, and 5 gallon can of water. (Tab V-20). There was a delay of 30 minutes after CW4 Higgins received the call to initiate rescue and launch of the aircraft (1330L to 1400L). This was required to finish the preflight inspection and to load the medical equipment. (Tab V-20). CW4 Higgins reported no difficulties in the rescue effort associated with weather, time of day, topography, civilians at rescue scene or local law enforcement (there were none).

(3) The disaster control group (DCG) arrived at the impact site at 0800 on 8 Jan 98. Lt Col Hugh Horstman, 388 OG/CV, arrived at 1000 local on the same day and took command of the site from the DCG commander, Lt Col John McClelland of the 75th ABW. The site is a four hour drive from Hill AFB via highways, then dirt roads to the entry control point. From the entry control point the site is approximately four miles, reachable only on foot or by special purpose vehicle. The crash site is located in a vast expanse of clay, mud, snow and ice at approximately 4200' elevation MSL. The area is a wetland with the water table approximately five feet under the surface of the earth, keeping the clay moist throughout the winter months. A few small bushes surround the crash site. Lt Col Horstman was able to access the site with two

snow cats and six 4WD ATVs. The only civilians encountered at the site were two US Department of Wildlife (Fish and Game) representatives who arrived late in the day. Their purpose was to ensure Air Force officials understood the fragile nature of the local environment and they left after 30 minutes. (Tab V-21).

**j. Maintenance Documentation.** Upon careful review of the original aircraft AFTO Forms 781 and their duplicates (Tab H-2 thru 7), no discrepancies are factors to this incident. There is a Pressure Breathing for Gs (PBG) pilot reported discrepancy which was entered into aircraft SN 88-0449 forms the flight prior to the mishap (Tab U-10). This discrepancy is on a red diagonal (flyable) (Tab U-34) and should be on a red-x (non-flyable) (Tab U-31). This board learned through Capt Hertzberg's testimony that the system was working during the mishap flight (Tab V-1.18). After reviewing the original aircraft AFTO Forms 781K, sections E and H and their duplicates (Tab H-3, H-6), there were no Time Compliance Technical Orders (TCTOs) overdue that contributed to this incident and no discrepancies are annotated in the AFTO Forms 781A or K (section I) which were a result of previous TCTO accomplishment. The original AFTO Forms 781K, sections A and G, and their duplicates do not indicate any overdue scheduled inspections (Tab H-3, H-6). No discrepancies are annotated in the AFTO Forms 781A or K (section I) which were a result of previous scheduled inspection accomplishment. Pre-mission oil analysis was accomplished on both aircraft and revealed no abnormalities (Tab D-2, D-3). Post-accident samples were not taken from aircraft SN 88-0449 due to the fact that the aircraft could not be recovered after the mishap. Post-accident samples were not taken from aircraft SN 88-0537 prior to or during this board because the aircraft was immediately impounded at Michael Army Air Field and due to the fact that the engine was functioning normally throughout the flight as stated by Capt Hufford (Tab V-3.23 thru 3.24). After a review of the Core Automated Maintenance System (CAMS), in addition to the thorough review of the aircraft jacket files, the active AFTO Forms 781, and engine equipment records, no open discrepancies for time change requirements or negative trends were noted. As per direction given in the letter of appointment to the Maintenance Member of the Accident Investigation Board, a review of the CAMS data for 180 days prior to the accident was accomplished. The only irregularity noted was the open pilot reported discrepancy for the PBG not working (Tab U-10) which has already been noted. The AF Form 711C, Aircraft Maintenance and Material Report (Tab D-2), indicated no components or accessories being removed for inspection as a result of this accident. No civilian agencies provided post-accident tear down work. There appeared to be no maintenance procedures, practices, or performance by either military or civilian technicians that contributed to this accident. There was an error in symbol entry into aircraft SN 88-0449 forms for a PBG malfunction (Tab U-24 thru 27) as noted by the testimony of A1C Pratt (Tab V-17.4, V-17.6), SSgt Driver (Tab V-16.4) and MSgt Randolph (Tab V-15.3). This discrepancy in documentation is an issue but cannot be considered a contributor in the mishap due to the testimony of Capt Hertzberg who stated that the PBG system worked as designed on the mishap sortie (Tab V-1.18).

**k. Maintenance Personnel and Supervision.** A review of aircraft preflight servicing and supervision of those tasks revealed no discrepancies. There appeared to be no maintenance practices or procedures, other than the incorrect symbol entry into the aircraft SN 88-0449 active 781A forms, as previously mentioned, which are factors in this mishap. The incorrect symbol

entry decision was made at the production superintendent level (a Master Sergeant) in consultation with the appropriate maintenance specialists. The error in forms documentation was due to the personnel involved in the decision process being unfamiliar with AFI 21-103/ACC SUP 1 (Tab U-17 thru 20) and 388<sup>th</sup> Operations Group Instruction 21-105 (Tab U-21 thru 27).

**l. Engine, Fuel, Hydraulic, and Oil Inspection Analysis.** Upon review of AF Form 711C (Tab D-2, D-3) and the engine equipment records, no abnormalities or open discrepancies were discovered. Engine inspection documentation was appropriately maintained. The base fuels laboratory noted no deficiencies in fuel delivery vehicle or aircraft fuel samples (Tab H-3, H-6). Neither hydraulic fluid nor engine oil analysis was accomplished on aircraft SN 88-0449 due to the fact that the aircraft wreckage could not be recovered. Hydraulic fluid and engine oil analyses were not accomplished prior to or during this board on aircraft SN 88-0537. The Safety Board, which preceded the Accident Investigation Board (AIB), elected not to take samples for analysis. The three week lapse in time between the accident and the convening of the AIB allowed oils and fluids to settle, making analysis after convening the AIB useless. In any event, Capt Hufford testified that there were no aircraft hydraulic or engine problems prior to the midair collision (Tab V-3.23, V-3.24).

