UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

F-15C, T/N 86-0176

493RD FIGHTER SQUADRON
48TH FIGHTER WING
ROYAL AIR FORCE LAKENHEATH, UNITED KINGDOM

LOCATION: ROYAL AIR FORCE LAKENHEATH, UNITED KINGDOM

DATE OF ACCIDENT: 15 JUNE 2020

BOARD PRESIDENT: MAJOR GENERAL DEAN A. TREMPS

Conducted IAW Air Force Instruction 51-307

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

F-15C, T/N 86-0176
ROYAL AIR FORCE LAKENHEATH, UNITED KINGDOM
15 JUNE 2020

At 0827 zulu time (Z) (0927 local time (L)) on 15 June 2020, an F-15C, tail number (T/N) 86-0176, from the 493rd Fighter Squadron (493 FS), Royal Air Force (RAF) Lakenheath, United Kingdom (UK), crashed in the North Sea, 124 nautical miles (NM) northeast of RAF Lakenheath during a local combat training flight. The mishap aircraft (MA) was completely destroyed. The mishap pilot (MP), assigned to the 493 FS, was fatally injured.

The weather in the airspace was reported to have multiple cloud layers up to 25,000 feet (ft) and thus the mishap sortie (MS) was conducted using Instrument Meteorological Conditions (IMC) Rules during the engagements, if IMC would be encountered. During an air-to-air training engagement, the MP was flying east at 20,300ft and was directed by his mishap element lead (MEL) to execute a hard right turn back toward the west and look for an exercise adversary aircraft (AA) at a lower altitude. The MP made a descending right turn toward the west, used his on-board radar to lock onto the AA (headed eastbound at 5,000ft less than 20 nautical miles (NM) away) and executed a simulated missile shot against the AA. The MP stabilized on approximately a westbound heading and continued his descent to 12,000ft at 507 knots true airspeed (KTAS). The MP made a radio transmission of his simulated missile kill of the AA. The MP received a "P_k miss" (Probability of Kill: Miss) radio transmission from the "Blue Air" Range Training Officer (RTO1), so the MP continued maneuvering to engage the AA which was then 5.5 NM southwest of the MP's position. The MP entered a descending left turn through IMC toward the south, lowering the MA pitch attitude to 42º low and varying from 21º to 107º of left bank angle. The MP sustained 0.3 to 3.8 gravitational (G) forces throughout the maneuver and accelerated to 579 KTAS, with a maximum vertical velocity of 38,800ft per minute descent. The MP breached the briefed training floor of 4,000ft and at approximately 1,000ft, the MP maneuvered the MA to nearly wings-level and pulled 8.2 G-forces in an apparent attempt to recover the MA above the water. The MA impacted the water at 10º pitch low, 4º of left bank and 566 KTAS. The MP did not eject from the MA.

The Accident Investigation Board President found, by a preponderance of the evidence, the cause of the mishap was the MP's fixation on his intercept of the AA and failure to execute cockpit instrument visual scans when the MP encountered IMC. Reduced visibility and lack of a discernible horizon for the MP resulted in spatial disorientation. The inability of the MP to accurately sense the pitch attitude of the MA due to spatial disorientation substantially contributed to the MA's undesirable low pitch attitude, rapidly descending altitude, and the resulting mishap.

SUMMARY OF FACTS AND STATEMENT OF OPINION
F-15C, T/N 86-0176
15 JUNE 2020

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

48 FW	48th Fighter Wing
493 FS	493rd Fighter Squadron
4FLUG	4-Ship Flight Lead Upgrade
AA	Adversary Aircraft
ACBT	Air Combat Training
ACES	Advanced Concept Ejection Seat
ACMI	Air Combat Maneuvering Instrumentation
AF	Air Force
AFAFRICA	U.S. Air Forces Africa
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFMAN	Air Force Manual
AFMES	Armed Forces Medical Examiner System
AFPET	Air Force Petroleum Office
AFTO	Air Force Technical Order
AGT	Airplane General Technician
AIB	Accident Investigation Board
AMU	Aircraft Maintenance Unit
AMXS	Aircraft Maintenance Squadron
AOC	Air Operations Center
AP	Adversary Pilot
AR	Aerial Refueling
ASAP	As Soon As Possible
ATC	Air Traffic Control
AWACS	Airborne Warning and Control System
AWL	Above Water Level
BASH	Bird/wildlife Aircraft Strike Hazard
B-Course	F-15C Formal Training Unit
BFM	Basic Fighter Maneuvers
BIT	Built-in Test
BVR	Beyond Visual Range
C2	Command and Control
CAF	Combat Air Forces
CANN	Cannibalization Program
Cat	Category
CAT	Crisis Action Team
Cert	Certification
CMR	Combat Mission Ready
Comm	Communication
COVID-19	Coronavirus Disease 2019
CSAR	Combat Search and Rescue
CT	Continuation Training
D&D	Distress and Diversion
DCA	Defensive Counter Air
DLO	Desired Learning Objective
DMO	Distributed Mission Operations
DNIF	Duty Not Involving Flying
DO	Director of Operations
DoD	Department of Defense
EA	Electronic Attack
EFB	Electronic Flight Bag
ELT	Emergency Locator Transmitter
EOR	End of Runway
EP	Emergency Procedure
ETIC	Estimated Time for Completion
FDL	Fighter Data Link
FDR	Flight Data Recorder
FLUG	Flight Lead Upgrade
FPM	Feet Per Minute
FS	Fighter Squadron
ft	Feet
FTU	Formal Training Unit
FW	Fighter Wing
G	Gravitational
GAT	Guidance Apportionment and Targeting
G-Ex	G-forces Awareness Exercise
GPS	Global Positioning System
HFACS	Human Factor Analysis Classification System
HMCG	Her Majesty's Coast Guard
HMS	Her Majesty's Ship
IAW	In Accordance With
ICADS	Individual Combat Aircrew Display System
IFE	In-Flight Emergency
IMC	Instrument Meteorological Conditions
IMDS	Integrated Maintenance Data System
IP	Instructor Pilot
I-SIB	Interim Safety Investigation Board
KTAS	Knots True Airspeed

L	Local Time
Lat	Latitude
LDS	Latter-Day Saints
LFE	Large Force Exercise
Long	Longitude
LOS	Line of Sight
LOX	Letter of X's
LPS	Lead Production Superintendent
MA	Mishap Aircraft
MC	Mission Capable
MDA	Managed Danger Area
MDSU	Mobile Diving and Salvage Unit
MEF	Mission Execution Forecast
MEL	Mishap Element Lead
MF	Mishap Formation
MFL	Mishap Formation Lead
MP	Mishap Pilot
MQ	Mission Qualified
MQT	Mission Qualification Training
MS	Mishap Sortie
MX	Maintenance Personnel
NAVAID	Navigational Aid
Net	Network
NM	Nautical Miles
NOTAM	Notice to Airmen
NVG	Night Vision Goggle
OCA	Offensive Counter Air
Ops	Operations
ORM	Operational Risk Management
OSC	On-Scene Commander
OSK	48 FW Weapons
OSS	Operations Support Squadron
OVC	Overcast
PAS	Protective Aircraft Shelter
PHA	Preventive Health Assessment
P_k	Probability of Kill
PPLI	Precise Participant Location and Identification
PRC	Personnel Recovery Center
PS	Production Superintendent
QAI	Quality Assurance Inspector
QC	Quality Control
RAF	Royal Air Force
RAP	Ready Aircrew Program
Regen	Regenerate
RMM	Removal Memory Module
RN	Royal Navy
ROV	Remotely Operated Vehicle
RP	Replaced Pilot
RTB	Return-To-Base
RTO	Range Training Officer
SA	Situational Awareness
SAR	Search and Rescue
SCL	Standard Conventional Load
SIB	Safety Investigation Board
SME	Subject Matter Expert
SOF	Supervisor of Flying
SPIN	Special Instruction
SPO	Systems Program Office
SPT	Support Aircraft
T/N	Tail Number
TA	Transition Altitude
Tac	Tactical
TAF	Terminal Area Forecast
TDY	Temporary Duty
TFR	Temporary Flight Restriction
TI	Tactical Intercepts
TOP3	Operations Supervisor
TR	Training Rule
UHF	Ultra High Frequency
UK	United Kingdom
USAFE	U.S. Air Forces in Europe
USAFESUP	U.S. Air Forces in Europe Supplement
USAFRICOM	U.S. Africa Command
USEUCOM	U.S. European Command
VFR	Visual Flight Rules
VHF	Very High Frequency
Vis	Visibility
VMC	Visual Meteorological Conditions
Vul	Vulnerability Period
WDO	Weapons Duty Officer
WX	Weather
Z	Zulu Time

The above list was compiled from the Summary of Facts, the Statement of Opinion, the Index of Tabs, and witness testimony and any other Tab reference cited in the report.

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 29 June 2020, General Jeffrey L. Harrigian, Commander, United States Air Forces in Europe – United States Air Forces Africa (USAFE-AFAFRICA), detailed Major General Dean A. Tremps to conduct an Accident Investigation Board (AIB) for an aerospace mishap involving an F-15C, tail number (T/N) 86-0176, that occurred in the North Sea, 124 nautical miles (NM) northeast of Royal Air Force (RAF) Lakenheath, United Kingdom (UK), on 15 June 2020 (Tabs J-34, L-3, Y-3 to Y-4, and Z-37). The investigation was conducted at RAF Lakenheath, UK, from 31 July 2020 through 22 August 2020. The following individuals were AIB members or Subject Matter Experts (SME) assisting the AIB: a Lieutenant Colonel legal advisor, a Lieutenant Colonel medical member, a Major pilot member, a Senior Master Sergeant maintenance member, a Master Sergeant recorder, a civilian reporter, and a contractor aircraft simulator operator as a SME (Tab Y-3 to Y-7).

b. Purpose

IAW Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations*, this AIB conducted a legal investigation to inquire into all the facts and circumstances surrounding this Air Force aerospace accident, prepare a publicly-releasable report, and obtain and preserve all available evidence for use in litigation, claims, disciplinary action, and adverse administrative action (Tab BB-53 to BB-54).