**m. Airframe and Aircraft, Missile, or Space Vehicle Systems.** The AF Form 711C (Tab D-2) does not indicate any components or accessories having been sent for testing or tear down due to potential deficiencies. There is no indication of any manufacturer being contacted concerning suspected system failure. There have been no repair stations that have overhauled, repaired, bench checked, or tested any components or accessories as a result of this incident. Neither Capt Hufford (Tab V-3.23) nor Capt Hertzberg (Tab V-1.18) indicated that they experienced any problems in the avionics, mechanical, electrical or hydraulic aircraft systems prior to the incident.

**n. Operations Personnel and Supervision:** The mission was authorized by Lt Col Walter E. Grace (Tab K-2). The briefing officer at the mission briefing was Lt Col Walter E. Grace, the squadron's Operations Officer. Lt Col Grace used a personal 2v4 briefing guide (Tab AA-9). Pilot interviews confirm the briefing was performed in a very professional and thorough manner (Tab V-1.4, V-3.4).

**o. Pilot Qualifications:** A review of Capt Hertzberg's (Spider 2) grade sheets for mission qualification training shows normal to above average progression. Capt Hertzberg is an accomplished wingman and has 442.9 hours in the F-16 (Tab G-2). A review of his Flight Evaluation folder revealed that all of his Mission Evaluations have resulted in a Qualification Level of "Qual, No Discrepancy." In his testimony, Lt Col Grace, the 421st's Operations Officer, remarked that he was flying with Capt Hertzberg to evaluate him for entry into the flight lead upgrade program (Tab V-5.11). Recent flight time is as follows (Tab G-4):

	Hours	Sorties
30 days	15.4	12
60 days	33.1	24
90 days	50.5	30

A review of Capt Hufford's grade sheets for flight lead upgrade showed normal to above average progression. Capt Hufford is an experienced flight lead and has 649 hours in the F-16 (Tab G-5). Capt Hufford also received "Qual, No Discrepancy" grades on all of his mission evaluations. In testimony, Lt Col Grace commented that Capt Hufford was a "strong pilot" and that he performed exceptionally well during his flight lead upgrade (Tab V-5.11). Recent flight time is as follows (Tab G-6):

	Hours	Sorties
30 days	13.1	11
60 days	34.5	27
90 days	47.9	31

Each pilot who testified for the board commented on the above average ability of both Capt Hufford and Capt Hertzberg (Tab V-5.11, V-6.9, V-7.8, V-8.5, V-9.2). Their operations officer, Lt Col Grace, testified, "both of them are dedicated, hard working, and real knowledgeable" (Tab V-5.11). In addition, their flight commander, Capt Miller, testified that this mishap has not changed his opinion of either pilot's professionalism and he supports Capt Hertzberg's entrance in the flight lead upgrade program as soon as possible (Tab V-9.2).

p. Medical: A thorough review of both mishap pilots' medical and dental records, including the post-mishap physical exams and toxicology tests, was performed. The mishap pilots were medically qualified at the time of the mishap. Capt Hertzberg and Capt Hufford both had current AF Form 1042s valid until 30 November 1998 and 30 April 1998 respectively (Tab X-4, X-7). The post-mishap toxicology tests were normal for both pilots. Specifically, there was no evidence of prescription or non-prescription medications in the blood or urine. Capt Hertzberg reported no medical problems prior to the mishap. Capt Hufford reported no medical problems prior to the mishap. He said he suffered a mild left biceps strain by pulling on the throttle as an instinctive attempt to duck under the oncoming aircraft. This subsequently resolved and he was returned to flying status. He adamantly affirms that he felt perfectly fit to fly the day of the mishap. Neither pilot suffered any apparent permanent injuries as a result of the mishap. Both pilots were medically cleared for flying duties on 16 Jan 98.

q. Nav aids and Facilities: Nav aids, facilities and NOTAMs were reviewed. Nothing was noted that could have contributed to the mishap (Tab V-5.6).

r. Weather:

(1) During the timeframe of the mishap, Hill AFB forecast conditions were unrestricted visibility, snow within 5 miles of the airfield, sky conditions 4,000 scattered, 10,000 overcast, minimal altimeter 30.02 (Tab K-4). At the time of the mishap, actual conditions at Hill were 6 miles visibility with light snow showers and mist, sky conditions 2,000 scattered, 4,500 broken, and 10,000 overcast, winds 060 at 5 knots and altimeter 30.05 (Tab K-5).

(2) During the timeframe of the mishap, forecast weather for the South UTTR was overcast clouds between 3,500 to 19,000, isolated snow showers with no restrictions to

visibility, surface winds 190 at 10 knots and minimum altimeter 30.00. Pilot testimony revealed that the only weather in the area was a 3,000 foot thick overcast deck from 13,000 - 16,000 feet. The intercepts were performed above this deck and the weather did not have any impact on the sortie (Tab V-8.3).

**s. Governing Directives and Publications:**

(1) Primary directives and publications relevant to this mishap.

(a) Pilot and Weapons Director related Instructions

*Air Force Instruction (AFI) 11-214, Aircrew, Weapons Director, and Terminal Attack Controller Procedures for Air Operations, pages 1-18 (Tab CC-2)*

*Air Combat Command Supplement 1 (ACC Sup 1) Aircrew, Weapons Director, and Terminal Attack Controller Procedures for Air Operations, pages 1-5 (Tab CC-20)*

(b) Maintenance related Instructions

*AFI 21-103 - Equipment Inventory, Status, and Utilization Reporting (Tab U-12)*

*AFI 21-103/ACC SUP 1 - Equipment Inventory, Multiple Status, and Utilization Reporting System (EIMSURS) (Tab U-17)*

*388 Operations Group Instruction 21-105 - Debriefing F-16 Aircrews 21) (Tab U-21)*

*Technical Order 00-20-1 - Preventive Maintenance Program General Policy Requirements and Procedures (Tab U-30)*

*Technical Order 00-20-5 - Aircraft, Drone, Aircrew Training Devices, Engines, and Air-Launched Missile Inspections, Flight Reports, and Supporting Maintenance Documents (Tab U-37)*

(2) Known or suspected deviations from directives or publication by pilot members or others involved in the mishap mission.

(a) Pilot: known or suspected deviations.

*AFI 11-214, Aircrew, Weapons Director, and Terminal Attack Controller Procedures for Air Operations, requires the following (Tab CC-18):*

**"5.2.9. Separation of Aircraft:**

5.2.9.1. Assign hard altitudes or altitude blocks to provide vertical separation for nonvisual set-ups. Require a minimum of 1,000 feet vertical separation ...