2. ACCIDENT SUMMARY

At approximately 0927 local time (L) on 15 June 2020, an F-15C, T/N 86-0176, from the 493rd Fighter Squadron (493 FS), RAF Lakenheath, UK, crashed in the North Sea (054°21.7'N, 001°40.5'E) during a local combat training flight (Tabs L-3, J-34, and AA-5). The mishap aircraft (MA) was destroyed (Tabs D-3 and J-34 to J-112). The mishap pilot (MP) assigned to the 493 FS was fatally injured (Tabs G-3 and X-3). The MP was flying as number 4 of four aircraft flying against six exercise adversary F-15C aircraft in a Defensive Counter Air (DCA) training mission over the North Sea (Tabs K-3, R-121, and AA-5). During the tactical portion of the training mission, the MP attempted to target and intercept an exercise adversary aircraft (AA) at a lower altitude (Tabs DD-8, Z-21. Z-23, and Z-25). During the course of the intercept, the MP accelerated in a steep dive and crashed in the North Sea after an apparent recovery attempt (Tabs S-20 and Z-3 to Z-25). There was no evidence that the MP ejected from the MA (Tab J-114).

3. BACKGROUND

a. U.S. Air Forces in Europe – U.S. Air Forces Africa (USAFE-AFAFRICA)

USAFE-AFAFRICA, headquartered at Ramstein Air Base, Germany, is a major command of the U.S. Air Force (Tab CC-3). It is the air component for two Department of Defense (DoD) combatant commands: U.S. European Command (USEUCOM) and U.S. Africa Command (USAFRICOM) (Tab CC-3). As the air component for both USEUCOM and USAFRICOM, USAFE-AFAFRICA executes the Air Force, USEUCOM and USAFRICOM missions with forward-based airpower and infrastructure to conduct and enable theater and global operations (Tab CC-3). USAFE-AFAFRICA directs air operations in a theater spanning three continents, covering more than 15 million square miles, containing 104 independent states, possessing more than one-fifth of the world's population, and more than a quarter of the world's gross domestic product. (Tab CC-3).

b. 48th Fighter Wing (48 FW)

As USAFE's only F-15 fighter wing, the 48 FW, located at RAF Lakenheath, UK, brings unique air combat capabilities to the fight, such as the most advanced Joint Direct Attack Munitions employed by the F-15E (Tab CC-5). The 48 FW provides all-weather, day-or-night air superiority, air-to-ground precision combat capability and multi-staged improvement program avionics (Tab CC-5). The F-15E Strike Eagle employs Precision Guided Munitions using the Low Altitude Night Targeting and Infrared Navigation system and Sniper Advanced Targeting Pod technology (Tab CC-5). The F-15C Eagle employs advanced technology including the Air Intercept Missile 9X and the Joint Helmet Mounted Cueing System providing the most advanced technology, capable of eliminating enemy air threats anytime, anywhere (Tab CC-5). When teamed together, the F-15E and F-15C provide air combat capability never before seen in the history of airpower (Tab CC-5).

c. 493rd Fighter Squadron (493 FS)

The 493 FS is a combat-ready F-15C/D Eagle squadron capable of executing air superiority and air defense missions in support of war plans and contingency operations for USEUCOM, USAFRICOM and the North Atlantic Treaty Organization (Tab CC-7). The 493 FS employs the full array of air-to-air weapons and electronic identification systems (Tab CC-7). The squadron maintains the ability to rapidly generate, deploy and sustain operations to execute wartime and peacetime taskings in any theater of operations in the world (Tab CC-7).

d. F-15C Eagle

The F-15C Eagle is an all-weather, extremely maneuverable, tactical fighter designed to permit the Air Force to gain and maintain air supremacy over the battlefield (Tab CC-9). The Eagle's air superiority is achieved through a mixture of unprecedented maneuverability and acceleration, range, weapons and avionics (Tab CC-9). It can penetrate enemy defense, outperform, and outfight any current enemy aircraft (Tab CC-9). The F-15C has electronic systems and weaponry to detect, acquire, track and attack enemy aircraft while operating in friendly or enemy controlled airspace (Tab CC-9). The weapons and flight control systems are designed so one person can safely and effectively perform air-to-air combat (Tab CC-9). The F-15D is the two-seat version of the F-15C (Tab CC-10).

e. Training Rules (TRs)

The TRs are a set of rules and procedures prescribed for air-to-air training operations and are designed to promote safe and effective mission accomplishment (Tab BB-8 to BB-9). The TRs are the foundation for coordination and execution among all training participants to include command authorities, controlling agencies, and airborne weapons systems (Tab BB-8 to BB-9).

f. Instrument Meteorological Conditions (IMC)

IMC describes a condition in which any of the criteria for Visual Meteorological Conditions (VMC) are not met (Tab BB-15). For operations occurring within the scope of the TRs, the VMC criteria are: 2,000 feet (ft) vertical and 1 NM horizontal cloud clearance with 5 NM visibility and a discernible horizon (Tab BB-15).

g. IMC Rules

Within the TRs are provisions called "IMC Rules" that allow for air-to-air training to occur while aircraft are in IMC (Tab BB-17). IMC Rules impose a pitch limitation of 15° and a bank limitation of 60° if operating in these conditions (Tab BB-17 to BB-18).

h. Range Training Officer (RTO)

RTOs use Air Combat Maneuvering Instrumentation (ACMI) and the Individual Combat Aircrew Display System (ICADS) to monitor the airspace during training missions and are in radio contact with the participants (Tabs Z-35 and BB-13). The RTO's responsibilities are to monitor the mission for flight safety, facilitate training, provide real-time simulated kill removal, and assist flight leads in mission reconstruction during debriefs (Tab BB-26).

i. Experienced and Inexperienced Pilots

An experienced pilot, as defined by Air Force Manual (AFMAN) 11-2F-15, Volume 1, *F-15-Aircrew Training,* consistently demonstrates the skills (airmanship, situational awareness, and tactical leadership) required to effectively employ fighter aircraft in combat (Tab BB-36). Designation as an experienced pilot requires squadron commander approval, completion of a formal training unit course (FTU), and a requisite number of flying sorties (Tab BB-36). The flying sortie requirement varies based on flying history in the F-15C/D and other fighter aircraft (Tab BB-36 to BB-37). A pilot that does not meet these criteria is considered inexperienced (Tab BB-36). A newly qualified F-15C pilot with no prior fighter aircraft experience would require a 4-ship flight lead certification and 250 F-15C/D sorties to be considered experienced (Tab BB-36).

j. P5 Pod Data

The P5 pod provides basic aircraft trajectory information, independent of onboard aircraft data. Given the MA attitude information, the roll, pitch, and yaw rates are estimated using mathematical calculations (Tab J-113).

4. SEQUENCE OF EVENTS

a. Mission

The mishap sortie (MS) was scheduled and authorized by the 493 FS Operations Supervisor (TOP3) on Monday, 15 June 2020, as a 4-ship flight lead upgrade (4FLUG) certification sortie for the mishap formation lead (MFL) (Tabs R-120 to R-121 and AA-5). The MP was assigned to the number four position in the mishap formation (MF) (Tabs K-3, R-115 and AA-5). The MS involved nine F-15C and one F-15D aircraft, four of which were planned as "Blue Air" (MF) conducting DCA operations and six that were planned as adversary training aids (also known as "Red Air") (Tab AA-5). Additionally, a contractor-operated Dassault Falcon 20 supplemented Red Air as an electronic attack (EA) platform, while Her Majesty's Ship (HMS) Queen Elizabeth was the simulated defended asset and performed command and control (C2) for the Blue Air forces (Tab R-121, R-141, R-164 and CC-11 to CC-14). The MS was executed over the North Sea in the

EGD-323 Managed Danger Area (MDA) airspace, approximately 75 NM north of RAF Lakenheath, UK (Tabs R-141 and Z-31).

b. Planning

During the preceding week and day before the MS, the MFL completed mission planning and coordination with the RTO (Tab V-7. 2, V-7.6 and V-7.10).

On the morning of the MS, a pilot scheduled to fly in the Blue Air flight notified the TOP3 of an illness (Tab R-115). At approximately 0545L, the TOP3 replaced the ill pilot with the MP, which reassigned the MP from the Red Air flight to the number 4 position in the Blue Air flight, followed by a return to base (RTB), refueling in the MA, and a second sortie (Tabs K-3, R-115, and V-8.2).

Prior to 0630L, the MFL and adversary pilot 1 (AP1) completed Operational Risk Management (ORM) worksheets, which are standardized checklists identifying common risk factors for a sortie (Tabs V-7.4, V-17.3, EE-3 and EE-5). As cumulative risk increases, the level of the authority required to approve the mission profile also increases (Tab EE-3 and EE-5). Both flight leads calculated a low level of risk for the MS (Tab EE-3 and EE-5).

At 0630L, the MFL conducted a coordination brief attended by MF pilots and the Red Air pilots (Tab R-115, R-121 to R-123). The Squadron Commander was the instructor pilot (IP) for the MFL and flew as the number 2 position in the MF (Tab R-116 and R-120 to R-121). The Blue RTO (RTO1) and Red RTO (RTO2) did not attend the coordination brief, but were briefed by the MFL prior to the coordination brief (Tab V-5.2, V-6.2, and V-7.2). The coordination brief covered weather, TRs, special instructions (SPINs), and other routine items IAW AFI 11-214, *Air Operations Rules and Procedures*, dated 14 August 2012, incorporating Change 1, dated 23 March 2016 (Tabs F-3 to F-39, R-121 to R-123, and BB-36). IMC Rules were discussed during the TRs phase of the briefing. (Tab V-7.4, V-16.2, and V-18.3). Following the coordination brief, the MFL conducted a brief covering mission tactics with only Blue Air pilots present (Tab V-7.3 to V-7.4, V-16.2, V-17.2, and V-18.3). Afterwards, the IP briefed the MP on topics covering the Basic Fighter Maneuvers (BFM) flight scheduled following the RTB and refueling operations (Tab V-18.3).

c. Preflight

After the flight briefings, the MF assembled at the 493 FS operations desk and received an update from the TOP3 prior to proceeding to their assigned aircraft (Tab V-7.4 to V-7.7, V-8.2 to V-8.4, V-16.2 to V-16.3, and V-18.3 to V-18.4). During this brief, the TOP3 assigned the MF their aircraft, provided updated local and airspace weather (see Section 7), and reviewed the MF's ORM worksheet (Tabs F-5, V-7.4 to V-7.7, V-8.2 to V-8.4, V-16.2 to V-16.3, and V-18.3 to V-18.4). Due to discussions with the maintenance Production Superintendent (PS) regarding taxiway construction in the vicinity of the MF's aircraft, the MF proceeded to the aircraft three to four minutes late (Tab R-123). The MA was configured with air-to-air training missiles, two external fuel tanks, and an ACMI telemetry pod (Tabs K-3, AA-5 and AA-9). The MF did not experience any abnormalities during engine start (Tab R-122 to R-124).

d. Summary of Accident

The MF taxied, took off at 0847L, and departed to the airspace, encountering an overcast layer of clouds from 500ft to 1,500ft (Tabs R-122 to R-124, and AA-3). When established in the training airspace, the MF performed a G-force awareness exercise, a maneuver designed to heighten pilot awareness of G-forces and test related aircraft systems (Tabs R-124 and BB-10). The MFL directed the IP to perform a weather check (see Section 7) and obtained a weather observation from the Red Air flight lead (Tabs K-3, R-116, R-123, R-125, and AA-5). Due to clouds throughout the airspace, the MFL declared over the Blue Air radio channel, "UNLIMITED, Clear of Clouds, IMC Rules, [Altimeter] 29.88," which established the type of maneuvering category to be used IAW the Air-to-Air TRs (Tabs R-116, R-123, R-135, and BB-18). In this case, aircraft in the MS operated with the UNLIMITED category (no maneuvering limitations above 5,000ft) while in VMC, and they operated using IMC Rules when in IMC (Tab BB-18).

Tactical execution of the mission began at 0915L (Tab R-161). The following events are summarized at the end of Section 4e in Figure 12 and Table 1.

At 0925:47L (Figure 1), the MF and Red Air flight converged within 10 NM of each other, requiring a transition to more restrictive maneuvering for aircraft operating in IMC, IAW the TRs (Tabs L-3, Z-19, and BB-18). Separation between the MF and Red Air flight remained less than 10 NM throughout the mishap sequence (Tabs L-3, Z-19, and Z-35).

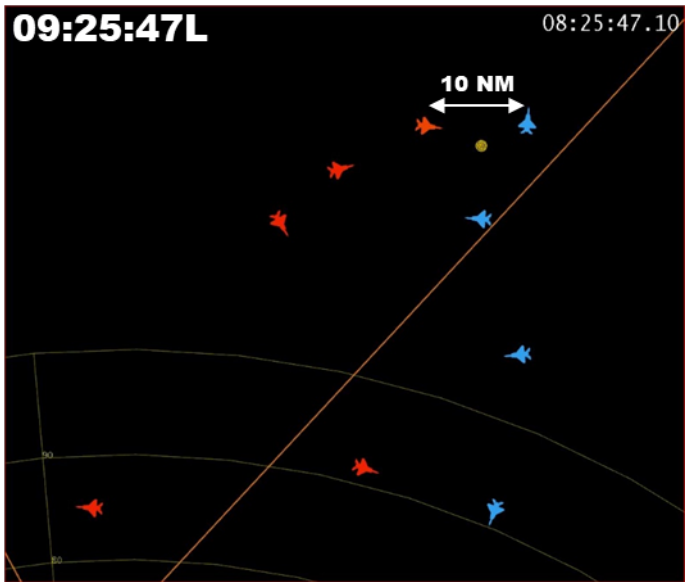

Figure 1 – 0925:47L, MF and adversaries less than 10 NM (Tabs L-3 and Z-19).

At 0926:15L, the mishap element lead (MEL) directed the MP to execute a hard right turn back to the west and look for an AA at a lower altitude (Tab DD-8 and DD-15).

At 0926:20L, the MP was at 20,300ft heading southeast (125°) as the MP initiated a right turn to engage the AA, located 18.5 NM to the west at 5,000ft (Tabs L-3, Z-29, and Z-35). The MP descended below 20,000ft mid-turn, and stabilized on westbound heading (267°) at 17,100ft and 560 knots true airspeed (KTAS) (Tabs L-3, S-20, and Z-33).

At 0926:51L (Figure 2), the MP fired a simulated air-to-air missile against the AA and made a radio call to inform RTO1 and the other pilots in the MF (Tab DD-8).

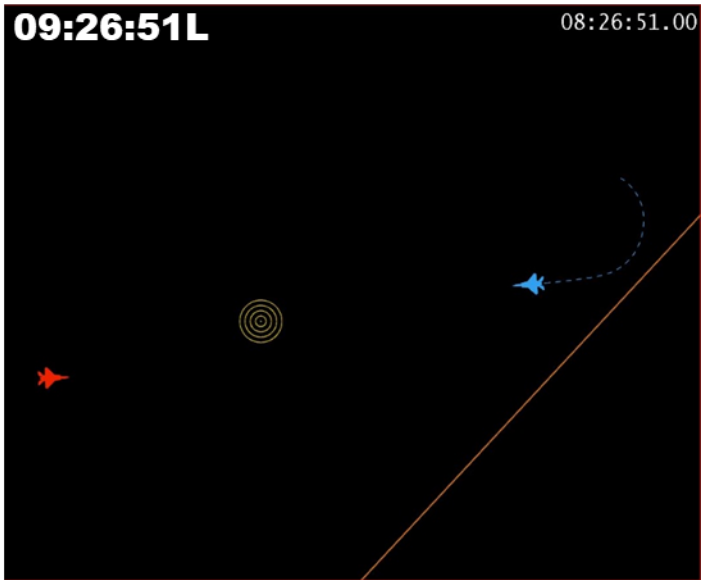

Figure 2 – 0926:51L, MP simulated missile employment on AA
(Tabs L-3, Z-21, DD-8, and DD-15).

At 0926:57L, the MP turned further right to a northwest (300°) heading, and then continued descending (Tabs L-3 and S-20).

At 0927:01L (Figure 3), the MA reached a maximum bank angle of 94°, maximum pitch of 17° nose-down, and descent rate of 16,000 feet per minute (fpm) at 530 KTAS (Tabs L-3 and S-20). Passing 14,000ft, the MP initiated a left turn (to the west) and reduced the descent rate to 7,200 fpm (Tabs L-3 and S-20).

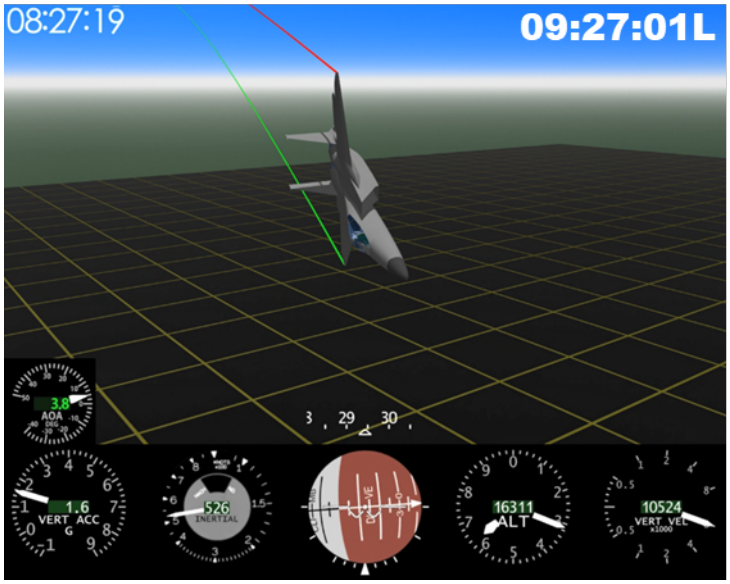

Figure 3 – 0927:01L, MA in maneuver to the northwest (Tabs S-20 and Z-3).

At 0927:14L, the MP made a radio transmission informing RTO1 of the simulated missile kill of the AA (Tabs R-126, DD-8, and DD-15).

At 0927:21L (Figure 4), RTO1 responded to the MP with "P_k miss" (Probability of Kill: Miss), indicating that the simulated missile did not kill the AA (Tabs R-126, DD-8, and DD-15).