5.2.9.2. Aircraft may not transit or enter the altitude or altitude block of any adversary unless at least one of the following conditions apply:

Adversary is beyond 10 NM.

Adversary is within 10 NM, but not a conflict (i.e., collision potential) based on situation awareness (SA).  
Establishing visual contact.

Fighter verbally confirms adversary's hard altitude and maintains required vertical separation.

5.2.9.3. Determine positive lateral separation by geography, through timing, through onboard systems, or by GCI or AWACS.

5.2.9.4. Each participant must use "see and avoid" techniques to ensure a clear flight path, especially while entering and leaving engagements. Aircrews should use visual contact, onboard systems, AWACS or GCI, situation awareness, and other aids to clear the area. If during visual setups loss of visual or tally occurs, establish positive separation until regaining visual contact. Any attacker losing sight will maneuver away from the defender's last known position. Defenders will maneuver predictably if loss of sight and SA occurs. Only when the attacker can ensure separation from the trailers, can the attacker perform rear quarter attacks against the leaders of a lead-trail formation.

5.2.9.5. Aircrew can not rely on altitude blocks to guarantee separation once any participant initiates visual maneuvering. After a "TERMINATE" or "KNOCK IT OFF" call, all participants will return to assigned altitude blocks while clearing their flight paths.

5.2.9.6. Establish and maintain a minimum of 1,000 feet (500 feet if below 5,000 AGL) altitude separation from other friendly aircraft or friendly flights within 10 NM unless SA allows, or the flights deconflict attacks by space or time.

5.2.9.7. Do not maneuver aircraft inside minimum range of an opposing aircraft. If a violation of minimum range appears imminent or has occurred, each aircraft will perform a "KNOCK-IT-OFF/TERMINATE," clear its flight path, cease tactical maneuvering, and re-establish required minimum range. Minimum range is MAJCOM or service directed.

5.2.9.8. Attackers will prepare for defenders to release countermeasures at anytime when operating in a chaff, flare, or smokey devil environment. The possibilities of aircraft and chaff, flare, or smokey devil collision increases significantly as the attacker approaches gun range. Attackers must avoid dead six o'clock approaches and break off all attacks with out-of-plane maneuvers.

5.2.9.9. When two aircraft approach head-on, each will clear to the right unless maneuvering to do so would result in crossing flight paths. Aircraft with the higher nose position will attempt to go above the opponent, energy state and altitude permitting.

5.2.9.10. Participants will cease weapons employment (actual or simulated) under the following conditions: Pure pursuit head-on missile attacks before 9,000 feet slant range (3000 feet for helicopter versus helicopter).

Any gun attack exceeding 135 degrees aspect.

Target aircraft begins an air-to-surface delivery maneuver.

Airspeed drops below minimum maneuvering airspeed."

The mishap pilots deviated from the training rules in *AFI 11-214* that are highlighted above.

*Air Combat Command Supplement 1 (ACC Sup 1) Aircrew, Weapons Director, and Terminal Attack Controller Procedures for Air Operations (Tab CC-21)*

2.7.1. Equipped units will wear the Combined Advanced Technology Enhanced Design G Ensemble (COMBAT EDGE) on all day air-to-air sorties and other sorties when aircrews plan or are likely to maneuver at or above six Gs during the mission.

A pilot reported a Pressure Breathing for Gs (PBG) [COMBAT EDGE] discrepancy in SN 88-0449 aircraft forms (i.e. the system was not working) on the flight prior to the mishap. This discrepancy was identified as a minor discrepancy versus a grounding condition which was required by regulation (see information below under maintenance deviations). Capt Hertzberg stated he did not notice the write-up in the forms and accepted the jet for an air-to-air mission; however, he indicated that the



system was in fact functioning during the mishap flight (Tab V-1.14). Because the PBG system was working on the mishap sortie, the failure to ground the aircraft was not a factor.

(b) Weapons Director: known or suspected deviations.

*AFI 11-214, Aircrew, Weapons Director, and Terminal Attack Controller Procedures for Air Operations, requires the following (Tab CC-15):*

*"5.2.3. Communications.*

*5.2.3.2. WD (Weapon Directors) procedures:*

*5.2.3.2.6. Unless prebriefed to the contrary, make the following calls:*

*Vectors to position aircraft for initial setups.*

*Advise aircrew of Minimum Safe Altitude (MSA).*

*A range call at 10 NM from any merge."*

The weapons director (Clover) of Nail 3 (Capt Hufford) failed to make the required 10 NM range call during the mishap intercept. This is normally used as a reminder for players to check their altitude so they can ensure they are in the correct altitude block to deconflict with the opposing flight. Failure to make the 10 NM range call was not a factor during the mishap because Nail 3 (Capt Hufford) had radar contact on all factor groups, followed by a tally on (he saw) Spider 3 and 4. The mid-air collision happened in Nail 3's altitude block. The other weapons director of Nail 1/Spider 3 flight made the required 10 NM calls.

(c) Maintenance: known or suspected deviations.

There was a documentation error in aircraft SN 88-0449's active AFTO Forms 781A. This documentation error was a pilot reported discrepancy for Pressure Breathing for Gs (PBG) on the flight prior to the mishap. This discrepancy was identified as a minor discrepancy versus a grounding condition. This is in violation of AFI 21-103/ACC SUP 1 which indicates that environmental and oxygen components must be working for the aircraft to be reported Fully Mission Capable (FMC). This error is also in violation of 388 Operations Group Instruction 21-105 which identifies problems with pressurization and the oxygen system as being a grounding discrepancy. In his testimony, Capt Hertzberg indicated that the system was in fact functioning during the mishap flight. Technical Orders 00-20-1 and 00-20-5 give the definition and proper documentation rules for minor maintenance discrepancies which can be flown and major grounding discrepancies which cannot. Because the PBG system was working on the mishap sortie, there were no regulatory violations which contributed directly to this mishap.