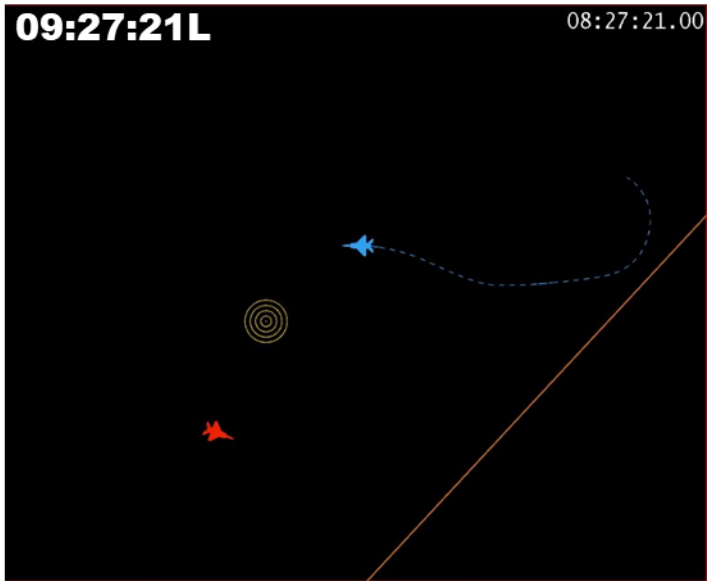

Figure 4 – 0927:21L, MA at the "P_k miss" radio transmission.
(Tabs L-3, R-126, Z-23, and DD-8).

At 0927:23L (Figure 5), the MP began a roll to the left in the direction of the AA, which was 5.5 NM to the southwest (Tabs L-3, S-20, and Z-35). The MP was heading west (267°) at 12,000ft, 507 KTAS, with 107° of left bank, 17° of nose-down pitch, and descending at 15,800 fpm (Tabs L-3, S-20, and Z-35). Other aircraft in the MF had pilot-programmable altitude warnings set for the 10,000ft to 12,500ft range (Tab V-7.3, V-16.2, 17.2, and V-18.3); it is unknown at what altitude the MP set the warning during the MS.

Figure 5 – 0927:23L, MA rolled 107° left (Tabs S-20 and Z-5).

From 0927:24-0927:29L (Figure 6), the MP stopped the turn, reduced the bank angle to 21°, and decreased the G-forces to 0.3 to 0.8 (Tabs L-3, S-20, and Z-35). During this time, the pitch attitude lowered to 25° nose-down, descent rate increased to 22,800 fpm, airspeed increased to 520 KTAS, and the MA descended through 10,200ft (Tabs L-3, S-20, and Z-35).

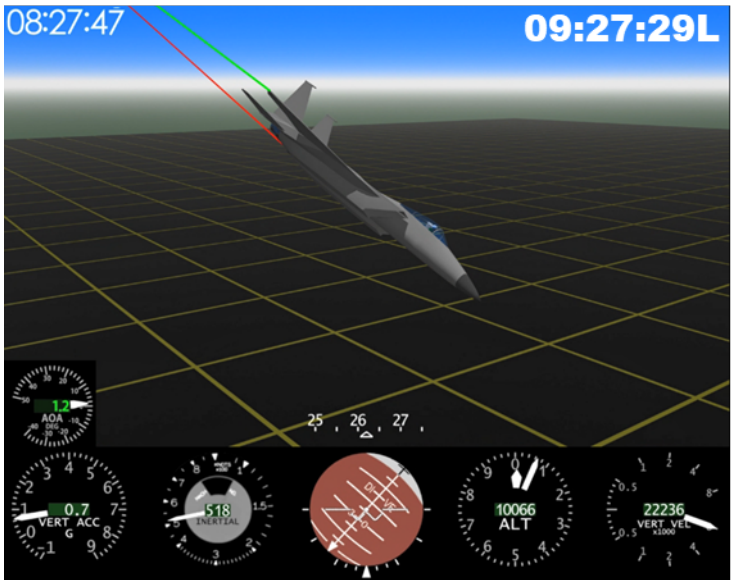

Figure 6 – 0927:29L, MA at the end of G-unload maneuver (Tabs S-20, Z-7, and Z-35).

At 0927:29L, the MP increased G-forces and resumed the turn in the direction of the AA. (Tabs L-3, S-20, and Z-35). The bank angle was initially increased to 107° then slowly reduced, the pitch attitude lowered to 42° nose-down, and the MA's airspeed and descent rate increased (Figure 7) (Tabs L-3, S-20, and Z-35). The MP sustained between 1.1 and 3.8 G-forces from this point until 0927:45L (Tabs L-3, S-20, and Z-35).

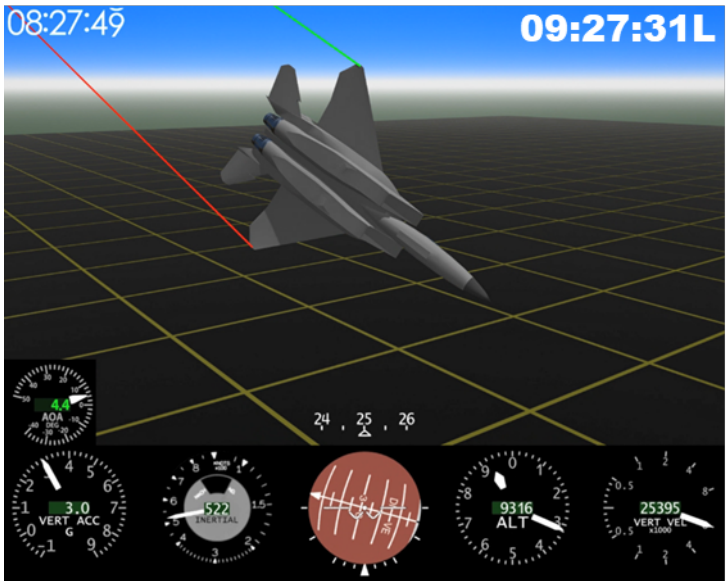

Figure 7 – 0927:31L, MA established in maximum bank (107°) after resuming turn. (Tabs S-20, Z-9 and Z-35).

At 0927:39L, the MA crossed the Transition Altitude (TA) of 5,000ft (Tabs L-3, S-20, Z-11, and Z-35). The TA was the minimum altitude allowed by the TRs for unlimited maneuvering in VMC and coincided with the minimum altitude for operating in IMC for the MS (Tabs V-16.2, V-17.4, and BB-21).

At 0927:40L (Figure 8), the MA breached the 4,000ft training floor (Tabs L-3, S-20, and Z-35). The training floor was the minimum altitude established in the SPINs and coordination brief for tactical execution during the MS (Tabs V-16.2, V-17.4, and AA-7). At the training floor, the MA was heading southwest (205°), 566 KTAS, with 52° of left bank, 41° of nose-down pitch, and descending at 38,800 fpm (Tabs L-3, S-20, and Z-35).

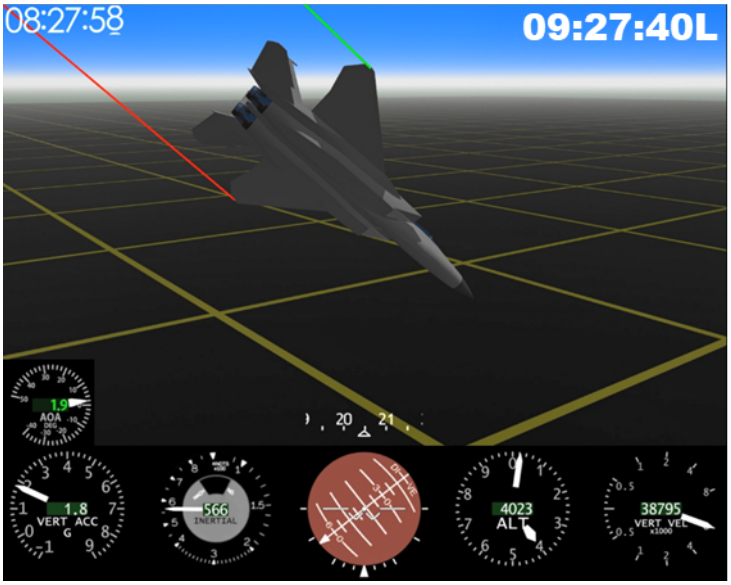

Figure 8 – 0927:40, MA breached the 4,000ft training floor (Tabs S-20, Z-13, and Z-35).

At 0927:45L (Figure 9), passing 1,000ft the MP abruptly reduced bank and pitch angles and rapidly increased G-forces to 8.2 (Tabs S-20 and Z-35). The MA was heading south (182°), 579 KTAS, with 40° of left bank, 31° of nose-down pitch, and descending at 33,300 fpm (Tabs J-114, L-3, S-20, and Z-35).

Figure 9 – 0927:45, MP rapidly reduced bank and pitch (Tabs S-20, Z-15, and Z-35).

Parametric data indicate a sudden decrease in G-forces during the last 0.7 seconds of flight which was inconsistent with the other parameters (Tab J-121). This decrease in G-forces with the pitch and bank attitude of the MA at this moment should have coincided with a cessation of pitch angle reduction, airspeed stabilizing or increasing, and descent rate stabilizing or increasing. Rather, during this same period the pitch angle was reduced from 19° to 10° down, bank angle was decreased by 10°, airspeed decreased 9 KTAS, and the descent rate decreased by at least 4,000 fpm, all of which are indicative of positive control inputs by the MP up until the moment of impact (Tabs J-121 to J-123, L-3, S-20, and Z-35).

e. Impact

At 0927:47L (Figures 10 and 11), the MA impacted the water at 054°21.7'N, 001°40.5'E, heading south (178°), 566 KTAS, with 4° of left bank, 10° of nose-down pitch, and descent rate of 17,300 fpm (Tabs L-3, J-34, and Z-35).

Figure 10 – 0927:47, MA attitude at impact (Tabs S-20, Z-17, and Z-35).