MARK G. CHAURET, Lt Col, USAF  
Accident Investigation Board President

27 Feb 98

## STATEMENT OF OPINION

### F-16 MID-AIR COLLISION

7 JAN 98

1. UNDER 10 U.S.C. 2254(d) ANY OPINION OF THE ACCIDENT INVESTIGATORS AS TO THE CAUSE OR CAUSES 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 AN AIRCRAFT 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.

2. OPINION SUMMARY (See Discussion of Opinion section after the Opinion Summary section for detailed explanation):

a. The primary cause of this mishap, supported by clear and convincing evidence, was Capt Hufford's failure to use proper "see and avoid" techniques to ensure a clear flight path while entering and leaving an engagement as required by *AFI 11-214* which states, "Each participant must use 'see and avoid' techniques to ensure a clear flight path, especially while entering and leaving engagements" (Tab CC-18, para. 5.2.9.4).

b. An additional primary cause of this mishap, supported by clear and convincing evidence was Capt Hertzberg's failure to use proper "see and avoid" techniques to ensure a clear flight path. *AFI 11-214* states, "Each participant must use 'see and avoid' techniques to ensure a clear flight path, especially while entering and leaving engagements" (Tab CC-18, para. 5.2.9.4).

c. An additional primary cause of this mishap, supported by clear and convincing evidence, was Capt Hertzberg's failure to follow *AFI 11-214* training rule, "Any attacker losing sight will maneuver away from the defender's last known position. Defenders will maneuver predictably if loss of sight and SA occurs" (Tab CC-18, para. 5.2.9.4).

d. A contributing factor to this mishap, supported by clear and convincing evidence, was that Capt Hufford failed to follow *AFI 11-214* training rule, "Participants will cease weapons employment (actual or simulated) under the following conditions: Pure pursuit head-on missile attacks before 9,000 feet slant range" (Tab CC-19, para. 5.2.9.10).

e. A contributing factor to this mishap, supported by clear and convincing evidence, was that Capt Hufford and Capt Hertzberg failed to follow *AFI 11-214* training rule, "When two aircraft approach head-on, each will clear to the right unless maneuvering to do so would result in crossing flight paths" (Tab CC-19, para. 5.2.9.9).

f. Supported by clear and convincing evidence, human factors that contributed to Capt Hufford's and Capt Hertzberg's failure to see and avoid each other are as follows (Tab DD):

(1) In reference to Capt Hufford, human factors that contributed to the mishap include a decreased situational awareness secondary to motivation to succeed-excessive, task saturation in association with the stress performance curve, human reaction time, task misprioritization, channelized attention, and misperception of speed / closure rate.

(2) In reference to Capt Hertzberg, human factors that contributed to the mishap include a decreased situational awareness secondary to task saturation, task misprioritization, channelized attention, human reaction time, and misperception of speed / closure rate.

g. See last page of this report for Conclusions.

3. **DISCUSSION OF OPINION:** I did not use the Mishap Pilots' aircraft (Heads Up Display) HUD tapes or radar tapes to derive my opinion of the cause of this mishap. Capt Hertzberg's tape was destroyed and not usable. Although Capt Hufford had his tape on for the first three intercepts, he failed to turn it on for the fourth (mishap) intercept. Air Combat Maneuvering Instrumentation (ACMI) was used during the flight which provided excellent information; although, at times, track files of the various aircraft were lost during portions of the mishap intercept. The ACMI track files on the two mishap pilots' aircraft were good at times to include the latter parts of the intercepts as verified by "Zero" track file. The track file on Spider 1 (Capt Hertzberg's flight lead) was also good; however, Nail 4's (Capt Hufford's wingman) track file was not that good during the latter portions of the intercept. Nail 4's attitude, nose position, and location on the ACMI screen may be questionable at times (Tab Z, V.19). Additional information was drawn from Nail 4's (Capt Hufford's wingman) and Spider 1's (Capt Hertzberg's flight lead) aircraft video HUD and radar tapes. Also, Part 1 of the Safety Report included Lockheed analysis and additional information which was very useful (Tab A thru S). Testimony from numerous sources, to include the mishap pilots, also provided very valuable information (Tab V).

a. **CAPT HUFFORD:** The primary cause of this mishap, supported by clear and convincing evidence, was Capt Hufford's failure to use proper "see and avoid" techniques to ensure a clear flight path while entering and leaving an engagement as required by *AFI 11-214* which states, "Each participant must use 'see and avoid' techniques to ensure a clear flight path, especially while entering and leaving engagements" (Tab CC-18, para. 5.2.9.4). The facts show that Capt Hufford was tally (saw) two aircraft, Spider 1 and Spider 2, and was the flight leader of the attacking flight, Nail 3 (Capt Hufford) and Nail 4 (Tab V-5.7, Z-3). In his sworn testimony, Capt Hufford, Nail 3, admitted to purposely looking away from Capt Hertzberg, Spider 2, even though Capt Hertzberg was only 1.3 NM in front of him as verified by ACMI (Tab Z-25, Z-25.1, V-3.12). Capt Hufford made a critical error by misprioritizing his tasks by being more concerned about his wingman's position than flight path deconfliction with Capt Hertzberg. By momentarily looking away at such a short range (approximately 1.3 NM), Capt Hufford significantly impacted his ability to properly react to avoid the mid-air collision and placed himself in a position which allowed very little room for error. After regaining sight of

Capt Hertzberg, Capt Hufford made an additional critical error by not aggressively maneuvering his aircraft away from Capt Hertzberg. After Capt Hufford realized that he was too close to get a boresight lock, he waited too long to make a last ditch maneuver to miss Capt Hertzberg. After "bailing" (aborting) on the "concept of a getting a boresight lock", Capt Hufford "froze;" i.e., decided to maintain his present flight path because breaking to either side might match the other pilot's maneuver and result in a collision. Realizing that the other pilot was still coming at him, he made a last ditch maneuver toward the left and down with a resultant collision of right wings (Tab V-3.12, 3.13, V-4.5). Capt Hufford should have aggressively rolled his aircraft and pulled down and away from Capt Hertzberg when he first noted the collision course, rather than wait for the other pilot to make the first move.

**b. CAPT HERTZBERG:** An additional primary cause of this mishap, supported by clear and convincing evidence was Capt Hertzberg's failure to use proper "see and avoid" techniques to ensure a clear flight path. Although he was initially a defender in the engagement, he was still responsible for clearing his flight path. *AFI 11-214* states, "Each participant must use 'see and avoid' techniques to ensure a clear flight path, especially while entering and leaving engagements" (Tab CC-18, par. 5.2.9.4). Capt Hertzberg was tally two (saw both Nails), he maneuvered his jet, and he took an offensive position due to the fact he was shooting Nail 4 (the trailer of the attacking flight) (Tab Z-7, N-11, V-2.4, Z-17). Capt Hertzberg did enter Capt Hufford's altitude block (Tab C-2, Z-39); however, *AFI 11-214* allows a pilot to enter the opposing aircraft's block if he has "established a visual contact" on all opposing aircraft (the two ship of Nails) (Tab CC-18). Nevertheless, he did err in the fact that he did not avoid the leader (Capt Hufford) during the post execution (leaving) of his attack on the trailer of the formation. After losing sight of Capt Hufford under his nose, Capt Hertzberg testified that he attempted to maneuver his aircraft up to the right and away from the last known position and vector of Capt Hufford (Tab V-1.6). Capt Hertzberg stated "He's (Capt Hufford) tracking to the left and where I'm going to lose him is when he passes through the lower left hand corner of the HUD about to disappear under the nose and that's when I elect to maneuver away to the right" (Tab V-2.4) and "As I started to pull away to avoid Nail 3 (Capt Hufford) disappearing under my nose, the range looked to me at about one and a half miles to maybe just outside of that" (Tab V-2.5). ACMI data is lost on Capt Hertzberg from 1.9 NM to 1.3 NM, so it is hard to verify this statement. However, at 1.9 NM (just prior to the track lost) the ACMI data shows Capt Hertzberg in a right hand bank, which could be an attempt to deconflict with Capt Hufford (Tab Z-20, Z-20.1). The next ACMI data on Capt Hertzberg was a full system ACMI track for 1/10 of a second (Zero Filters) which showed Capt Hertzberg in a left hand bank pointed at Capt Hufford at a range of 1.3 NM (Tab Z-25, Z-25.1). The full system track was then lost on him and the system went to a 1 track, which is reasonably good data on the bank angle/aircraft attitude with some positional drift (Tab Z-2.2, V-1.19, Z-26 thru Z-35.1). Somewhere between the lost ACMI track of Capt Hertzberg at 1.9 NM and reacquired ACMI track at 1.3 NM, Capt Hertzberg reversed his turn to the left in an attempt to regain a tally ho (i.e., he was trying to regain sight of Capt Hufford); in doing so, Capt Hertzberg positioned his aircraft on a collision course with Capt Hufford without a tally ho; i.e., he did not actually maneuver away from the last known flight path of Capt Hufford. ACMI showed Capt Hertzberg in a 34 degree left bank at 1.0 Gs at 1.3 NM. (Tab Z-25.1). At about two to three seconds to impact (approximately 3000-4000 feet), Capt Hertzberg

regained the tally and made a last ditch maneuver to the right (he reversed his turn from left to right) in an attempt to maneuver right and up from Capt Hufford. Because Capt Hertzberg reversed his turn during his last ditch maneuver, his turn maneuvered in the same direction as Capt Hufford's last ditch maneuver. Capt Hertzberg's last ditch maneuver effectively countered Capt Hufford's last ditch maneuver and the aircraft collided.

c. **CAPT HERTZBERG:** An additional primary cause of this mishap, supported by clear and convincing evidence, was Capt Hertzberg's failure to follow *AFI 11-214* training rule, "Any attacker losing sight will maneuver away from the defender's last known position. Defenders will maneuver predictably if loss of sight and SA occurs" (Tab CC-18, para. 5.2.9.4). Capt Hertzberg was both a defender and an attacker during this merge; however, after Capt Hertzberg lost sight of Capt Hufford he failed to accomplish either of the above procedures; i.e., after losing sight he did not "continue" to maneuver away from the opposing aircraft's last known position nor did he maintain a predictable flight path (Tab V-1.6, V-2.3, Z-20 thru 35.1). Capt Hertzberg stated that he lost sight of Capt Hufford on the left side of the nose of his aircraft just below the lower left hand side of the HUD. After Capt Hertzberg lost sight of Capt Hufford, he stated he initially maneuvered to the right, away from Capt Hufford's last known vector. However, he reversed his turn to the left to regain a tally, putting himself on a collision course with Capt Hufford. Also, after he regained the tally ho at 3000-4000 feet, he reversed his turn to the right in a last ditch avoidance maneuver; however, Capt Hufford was now on the right side of his aircraft. This maneuver canceled the last ditch effort of Capt Hufford who's last ditch avoidance maneuver was in the same direction (Tab V-1.6, V-1.7, V-2.3, V-2.4, Z-20 thru 35.1).

d. **CAPT HUFFORD:** A contributing factor to this mishap, supported by clear and convincing evidence, was that Capt Hufford failed to follow *AFI 11-214* training rule, "Participants will cease weapons employment (actual or simulated) under the following conditions: Pure pursuit head-on missile attacks before 9,000 feet slant range" (Tab CC-19, para. 5.2.9.10). After regaining tally or just prior to regaining the tally on Capt Hertzberg, Capt Hufford initially unloaded his jet (pushed the nose of his jet) for about 1/2 of a second as verified by the ACMI towards Capt Hertzberg (Tab Z-27 thru Z-31.1). As stated by Capt Hufford, this may have been in an attempt to keep from climbing towards Capt Hertzberg or to initially try to get a boresight lock at 1.2 to 1.1 NM from Capt Hertzberg. Capt Hufford stated, "It could be an initial try to get the boresight cross on, because I do, for half a second, consider doing that. But it's pretty quick that I go, nah, it's not going to work (Tab V-4.8)." Later in his testimony, he states he was unsure of exactly why he unloaded the jet (Tab V-4.6). Since Capt Hufford was in an approximate 70 degree bank turn while unloading his jet, as verified by the ACMI (Tab Z-30), this maneuvered his jet more in the direction towards Capt Hertzberg than vertical down and away. It is my opinion that Capt Hufford was attempting to get a radar lock to employ weapons inside of 1.5 NM (9,000 feet) before he realized his range from Capt Hertzberg (1.2 to 1.1 NM). *AFI 11-214* states, "Participants will cease weapons employment (actual or simulated) under the following conditions: Pure pursuit head-on missile attacks before 9,000 feet slant range" (Tab CC-19, para. 5.2.9.10). Even though the word "cease" is used (instead of participant will not attempt), one cannot attempt to start a pure pursuit head-on