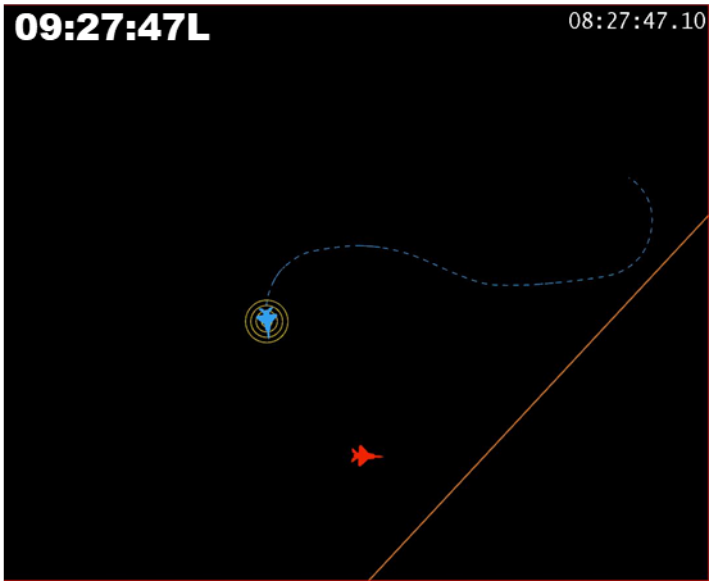

Figure 11 – Final position of MA at impact (Tabs L-3, Z-25, and Z-35).

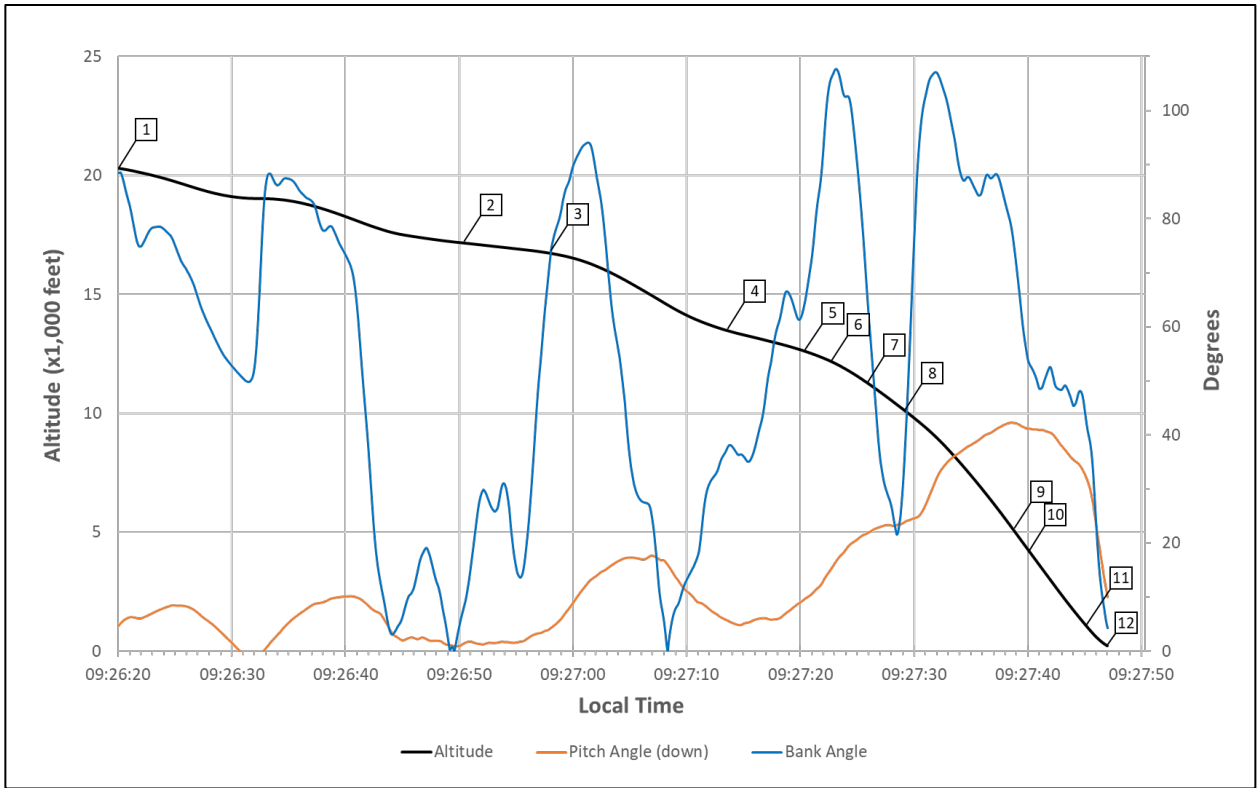

Figure 12 – Altitude, pitch, and bank over time (Tabs L-3, Z-27, and Z-35).
See Table 1 for Event Index.

Index	Time (L)	ICADS (ZULU)	GPS Time	Event
	09:25:47	08:25:47	08:26:05	MF & Red Air less than 10 NM separation
1	09:26:20	08:26:20	08:26:38	MP initiated right turn to west
2	09:26:51	08:26:51	08:27:09	MP simulated missile employment on AA
3	09:26:57	08:26:57	08:27:15	MP rolled right to 94° bank
4	09:27:14	08:27:14	08:27:32	MP transmitted simulated missile kill
5	09:27:21	08:27:21	08:27:39	RTO1 transmitted, "$P_k$miss," simulated missile miss
6	09:27:23	08:27:23	08:27:41	MP rolled left to 107° bank
7	09:27:24	08:27:24	08:27:42	MP reduced bank angle & G-forces
8	09:27:29	08:27:29	08:27:47	MP resumed turn to south, increased pitch & bank
9	09:27:39	08:27:39	08:27:57	MA crossed TA of 5,000ft
10	09:27:40	08:27:40	08:27:58	MA breached training floor of 4,000ft
11	09:27:45	08:27:45	08:28:03	MP rapidly reduced pitch attitude & bank angle
12	09:27:47	08:27:47	08:28:05	MA impacted the water
	09:29:15	08:29:15	08:29:33	"Knock-It-Off" transmitted on Blue Air C2 frequency

Table 1 – Event Index. The event index corresponds to the callouts in Figure 12.
The ICADS and Global Positioning System (GPS) times reflect the source time for the 2D and 3D animations, respectively (Tabs L-3, S-20, Z-35, and DD-8 to DD-15).

f. Egress and Aircrew Flight Equipment (AFE)

All flight and survival equipment had current inspections, and a preflight was conducted by AFE personnel (Tab FF-3, FF-5, and F-10 to F-19). The post-flight condition of AFE recovered was severely damaged and significantly fragmented (Tabs J-34 to J-112, and S-11). The emergency beacon was not recovered, though a portion of the battery was retrieved from the ocean floor (Tab J-101). Transmissions from the emergency beacon were not heard by other aircraft on the MS (Tab R-128).

There is no evidence that the ejection sequence was initiated (Tabs J-114 and X-3). With 31° of nose-down pitch at 579 KTAS, the F-15C Flight Manual states that the Advanced Concept Ejection Seat (ACES) II would have required at least 1,700ft of altitude to complete the ejection sequence with minimum terrain clearance (Tab BB-5). At 0927:45L, the MA passed 1,000ft with the aforementioned parameters then suddenly reduced bank angle and pitch attitude, actions indicating a recovery attempt (Tabs J-114, L-3, S-20, and Z-35). At this time, if the MP had attempted to eject instead of recover the MA, the MP could not have successfully ejected due to the low altitude (Tab BB-5).

g. Search and Rescue (SAR)

The MA crashed at 0927:47L, and tactical execution briefly continued on the MS (Tab DD-9 and DD-15). Multiple members of the MF attempted to contact the MP on several radio frequencies. (Tab DD-9 and DD-15). At 0929:15L, the IP initiated the "Knock-it-off" call following no response from the MP (Tab DD-9 and DD-15). The "Knock-it-off" call signifies the end of tactical execution and ends the overall training scenario when safety of flight is a factor or the desired learning objectives are either met or are unattainable (Tab BB-10). The MF, with the assistance of RTO1 and C2, used onboard and off-board sensors to search for the MA, initially suspecting the MA may have had an electrical or other systems issue (Tabs R-127, and DD-9 to DD-12). The MEL attempted to descend below the weather but was unable to do so (see Section 7) (Tab R-137).

At 0934L, the MFL contacted the Supervisor of Flying (SOF1) to initiate the SAR operation. (Tab DD-12 and DD-15). Multiple forces were launched or coordinated to assist in SAR activities, including F-15Es, KC-135s, a RAF E-3D, Royal Navy (RN) surface vessels, and Her Majesty's Coast Guard (HMCG) helicopters (Tabs R-255, R-260, and GG-3). Poor low-level weather in the search area hampered the airborne SAR efforts (Tabs R-255, V-16.3 to V-16.6, and V-17.5 to V-17.6). At approximately 1135L, aircraft were able to locate an oil slick and the MP's shredded life raft (Tabs R-255, R-260, and S-3 to S-9). Over the subsequent hours, RN surface vessels recovered items from a stationary debris field that included the MP's survival kit and unopened parachute (Tabs R-255, R-260, and GG-3).

h. Recovery of Remains

Preliminary search and recovery was conducted by the RN at the surface debris field (Tab S-5 to S-19). On 15 June 2020 at 1441L, the RN recovered human remains within the debris field. (Tab GG-3). Subsequent search and salvage operations were conducted by contracted vessels and Mobile Diving and Salvage Unit (MDSU) 2 at the underwater debris field from 7 July 2020 to

16 July 2020 (Tab J-31 to J-32 and J-34 to J-112). The complete debris field was approximately 242 by 631 meters (Tab J-31 to J-32). Remotely Operated Vehicle (ROV) operations positively identified the debris field as wreckage from the MA (Tab J-31 to J-32). An ROV passed over the entire debris field to visually identify and recover any components that could be recognized and potentially useful for any area of investigation (Tab J-31 to J-32). The ROV visually verified a target, marked the location, and then it was recovered by either use of the ROV mechanical arms or MDSU divers aboard the vessel (Tab J-31 to J-32).