missile attack inside 9,000 feet without later having to cease inside 9,000 feet. Capt Hufford admitted to thinking about getting a boresight lock and his actions were consistent with someone who would be performing a "Pure pursuit head-on missile attack" well inside of 9,000 feet slant range. He was 6,500-7,000 feet when he was unloading his jet towards Capt Hertzberg (Tab Z-30, V-4.10). The reason behind the 9,000-foot rule is to allow pilots the time to maneuver away from the opposing aircraft and pass outside of 500 feet from each other. Any attempt inside 9,000 feet allows little room (and maybe no room) to maneuver away from a collision.

**e. CAPT HUFFORD AND CAPT HERTZBERG:** A contributing factor to this mishap, supported by clear and convincing evidence, was that Capt Hufford and Capt Hertzberg failed to follow *AFI 11-214* training rule, "When two aircraft approach head-on, each will clear to the right unless maneuvering to do so would result in crossing flight paths" (Tab CC-19, para. 5.2.9.9).

(1) Capt Hufford crossed the nose of Capt Hertzberg during the final stages of the intercept just prior to impact (Tab EE). Capt Hertzberg stated that Capt Hufford was left of his nose during the time he (Capt Hertzberg) was employing a simulated missile on Capt Hufford's wingman. Capt Hufford stated that Capt Hertzberg was also left of his nose after passing Capt Hertzberg's flight lead. Both of these times (when Capt Hertzberg was shooting the wingman and Capt Hufford was passing the flight lead) are within seconds of each other (Tab EE). Capt Hufford stated that he reversed his turn after passing Capt Hertzberg's flight lead in an attempt to maintain south of Capt Hertzberg and an attempt to remain outside of Nail flight. However, when Capt Hufford reversed his turn towards the south, it resulted in Capt Hufford crossing the nose of Capt Hertzberg because the accident was a right to right pass. Additionally, as you will note below, Capt Hertzberg also reversed his turn during the engagement (he went from a right hand break turn, to a missile shot (simulated), to continue his right turn (lost tally), then later to a left bank to regain the tally then back to a right hand turn just prior to impact). The left hand bank/turn (which may have tracked left on the nose of Capt Hufford) may have been seen by Capt Hufford at the time he was focusing ahead at Capt Hertzberg (1.2 NM) and this may have caused Capt Hufford to think that Capt Hertzberg was initially going to pass to his right. This could be an additional reason why Capt Hufford tried to maneuver to the left at end game.

(2) Capt Hertzberg stated that he lost sight of Capt Hufford on the left side of his aircraft just below the lower left hand side of the HUD. After Capt Hertzberg lost sight of Capt Hufford, he stated he initially maneuvered to the right, away from Capt Hufford's last known vector. However, he reversed his turn to the left to regain a tally. During the turn to the left, Capt Hertzberg crossed the nose of Capt Hufford. Additionally, just prior to the impact, Capt Hertzberg attempted to re-cross the nose of Capt Hufford by pulling to the right. This caused Capt Hufford's right wing to hit Capt Hufford's right wing. (Tab Z-2.21 thru 39.1, Tab EE). *AFI 11-214* states, "When two aircraft approach head-on, each will clear to the right unless maneuvering to do so would result in crossing flight paths" (Tab CC-19, para. 5.2.9.9). After Capt Hertzberg regained the tally ho at 3000-4000 feet, he reversed his turn to the right in a last

ditch avoidance maneuver; however, Capt Hufford was now on the right side of his aircraft. The last ditch maneuver to the right was in violation of this regulatory guidance; i.e. this maneuver was in a direction towards the other aircraft's flight path (Tab V-1.6, V-1.7, V-2.3, V-2.4, Z-20 thru 35.1).

**f. CAPT HUFFORD AND CAPT HERTZBERG:** Supported by clear and convincing evidence, human factors that contributed to Capt Hufford's and Capt Hertzberg's failure to see and avoid each other are as follows (Tab DD):

(1) In reference to Capt Hufford, human factors that contributed to this include a decreased situational awareness secondary to motivation to succeed-excessive, task saturation in association with the stress performance curve, human reaction time, task misprioritization, channelized attention, and misperception of speed / closure rate.

(a) Although Capt Hufford had both Spider 1 and Spider 2 (Capt Hertzberg) in his sight, his situational awareness might have been decreased by a number of factors. The psychological factor / behavior of "motivation to succeed - excessive" contributed to the mishap. This factor is "when the individual is preoccupied with success to the exclusion of other mission factors leading to an unsafe situation." The pilots interviewed from the 421<sup>st</sup> described Capt Hufford as a "fast burner" (high performer) and a "very sharp" pilot hopefully headed for the Instructor Pilot (IP) upgrade program. Capt Hufford also stated that he is hopeful of being an IP in the future and was trying to do some teaching between engagements (Tab V-4.11). This desire to be an IP and teach and instruct other pilots, although an admirable goal, to an excess contributed to the collision by drawing attention and decision-making time away from the merge and focused more on what he was going to teach his wingman. Reference *Safety Investigation Board Life Science Investigation Human Factor Terms Definitions* (Tab DD-11).