The following list is not exhaustive in nature, but is provided to show what types of items were recovered: all primary flight control actuators, multiple sections of avionics boxes, various egress components including the drogue chute, drogue gun, life raft, sections of AFE, the aircraft Digital Video Recorder Removable Memory Module (RMM), various hydraulic components, aircraft structure and canopy glass pieces, captive air training missile sections, and select cockpit gauges and displays (Tab J-32). The Flight Data Recorder (FDR) was not recovered (Tab J-32).

5. MAINTENANCE

The AIB, having reviewed and analyzed all pertinent maintenance records of the MA, found no evidence that improper maintenance was a factor in this mishap.

a. Maintenance Documentation

Collectively, the Air Force Technical Order (AFTO) 781-series of forms capture maintenance actions (both scheduled and unscheduled), inspections, servicing, configuration, current status, and flight activities for an aircraft (Tab BB-43 to BB-44).

The Integrated Maintenance Data System (IMDS) is an electronic database used to track the AFTO 781-series forms, as well as to schedule future maintenance, and serves as a historical record of maintenance actions for an aircraft (Tab BB-45 to BB-46).

Review of the MA's AFTO 781 forms and IMDS revealed no overdue inspections or open Time Compliance Technical Orders, which are time-based maintenance actions, that would have prohibited the MA's flight operations on the day of the MS (Tab D-5 to D-26). All required maintenance actions were completed IAW AFTO 00-20-1, *Aerospace Equipment Maintenance Inspection*, *Documentation, Policies, and Procedures,* dated 1 June 2018, and evidence revealed there were no recurring maintenance problems (Tabs D-5 to D-26, U-15 to U-28, and U-31 to U-66).

b. Inspections

Although not an inspection, it should be noted the MA was in the Cannibalization Program (CANN) from 18 February 2020 to 1 May 2020, meaning that it was in a non-flying status and could be used as a source for aircraft parts (Tabs U-43 to U-46, BB-47, and BB-51 to BB-52). The MA was removed from CANN and rebuilt 45 days prior to the MS (Tab U-31 to U-34 and U-46 to U-47). The AIB reviewed all CANN and rebuild maintenance actions and found nothing of concern (Tab U-31 to U-34 and U-55 to U-62). During the 45 days of flight operations

immediately after CANN rebuild and prior to the MS, there were no maintenance actions performed on any component that was replaced while the MA was in CANN status (Tab U-5 to U-10 and U-55 to U-62). No evidence indicated any CANN actions contributed to the mishap.

The MA's last flight immediately prior to the MS was on 10 June 2020 (Julian Date: 20162) (Tab U-5). After that flight, maintenance personnel (MX) 1 performed a combined post-flight/pre-flight inspection the same day and found no discrepancies (Tab D-5 to D-16). A pre-flight inspection is valid for no more than 72 hours (Tab U-29 to U-30). A subsequent preflight inspection was accomplished on 15 June 2020 by MX2 with two hydraulic servicing discrepancies noted (Tab D-11 to D-12 and D-15). Both discrepancies were corrected and all other servicing data were verified to be correct during the electrical power-on operational check (Tabs D-5 to D-16 and U-55 to U-62). All required maintenance actions were completed by properly trained and certified technicians IAW applicable technical data (Tabs D-5 to D-26, U-3, and U-55 to U-62).

c. Maintenance Procedures

All of the MA's forms and IMDS history showed maintenance was conducted IAW applicable Technical Orders (Tabs D-5 to D-26 and U-49 to U-62). No evidence indicated any local maintenance procedures contributed to the mishap.

d. Maintenance Personnel and Supervision

The MA was maintained by members of the 48th Aircraft Maintenance Squadron (AMXS) / 493rd Aircraft Maintenance Unit (AMU) (Tab R-169). Maintenance training records showed that all personnel who worked on the MA were fully qualified and had the appropriate level of experience, to include all pre-flight servicing actions (Tab U-3). No evidence indicated that local maintenance personnel or supervision contributed to the mishap.

e. Fuel, Hydraulic, Oil, and Oxygen Inspection Analyses

Post-mishap analysis of onboard fuel, oil, and oxygen was not possible due to the nature of the mishap and the environment of recovery actions (Tab J-31 to J-112). The Air Force Petroleum Office (AFPET) completed analysis of oil, hydraulic fluid, and liquid oxygen taken from the servicing equipment used on the MA with results testing normal and/or within applicable technical standards (Tabs D-27 to D-30 and U-11 to U-14).

f. Unscheduled Maintenance

The MA flew 16 complete sorties over the 45-day period from its rebuild after its time in CANN status to the date of the MS (Tab U-5 to U-8). During this period, the MA completed 15 sorties with zero or minor aircraft or system discrepancies and remained mission capable (MC) (Tab U-5 to U-10 and U-63 to U-66). Additionally, there were no discrepancies associated with aircraft flight controls or cockpit instrumentation during this time, indicating flight controls and instruments were functional within normal operating parameters (Tab U-5 to U-10 and U-53 to U-62). On the last flight prior to the MS, 10 June 2020, the pilot of the MA reported a major discrepancy in mission essential equipment (left bleed air light illuminated in airspace) (Tab U-5 and U-15 to U-16). That discrepancy was troubleshot by qualified technicians, corrected, and

passed required tests prior to the MS (Tabs R-167 to R-173, U-3 to U-10, U-15 to U-16, and U-55 to U-62). There is no evidence to suggest unscheduled maintenance was a factor in this mishap.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

On the day of the MS, the MA was fully MC with no discrepancies affecting safety of flight or performance capability (Tabs D-5 to D-22, R-167 to R-184, and R-201 to R-218).

The MA crashed in the North Sea at a high rate of speed resulting in complete destruction with a majority of the wreckage unrecovered from the ocean floor (Tabs D-3 and J-31 to J-112). Relevant structures were unavailable (Tabs D-3 and J-31 to J-112).

b. Evaluation and Analysis

Engineering analysis, in addition to evaluation of the P5 pod data by the F-15 Systems Program Office (SPO) indicate MA trajectory was in line with intentional MP flight control inputs. (Tab J-113 to J-123). There is no evidence of aircraft malfunction or component failure and the data appear consistent with basic aircraft maneuvering; there is no evidence to suggest aircraft equipment was not functioning as intended (Tab J-113 to J-123).

7. WEATHER

a. Forecast Weather

RAF Lakenheath weather forecast for the MP's initial takeoff at 0830L was northeast winds (040°) at 9 knots, 9 kilometers visibility with mist, and an overcast ceiling at 500ft above ground level (Tab F-5).

The forecasted weather in the EGD-323 MDA airspace was northwest winds (290º) at 9 knots, unrestricted visibility, broken clouds from 7,000ft to 25,000ft, and scattered clouds from 25,000ft to 28,000ft (Tab F-5).

b. Observed Weather

RAF Lakenheath departure weather observed by the IP was overcast clouds from 500ft to 1,500ft, then clear of clouds above until reaching the EGD-323 MDA (Tab R-122).

At 0909L, prior to tactical mission execution, the IP performed a check of the EGD-323 MDA airspace weather approximately 20 NM south of the crash site (Tabs R-122 and HH-3). The IP reported a little bit of haze, 10 NM visibility, and "not the best horizon" from 5,000ft to between 10,000ft and 14,000ft; broken to overcast cloud layers starting between 10,000ft and 14,000ft continuing up to 20,000ft; a thick layer of clouds from 20,000ft to 25,000ft; and clear of clouds above 25,000ft (Tab R-122).

At 0927L, at the time of the mishap, the adversary pilot (AP1) was 5.5 NM south of the crash site at 5,500ft and reported low-level clouds below as well as clouds above the aircraft, precipitation, greater than 5 NM visibility, and no discernible horizon to the north or east (Tabs V-17.4 to V-17.6, Z-25, and Z-35). AP1 reported that the weather to the northeast and east appeared to be progressively worse (Tab V-17.4 to V-17.6). Additionally, AP1 descended down to 2,000ft and was unable to make visual contact with the surface (Tab V-17.4 to V-17. 6).

At 0934L, during SAR operations, the MEL descended westbound from 20,000ft to 1,000ft, following the approximate path of the MA (Tabs V-16.3 to V-16.6, DD-10 to DD-12, and DD-15). The MEL reported overcast clouds from less than 1,000ft to between 4,000ft and 5,000ft; clear of clouds with a difficult to discern horizon between 4,000ft and 5,000ft up to between 8,000ft and 9,000ft; overcast from between 8,000ft and 9,000ft up to 14,000ft; and clear of clouds from 14,000ft to 20,000ft. (Tab V-16.3 to V-16.6). The MEL was not able to make visual contact with the surface at 1,000ft in vicinity of the crash site (Tab V-16.3 to V-16.6).

c. Space Environment

The effect of space weather on GPS, ultra high frequency (UHF), and high frequency communications was negligible (Tab F-4).

d. Operations

Review of the applicable weather data did not disclose any weather phenomena that met or exceeded any operational limitation for the MA, the MP, or the MF (Tabs F-3 to F-17, R-122).

8. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was an inexperienced F-15C pilot that had 270.7 total military flying hours on the date of the MS, including 64.3 hours in the F-15C/D and 151.7 F-15C simulator hours (Tab G-9 to G-10). MP's recent flying hours are reflected below in Table 2 (Tab G-5, and G-9 to G-12). The MP had a current instrument qualification evaluation AF Form 8, Certificate of Aircrew Qualification, flying evaluation completed 16 August 2019 (Tab G-16 to G-17). The MP also had a current mission qualification evaluation AF Form 8, Certificate of Aircrew Qualification, flying evaluation completed 20 May 2020 (Tab G-14 to G-15).

The MP recently graduated from the F-15C FTU on 17 January 2020 and qualified as an F-15C wingman on 20 May 2020 after completing Mission Qualification Training (MQT) (Tabs G-14 to G-15, and T-3). The MP received high marks for performance in the FTU and had slightly above average gradesheet reports in MQT (Tabs G-21 to G-39, and T-3). In the squadron, the MP had a reputation as a hard worker who exerted significant effort studying and preparing for missions (Tab V-1.2 and V-9.3).

The MP received training in the FTU regarding execution using IMC Rules (Tab T-37 to T-39). The MP completed at least one sortie on which IMC Rules were used, and execution in actual IMC

occurred on that sortie (Tab T-37 to T-39). During MQT, the MP received specific training regarding tactical intercepts in IMC (Tabs G-29, V-8.5, V-18.6, and T-13).

	Hours	Sorties
30 days	8.4	8
60 days	15.0	14
90 days	17.5	16

Table 2 – MP's recent flying hours (30/60/90-day look-back) (Tab G-5, and G-9 to G-12).

9. MEDICAL

a. Qualifications

At the time of mishap, the MP was medically qualified for flight duty with current DD Form 2992 (Tab X-5). A review of the MP's medical records, Aerospace Information Management System, and Aeromedical Information Management Waiver Tracking System did not show any discrepancies in the MP's health qualifications.

The MP was on Duty Not Involving Flying (DNIF) from 31 March 2020 to 6 April 2020 for a common illness, but the MP's condition had resolved well prior to the mishap (Tab X-6).

The MP's last flyer Preventive Health Assessment (PHA) was 13 November 2019 (Tab X-3). The MP's responses to the PHA questionnaire were unremarkable, raised no medical concerns and the MP was cleared after his required annual flight duty medical examination (Tab X-3 and X-7).

b. Health

The MP's outpatient medical and dental records were reviewed (Tab X-3). The AIB identified no significant health issues (Tab X-3).

The AIB considered acceleration-induced loss of consciousness as the MP momentarily attained 8.2 G-forces 0.7 seconds prior to impact (Tab L-3). A comprehensive study on healthy individuals demonstrated that a minimum of 5 seconds from rapid acceleration to 9 G-forces are needed to lose consciousness (Tab X-11 to X-12).

c. Pathology

The MP's remains were transported to Dover Air Force Base (AFB) where the department of the Armed Forces Medical Examiner System (AFMES) conducted an autopsy (Tab X-3). The cause of death was an accident due to impact (Tab X-3). The AFMES Forensic Toxicology Laboratory performed toxicology tests for alcohol, common drugs, and carbon monoxide. All test results were negative (Tab X-3).

d. Lifestyle

Based upon interviews with friends and coworkers, there was no evidence to suggest lifestyle factors played a role in the mishap (Tab V-1.2 to V-1.3, V-3.2 to V-3.3, and V-9.2 to V-9.4).

e. Crew Rest and Crew Duty Time

Crew rest is compulsory for aircrew members prior to performing any duties involving aircraft operations and is a minimum of 12 non-duty hours before the Flight Duty Period begins. (Tab BB-42). Crew rest is free time and includes time for meals, transportation, and rest. This time must include an opportunity for at least 8 hours of uninterrupted sleep (Tab BB-42). Crew rest period cannot begin until after the completion of official duties (Tab BB-42). The AIB found no evidence that the MP was not afforded adequate crew rest prior to the mishap flight.

Maintenance members are limited to no more than 12 hours of continuous duty in a 24-hour period with the opportunity for 8 hours of uninterrupted sleep within that 24-hour period. (Tab BB-40).

A review of the 72-hour and 7-day histories for the flying and maintenance crew found no violation of the duty-hour limitations (Tab X-9).

10. OPERATIONS AND SUPERVISION

a. Operations

On the day of the mishap, the 493 FS had 31 assigned and attached pilots (Tab G-3). Of those 31 pilots, 17 were defined as experienced and 14 as inexperienced (Tabs G-3, BB-36 to BB-37). To mitigate the risk of exposure to Coronavirus Disease 2019 (COVID-19), the squadron operated as two teams (Tab V-7.9). Every week, the teams alternated between flying and simulator operations (Tab V-5.4, V-6.3, V-7.9, V-8.6, V-16.4, and V-18.7). The pilot perception regarding readiness was that the increased simulator time honed tactical skills though the compressed flying schedule slightly atrophied certain muscle-memory actions, such as ground operations and communicating with air traffic control (ATC) (Tab V-5.4, V-6.3 to V-6.4, V-7.9, V-16.4, V-17.5, and V-18.7). The consensus amongst those interviewed was that the COVID-19 split-operations produced a level of readiness on par or better than operations prior to COVID-19 (Tab V-5.4, V-6.3 to V-6.4, V-7.9, V-16.4, V-17.5, and V-18.7). There is no evidence that operations tempo contributed to this mishap.

b. Supervision

The MS was led by a 2-ship flight lead executing a 4FLUG certification (Tabs G-3, R-121, and AA-5). The IP in the MF was an experienced F-15C Weapons Officer who was also the 493 FS Commander. (Tabs G-3 and AA-5).

The 493 FS TOP3, a qualified and experienced F-15C IP, oversaw flying operations for the squadron on the day of the mishap (Tab G-3). The squadron had an active ORM program, and the TOP3 reviewed the worksheets from the MF and Red Air formation (Tab EE-3 and EE-5). While some risk factors were not documented on the ORM worksheets, prior to proceeding to the aircraft, the TOP3 briefed both formations on aircraft assignments, weather, hot refueling operations, and the airfield status, encompassing items missed (Tabs V-8.3 to V-8.4, and EE-3 to EE-5). The ORM remained at the TOP3 approval level when the risk factors from both ORM worksheets were aggregated (Tabs V-7.4 to V-7.7, V-8.2 to V-8.4, V-17.3, V-18.3, and EE-3 to EE-5).

The SOF1 was a qualified instructor in that duty position (Tab T-41). In the course of accomplishing the SOF mishap checklist, SOF2 was detailed to augment and assist SOF1. (Tabs R-259 to R-262, and T-41 to T-42).

There is no evidence that operations supervision contributed to this mishap.

11. HUMAN FACTORS ANALYSIS

a. Introduction

AFI 91-204_GM2020-01, *Safety Investigations and Hazard Reporting*, dated 27 April 2018, incorporating the most current Department of Defense (DoD) Human Factors Analysis and Classification System (HFACS), Version 7.0, establishes several potential human factors for assessment during a mishap investigation (Tab BB-27 to BB-32). Relevant factors are listed below.

b. PC102 Fixation

HFACS code PC102 is a factor when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others (Tab BB-31).

c. AE105 Breakdown in Visual Scan

HFACS code AE105 is a factor when the individual fails to effectively execute visual scan patterns (Tab BB-28).

d. PE101 Environmental Conditions Affecting Vision

HFACS code PE101 is a factor that includes obscured windows; weather, fog, haze, darkness; smoke, etc.; brownout/whiteout (dust, snow, water, ash or other particulates); or when exposure to windblast affects the individual's ability to perform required duties (Tab BB-29).

e. PC508 Spatial Disorientation

HFACS code PC508 is a factor when an individual fails to correctly sense a position, motion, or attitude of the aircraft/vehicle/vessel or of oneself. Spatial Disorientation may be unrecognized and/or result in partial or total incapacitation (Tab BB-30).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

- AFI 11-202, Volume 2, *Aircrew Standardization/Evaluation Program,* dated 6 December 2018.
- AFI 11-202, Volume 2, USAFE-AFAFRICASUP*, Aircrew Standardization/Evaluation Program*, dated 2 April 2019, corrective actions applied 18 May 2020.

- AFI 11-214, *Air Operations Rules and Procedures*, dated 14 August 2012, incorporating Change 1, 23 March 2016
- AFI 11-401, *Aviation Management,* dated 10 December 2010
- AFI 11-401, USAFESUP*, Aviation Management,* dated 18 December 2015
- AFI 11-401, LAKENHEATHSUP*, Aviation Management,* dated 27 October 2017
- AFI 11-418, *Operations Supervision,* dated 28 February 2020
- AFI 21-101, *Aircraft and Equipment Maintenance Management*, dated 16 January 2020
- AFI 51-307, *Aerospace and Ground Accident Investigations*, dated 18 April 2019, incorporating Air Force Guidance Memorandum 2020-01, dated 26 February 2020
- AFI 91-204, *Safety Investigation and Hazard Reporting*, dated 27 April 2018, incorporating Air Force Guidance Memorandum 2020-01, dated 7 July 2020
- AFMAN 11-202, Volume 1, *Aircrew Training,* dated 27 September 2019
- AFMAN 11-202, Volume 1, *USAFE-AFAFRICA Supplement, Aircrew Training,* dated 8 January 2020
- AFMAN 11-202, Volume 3, *Flight Operations,* dated 10 June 2020
- AFMAN 11-2F-15, Volume 1, *F-15 Aircrew Training*, dated 13 June 2019
- AFMAN 11-2F-15, Volume 2, *F-15 Aircrew Evaluation Criteria*, 2 November 2018
- AFMAN 11-2F-15, Volume 3, *F-15 Operations Procedures*, 18 September 2014
- AFMAN 13-212, Volume 1, *Range Planning and Operations*, dated 22 June 2018
- AFTO 00-20-1, *Aerospace Equipment Maintenance Inspection*, *Documentation, Policies, and Procedures*, dated 1 June 2018. (https://www.tinker.af.mil/Portals/106/Documents/Technical%20Orders/AFD-180615-00-20-1.pdf).
- AFTO 00-20-2, *Maintenance Data Documentation*, dated 15 March 2016. https://www.tinker.af.mil/Portals/106/Documents/Technical%20Orders/AFD-082216-00-20-2.pdf).
- DoD Human Factors Analysis and Classification System (HFACS) Version 7.0, dated 27 April 2018.
- LAKENHEATHI 11-2F-15, Volume 3, *Local Operating Procedures,* 3 February 2017
- USAFEI 11-201, *Flying Operations Conducted at USAF-Occupied Royal Air Force (RAF) Installations in the United Kingdom (UK)*, dated 29 January 2007, incorporating Change 2, 21 March 2012, certified current 20 June 2017