(b) Task saturation in association with the stress performance curve was a contributing factor to this mishap. Single-seat aircraft are well known for the pilot's multi-tasked responsibilities to fly and maneuver the aircraft, maintain cognizance of real-world situation, threat awareness, operational functional modes, navigation and refueling status and rendezvous, sensor management, weapons management, communication management, and tactical coordination and decision-making. The task-saturated pilot is under more stress than when he is not task saturated. Some stress is actually beneficial to performance. The stress performance curve shows that as stress increases, the pilot's ability to handle multiple tasks increases up until a certain point (Tab DD-12). A point does exist, however, where additional stress now starts to lower performance. Too many tasks, in fact, start to degrade pilot performance rapidly. When engaged with so many different tasks, an oncoming jet will get closer, faster than anticipated. During the mishap intercept, Capt Hufford, although only a flight lead, adds the additional tasks on himself of evaluator or instructor (Tab V-4.11). These additional tasks over-burdened Capt Hufford and caused him to misprioritize his tasks, i.e., looking over his shoulder to find a wingman, when only 1.3 nautical miles away is an oncoming jet with a closure velocity of 1,021 knots (confirmed by ACMI). Therefore, task saturation, as associated with the stress performance curve, contributed to this mishap (Tab DD-12).

(c) Another factor which contributed to the mishap is the lag in human reaction time. Human studies show that human reaction time is a function of sensation (.10 seconds for light to travel from retina to brain), central vision focusing time (.29 seconds), perception (.65 seconds for minimum recognition time), decision (2.0 seconds estimated minimum), control operation (0.4 seconds), and aircraft response (.20 seconds) (Tab DD-7). According to these studies, the total minimum reaction time is 3.64 seconds and is applicable during a mid-air collision avoidance scenario in which at least one pilot is aware of the possible threat. At 1,021 knots of closure, Nail 3 (Capt Hufford) and Spider 2 (Capt Hertzberg) closed in on each other at a rate of 1,725 feet per second or 4.54 seconds from impact. Capt Hufford stated (Tab V-3.12 thru 3.13) that after making the hostile call, [1.3 nautical miles from Spider 2 (Capt Hertzberg) confirmed by ACMI], he looked back to see where his wingman was, thinking that Spider 2 (Capt Hertzberg) was trailing Spider 1 and going to pass him on the right also. This perception is supported by ACMI which shows Capt Hertzberg in a 40 degree left bank at 1.3 NM with a high probability tracking (Tab Z-25.1). As he looked back through the HUD, he immediately tallied Spider 2 (Capt Hertzberg) and gave a brief thought to radar lock him, but immediately decided Spider 2 (Capt Hertzberg) was too close. He then noticed "there is absolutely no line of sight" from Capt Hertzberg's aircraft (Tab V-3.12) and realized that Capt Hertzberg was coming straight at him.

At this point, Capt Hufford said he was about 4,000 feet from Capt Hertzberg and began a decision process as outlined in his testimony (Tab V-3.12). Capt Hufford decided to maintain his flight path because breaking to either side might match the other pilot's maneuver and result in a collision. Realizing that the other pilot was still coming at him, he made a last ditch maneuver toward the left and down with a resultant collision of right wings. The time to look back at a wingman, mentally process the tally of the wingman, then look back and mentally process the tally of Spider 2, think of locking the aircraft, decide it is too close, realize a collision is coming, decide on an escape maneuver, [during which the pilot said he froze until the last 2 seconds before the collision (Tab V-3.12)], operate the controls and have the aircraft respond, goes quickly, with a lot of distance traveled. Looking forward again and seeing Capt Hertzberg coming at him totally conflicted with what he expected to see. The resulting confusion probably added to the reaction time. His perception of freezing is probably just the time required to make a decision in such a high speed setting as evidenced in human factor studies.

Capt Hufford was approximately 7,800 feet, or 4.54 seconds from impact when he began to look back at his wingman. The closure rate of 1021 knots, or 1,725 feet per second, makes it nearly impossible for him to mentally process all this information and then maneuver the aircraft in sufficient time to avoid a collision. Furthermore, studies have shown that decision time in such scenarios is 2.0 seconds at a minimum. When added to the operations control time of .2 seconds and the aircraft response time of .4 seconds, Capt Hufford had a 3.0 second requisite to avoid the collision. At a closure rate of 1,021 Knots (1,725 feet / second), impact would occur in 2.32 seconds from 4,000 feet. Therefore, from the point where Capt Hufford started another decision process at 4,000 feet from Capt Hertzberg, there was virtually no way for Capt Hufford to avoid colliding with Capt Hertzberg. Therefore, the factor of human reaction time contributed to this mishap (Tab DD-7).



(d) Task misprioritization and channelized attention contributed to the mishap. I have already discussed the multi-tasked responsibilities of a single-seat aircraft pilot. In fact, in testimony, Capt Hufford repeatedly reports being "a few potatoes behind the jet" while he is approaching the merge (Tab V-3.5 thru 3.7). Capt Hufford further complicates the scenario with his desire to closely monitor his wingman for teaching and training purposes, perhaps too close to the merge. As a high performance aircraft pilot comes to the merge on an intercept, he needs to prioritize his mental efforts out in front of the aircraft in order to avoid a collision, avoid getting shot, and identifying and shooting his adversaries. As he comes out of the merge, his priorities change to maintaining a broader situational awareness while deconflicting with the other aircraft. Therefore, Capt Hufford added yet another task to himself by focusing too much on evaluating his wingman, task misprioritizing by looking back at his wingman too close to a merge with an oncoming aircraft, and not prioritizing enough out in front of the jet while channelizing too much on worrying about his wingman's position. These factors contributed to the mishap.

(e) Capt Hufford's misperception of speed and closure rate contributed to this mishap. Capt Hufford had excellent situational awareness as he started to merge with the Spider two ship. He had tally on both aircraft. His error was in assuming that Capt Hertzberg was going to continue as a lead-trail element with Spider 1 and pass on the right of his own aircraft. According to Capt Hertzberg's testimony (Tab V-2.3) he shot (simulated) Nail 4 while in a descending right turn and then pulled his nose up and to the right in attempt to deconflict with Capt Hufford. He lost tally of Capt Hufford under his left nose "for about 3 seconds," after which Capt Hertzberg rolled to the left in an attempt to regain tally on Capt Hufford. This may have telegraphed to Capt Hufford an intention to pass him on the right just before Capt Hufford turned to look at his wingman. When Capt Hufford looked back at his wingman, it was his perception that Capt Hertzberg was going to continue to move to the right and pass on the right. Therefore, Capt Hufford continued his turn to the left. When Capt Hufford looked forward again, Capt Hertzberg was still in a left bank trying to regain the tally, but then Capt Hertzberg began to "dig toward the South" in a right turn in an attempt to pass on the left side of Capt Hufford. Looking back at the wingman delayed Capt Hufford's ability to perceive Capt Hertzberg's speed, closure rate, bank angle and vector in time to make an early escape from the collision.