NOTICE: All directives and publications listed above are available digitally on the Air Force Departmental Publishing Office website at: http://www.e-publishing.af.mil, the Air Force Safety Center website at: https://www.safety.af.mil/Divisions/Human-Factors-Division/HFACS/, or the direct link immediately following the listed document.

b. Other Directives and Publications Relevant to the Mishap

- TO 1F-15A-1, *USAF Series F-15C/D Aircraft, Block 7 and up with Suite 6M and Suite 7C OFP*, dated 15 February 2009, incorporated Change 17, dated 10 August 2019

- TO 1F-15A-6WC-1, *Combined Preflight/Postflight Inspection USAF Series F-15C/D Aircraft*, dated 1 May 2007, incorporated Change 28, dated 28 February 2020.
- Air Force Tactics, Techniques, and Procedures 3-3.F-15C, *Combat Aircraft Fundamentals F-15C,* dated 6 November 2018
- 48 FW IFG, *Aircrew Aid – 48th Fighter Wing (EFB) In-Flight Guide*, dated 12 August 2020

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23 September 2020

DEAN A. TREMPS
Major General, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

F-15C, T/N 86-0176
RAF LAKENHEATH, UNITED KINGDOM
15 JUNE 2020

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

1. OPINION SUMMARY

This Accident Investigation Board (AIB) was conducted in accordance with (IAW) Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations*, dated 18 March 2019.

The mishap involving an F-15C, tail number (T/N) 86-0176, occurred at 0927 local time (L) on 15 June 2020. The mishap aircraft (MA) and mishap pilot (MP) were assigned to the 493rd Fighter Squadron (FS), 48th Fighter Wing (FW), Royal Air Force (RAF) Lakenheath, United Kingdom. The MP was the number four aircraft of a 4-ship flight, conducting a Defensive Counter Air (DCA) training sortie in the 48 FW's local airspace over the North Sea. The training scenario included five F-15C and one F-15D exercise adversary aircraft commonly referred to as "Red Air," also from the 493 FS.

The mishap sortie (MS) was planned and briefed without incident and had a valid flight authorization. There were no reported issues with aircraft pre-flight, taxi, takeoff, or departure. The weather in the airspace was reported to have multiple cloud layers up to 25,000 feet (ft), and thus the MS was conducted using Instrument Meteorological Conditions (IMC) Rules during the engagements, if IMC would be encountered. IMC Rules are designed to limit aircraft maneuvering and prescribe pitch and bank limits (15º pitch, 60º bank) while in IMC.

During the air-to-air engagement, the MP was flying east at an altitude of 20,300ft and was directed by his mishap element lead (MEL) to execute a hard right turn toward the west and look for an adversary aircraft (AA) at a lower altitude. The MP made a descending right turn toward the west, used his on-board radar to lock the AA (headed eastbound at 5,000ft less than 20 nautical miles (NM) away) and executed a simulated missile shot against the AA. The MP stabilized on approximately a westbound heading and continued his descent to 12,000ft at 507 knots true airspeed (KTAS). The MP made a radio transmission of his simulated missile kill of the AA. The MP received a "P_k miss" (Probability of Kill: Miss) radio transmission from the Range Training Officer (RTO1), so the MP entered a steep diving left turn to intercept the AA approximately 5 NM southwest of the MP's position. The MP sustained 0.3 to 3.8 gravitational (G) forces throughout the maneuver and accelerated to 579 KTAS, with a maximum vertical velocity of 38,800 feet per minute (fpm) descent. At 1,000ft, the MP maneuvered the MA to nearly wings-level and pulled 8.2 G-forces in an attempt to recover the MA above the water. The MA impacted the water at 10° pitch low, 4° of left bank and 566 KTAS. The MP did not eject from the MA.

2. CAUSE

I find, by a preponderance of the evidence, the cause of the mishap was the MP's fixation on his intercept of the AA and failure to execute cockpit instrument visual scans when he encountered IMC throughout the mishap sequence.

Based on testimony from other pilots in the vicinity, cloud layers were prevalent from 9,000ft to 14,000ft in addition to a cloud layer from 1,000ft to 4,000ft. With multiple layers of clouds in the airspace around the mishap area, testimony indicates the horizon was difficult if not impossible to discern below 9,000ft. After the MP received the "P_k miss" transmission from the RTO1, the MP was approximately 7,000ft above and 5.5 NM to the northeast of the AA. At 12,000ft, the MP immediately maneuvered toward the AA with an aggressive left bank of 107° and increased the pitch of the MA to 25° low, but then suddenly decreased the bank angle to 21° left bank, decreased G-forces to 0.3, however remained 25° pitch low. This maneuver strongly indicates the MP entered the IMC conditions and decreased his bank complying with the IMC Rules bank limitation of 60°, but neglected to adjust the MA low pitch attitude. It is evident the MP exited the clouds at 10,000ft when he continued his intercept and engagement of the AA by aggressively entering a left bank of 107°, increasing to 3.8 G-forces, while the MA pitch attitude lowered to 42°. As the MP approached the briefed training floor of 4,000ft with a left bank angle of 60°, the MA accelerated above 560 KTAS at 38,800 fpm descent. The MP's lack of awareness of accelerating downward through the briefed training floor of 4,000ft clearly indicates the MP fixated on acquiring the AA either visually or with his radar and did not monitor his aircraft altitude, airspeed and attitude cockpit instruments. As the MP exited the low cloud layer at approximately 1,000ft, with a visible horizon and "ground rush" of the rapidly approaching ocean, the MP immediately sensed his low pitch attitude and position and initiated a recovery attempt of the MA, but was unable to complete the recovery based upon the low altitude and speed of his descent.

It is my opinion, based on the weight of the evidence, the MP did not attempt to eject. Parametric data indicate a sudden decrease in G-forces during the last 0.7 seconds of flight inconsistent with the other parameters. This decrease in G-forces should have coincided with a cessation of pitch angle reduction, airspeed stabilizing or increasing, and descent rate stabilizing or increasing. However, during this same period the pitch angle was reduced from 19° to 10° down, bank angle was decreased by 10°, airspeed decreased 9 KTAS, and the descent rate decreased by at least 4,000 fpm, all of which indicate positive control inputs by the MP up until the moment of impact.

I considered and analyzed the possibility that the MP lost consciousness or an aircraft failure was the cause of the mishap; however, technical data clearly indicate the MA was responding to deliberate flight control inputs consistent with intent to intercept and shoot the AA until his recovery attempt. During the recovery attempt, the MA responded predictably to the MP's flight control inputs of roll and pitch changes thus indicating the MP was conscious, and there was no aircraft malfunction. Additionally, there were no discrepancies or malfunctions with cockpit instrumentation in previous maintenance inspections and flights preceding the MS; thus providing no evidence to indicate cockpit instruments were not functioning normally during the MS.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

I find, by a preponderance of the evidence, the airspace environmental conditions and subsequent spatial disorientation substantially contributed to the mishap.

Based on testimony of the weather conditions from the other pilots operating in the vicinity of the MP, I believe the MP exited the clouds at 10,000ft during his intercept of the AA, but the reduced visibility below the cloud layer and lack of discernible horizon resulted in the MP's spatial disorientation. Spatial disorientation occurs when an individual fails to correctly sense a position, motion, or attitude of the aircraft or oneself. Without a discernible horizon, the MP could not accurately sense the low pitch attitude of the MA and subsequent altitude loss. Spatial disorientation was unrecognized by the MP due to his failure to execute cockpit instrument visual scans during the mishap sequence. By aggressively maneuvering the aircraft with the lack of exterior visual references of the horizon, sky or ocean, the only way for the MP to recognize his spatial disorientation would have been for the MP to reference his cockpit instruments for pitch attitude and altitude indications.

The inability of the MP to correctly sense the pitch attitude of the MA due to spatial disorientation significantly contributed to the MA's undesirable low pitch, rapidly descending altitude and resulting mishap.

4. CONCLUSION

I find, by a preponderance of the evidence, the cause of the mishap was the MP's fixation on his intercept of the AA and failure to execute cockpit instrument visual scans when he encountered IMC throughout the mishap sequence.

I also find, by a preponderance of the evidence, airspace environmental conditions of reduced visibility and lack of a discernible horizon for the MP resulted in his spatial disorientation. The inability of the MP to accurately sense the pitch attitude of the MA due to spatial disorientation substantially contributed to the MA's undesirable low pitch, rapidly descending altitude and resulting mishap.

I developed my opinion after analyzing flight data; witness testimony; technical reports; audio and video recording; and AFIs, Directives, Manuals, and Technical Orders.

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23 September 2020

DEAN A. TREMPS
Major General, USAF
President, Accident Investigation Board

INDEX OF TABS