(2) In reference to Capt Hertzberg, human factors that contributed to the mishap include a decreased situational awareness secondary to task saturation, task misprioritization, channelized attention, human reaction time and misperception of speed / closure rate.

(a) Capt Hertzberg had excellent situational awareness on both Nail 3 (Capt Hufford) and Nail 4 as he began a descending right turn to engage them. His situational awareness might have been decreased by his task saturation, task misprioritization and channelized attention. I have already discussed the multi-tasked responsibilities of a single-seat aircraft pilot [para c (3) pg. 21]. Capt Hertzberg was so task-saturated or channelized with maneuvering and shooting Nail 4 that he failed to deconflict properly with Capt Hufford. As a high performance aircraft pilot comes to the merge on an intercept, he needs to channelize and prioritize his mental efforts out in front of the aircraft in order to avoid a collision, avoid getting shot, and identifying and

shooting his adversaries while leaving himself a safe outlet from the merge. This led to Capt Hertzberg not realizing how close he was to Capt Hufford (the lead) as Capt Hertzberg shot (simulated) Nail 4 (the trailer). Capt Hertzberg reported that after his shot (simulated), he lost visual of Capt Hufford through the left side nose of his HUD (Tab V-2.3) as he started a turn toward the right and up. He continued this turn (away from Capt Hufford's last known position and vector) for about "3.0 seconds." ACMI, however, suggests that Capt Hertzberg only pulled to level off in a slight right bank. After this, he rolled left in attempt to regain tally on the Nail flight. This left bank maneuver pointed his jet toward Capt Hufford within 1.3 NM and a closure rate of 1,725 feet per second confirmed by ACMI (Tab Z-26).

As Capt Hertzberg maneuvered "up and to the right," (level with a slight right bank,) he lost sight of Capt Hufford and thought he was maneuvering away from Capt Hufford's last known position. As he banked left, he saw Capt Hufford coming straight up at him inside 3,000 to 4,000 feet. Capt Hertzberg then selected afterburner while pulling up hard and to the right just approximately 2 seconds before the collision. Capt Hertzberg may not have been aware of his proximity to Capt Hufford while he was shooting Nail 4, due to being so task-saturated and channelized with Nail 4, that he misprioritized his deconfliction with Capt Hufford.

(b) Another factor contributing to decreased situational awareness is the lag in human reaction time. As discussed previously (para c, pg. 23), the total minimum reaction time is 3.64 seconds (Tab DD-7). At 1,021 knots of closure, Capt Hufford and Capt Hertzberg closed in on each other at a rate of 1,725 feet per second. Capt Hertzberg stated that he leveled off expecting to see Capt Hufford pass a half mile to his left, but instead saw Capt Hufford coming straight up at him about 3,000 - 4,000 feet away (Tab V-2.3). His reaction was to select afterburner and pull hard up and to the right. According to human reaction studies at fast closure rates, there was virtually no way for Capt Hertzberg to perceive, process the information and maneuver his aircraft fast enough to avoid a collision at that point (3.64 seconds minimal reaction time and 1.74 - 2.32 seconds to impact based on the above parameters at 3,000- 4,000 foot separation). Therefore, the lag in human reaction time contributed to this mishap (Tab DD-7).

(c) Capt Hertzberg's misperception of vector and closure rate also contributed to this mishap. Capt Hertzberg had excellent situational awareness as he started to merge with the Nail two ship. He had tally on both aircraft. Capt Hertzberg assumed Capt Hufford was going to continue engaging Spider 1 (Lt Col Grace), and that Capt Hufford was going to chase Spider 1 and pass Capt Hertzberg's aircraft on the left, therefore he maneuvered his aircraft to the right and up. His error was in assuming that Capt Hufford was going to continue engaging Lt Col Grace (Spider 1) and pass to the left side of his own aircraft. Capt Hertzberg stated that Capt Hufford was "continuing through west to northwest" (Tab V-2.4). This perception was probably due to the fact that Capt Hertzberg was pulling higher G's to the right, therefore giving the appearance that Capt Hufford was moving to the left across his HUD when in fact Capt Hufford was just beginning a left bank maneuver to the South according to the ACMI (Tab Z-17.1 thru 19.1).

According to Capt Hertzberg's testimony (Tab V-2.3), he shot (simulated) Capt Weeks (Nail 4) while in a descending right turn and then pulled his nose up and to the right for about three

seconds and then rolled level to regain the tally. ACMI, however, shows Capt Hertzberg pull up to level in a slight right bank for a few seconds and then roll to a left bank (Tab Z-26). Capt Hertzberg did not notice that Capt Hufford began a left turn as Capt Hertzberg was probably channelized on Nail 4. Capt Hertzberg's left hand bank may have telegraphed to Capt Hufford an intention to pass him on the right. When Capt Hufford looked back at his wingman, it was his perception that Capt Hertzberg was going to continue to move to his right and pass on the right in a lead trail with his element leader Spider 1. Therefore, Capt Hufford continued his turn to the left as he looked back to check his wingman. Capt Hertzberg probably did not see Capt Hufford's continued left turn while raising the nose of his jet in a slight right bank, and therefore continued to maneuver in a right turn in an attempt to pass on the left side of Capt Hufford. When Capt Hertzberg regained the tally at 3,000-4,000 feet separation, he attempted a last ditch maneuver to the right and up. Capt Hertzberg's misperception of Capt Hufford's speed, closure rate, bank angle and vector contributed to his maneuvering his jet into a collision course with Capt Hufford.

#### 4. CONCLUSION:

(a) It is my opinion, which is supported by clear and convincing evidence, that the lack of appropriate actions by BOTH mishap pilots, Capt Hufford and Capt Hertzberg, caused this mishap.

(b) The primary cause of this mishap, supported by clear and convincing evidence, was Capt Hufford's and Capt Hertzberg's failure to use proper "see and avoid" techniques to ensure a clear flight path while entering and leaving an engagement as required by AFI 11-214.



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