UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

F-16C, T/N 88-0549

80TH FIGHTER SQUADRON
8TH FIGTHER WING
KUNSAN AIR BASE

LOCATION: OSAN AIR BASE, SOUTH KOREA

DATE OF ACCIDENT: 6 MAY 2023

BOARD PRESIDENT: COLONEL LYNN E. SAVAGE

Conducted IAW Air Force Instruction 51-307

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

APR 1 9 2024

ACTION OF THE CONVENING AUTHORITY

The report of the Accident Investigation Board, conducted under the provisions of Air Force Instruction 51-307, *Aerospace and Ground Accident Investigations*, that investigated the 6 May 2023 Class A mishap occurring near Osan Air Base, South Korea, involving an F-16C, T/N 88-0549, assigned to the 80th Fighter Squadron, substantially complies with applicable regulatory and statutory guidance and on that basis is approved.

LAURA L. LENDERMAN
Lieutenant General, USAF
Commander, Pacific Air Forces

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

F-16C, T/N 88-0549
OSAN AIR BASE, SOUTH KOREA
6 MAY 2023

On 6 May 2023, the mishap pilot (MP), flying a F-16C, tail number (T/N) 88-0549, assigned to the 80th Fighter Squadron, "the Juvats," 8th Fighter Wing, Kunsan Air Base, South Korea, conducted a routine training sortie as part of the wing's local readiness exercise BEVERLY HERD. Two minutes and forty-one seconds after a 09:27 a.m. Korea Standard Time takeoff, the MP ejected from the mishap aircraft (MA) with minor injuries. The MA was destroyed upon impact in an agricultural field at approximately 09:30 a.m. Korean Standard Time, 8 nautical miles (nm) south of Osan Air Base. The mishap resulted in the loss of a $29,387,925.00 United States government asset.

The mishap flight was planned and authorized as a training mission within the local training airspace. The MP was flying as the second aircraft in a 4-ship formation. The prevailing weather at the airfield, and in the surrounding area, was clouds obscuring the horizon beginning at 1,400 feet up to 17,000 feet. While in the clouds, approximately 11 seconds after takeoff, a partial electrical power loss resulted in an inaccurate horizon, or attitude, information being indicated by the MP's flying instruments with no failure indications. As such, the MP was unable to tell where the horizon was located. The subsequent degradation and mismatch in data between the primary and standby horizon indicator instruments caused the pilot to become spatially disoriented and he ended up flying inadvertently to a very low altitude. The MP descended to 720 feet mean sea level where he did not have enough altitude to recover the aircraft without crashing into the ground, and chose to eject, which was successfully accomplished at 710 feet above ground level.

The Accident Investigation Board President found, by a preponderance of the evidence, the cause of the mishap was the combination of two factors. First, the MA experienced a partial electrical power loss. The power loss caused a cascading failure of the MP's primary flight and navigation instruments. The primary horizon direction indicator continued to respond to the MP flying inputs but displayed unreliable and inaccurate data without failure indications and interrupted the MP from transitioning fully to the standby horizon indicator for horizon reference. Second, the weather conditions at the time of the power disruption cause the MP to solely rely on his primary and standby flight instruments to maintain aircraft control during a critical phase of flight. The mismatch in data provided by the primary and standby attitude indicators, due to the power disruption, caused the MP to become spatially disoriented and unable to maintain aircraft control in the weather and at low altitude. The absence of either factor may have prevented this mishap.

SUMMARY OF FACTS AND STATEMENT OF OPINION
F16C, T/N 88-0549
OSAN AIR BASE, SOUTH KOREA
6 MAY 2023

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ACRONYMS AND ABBREVIATION

#3	Pilot #3
7 AF	7th Air Force
8 FW	8th Fighter Wing
80 FS	80th Fighter Squadron
AB	Air Base
AIB	Accident Investigation Board
A1C	Airman First Class
AC	Alternating Current
ACES II	Advanced Concept Ejection Seat Two
ADI	Attitude Directional Indicator
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFTO	Air Force Technical Order
AGCAS	Automatic Ground Collision Avoidance System
AGL	Above-Ground Level
AIB	Accident Investigation Board
Amn	Airman
AMU	Aircraft Maintenance Unit
AMUX	A-multiplex
AOA	Angle-of-Attack
ATAGS	Advanced Tactical Anti-G System
AUX	Auxiliary
BPO	Basic Post-Flight
BOMC	Base Operations Medical Cell
BRAG	Breathing Regulator/Anti-G
Capt	Captain
CADC	Central Air Data Computer
CAUT	Caution
CCTV	Close-Caption Television
CFiT	Controlled Flight into Terrain
CIP	Core Integrated Processor
CMR	Combat-Mission Ready
COCOM	Combatant Command
CSFDR	Crash Survival Flight Data Recorder
CSMU	Crash Survivable Memory Unit
Col	Colonel
DED	Data Entry Display
DFLCC	Digital Flight Control Computer
DoD	Department of Defense
ECS	Environmental Control System
EGI	Embedded GPS/INS
EHSI	Electronic Horizontal Situation Indicator
EOS	Emergency Oxygen System
EPS	Emergency Power System
FDR	Flight Data Recorder
FL	Flight Level
FLCS	Flight Control System
FPM	Feet Per Minute
FPS	Fire Protection System
FRC	Fault Reporting Codes
FS	Fighter Squadron
FW	Fighter Wing
ft	Feet
g	Gravitational Force
GLOC	G-Induced Loss of Consciousness
GPS	Global Positioning System
HFACS	Human Factors Analysis and Classification System
HUD	Heads-Up Display
IAW	In Accordance With
IDMT	Independent Duty Medical Technician
IFDL	Intra-Flight Data Link
IFE	In-Flight Emergency
IMC	Instrument Meteorological Conditions
IMDS	Integrated Maintenance Data System
INS	Inertial Navigation System
IP	Instructor Pilot
JASSM	Joint Air-to-Surface Standoff Missile
JDAM	Joint Direct Attack Munitions
K	Thousand
KEAS	Knots Equivalent Airspeed
KCAS	Knots Calibrated Airspeed
KTAS	Knots True Airspeed
kts	Knots
L	Local Time
LM	Lockheed Martin
Lt Col	Lieutenant Colonel
LWD	Left Wing Down
M	Mach

MA	Mishap Aircraft
Maj	Major
MAJCOM	Major Command
METAR	Meteorological Aerodrome Report
MFL	Maintenance Fault List
MFP	Mishap Flight Lead
MIDS	Multifunction Information Distribution System
MOA	Military Operating Area
MP	Mishap Pilot
MS	Mishap Sortie
MSgt	Master Sergeant
MSL	Mean Sea Level
ND	Nose Down
NLG	Nose Landing Gear
NM	Nautical Miles
NOTAMs	Notices to Airmen
NVGs	Night Vision Goggles
OG	Operations Group
ORM	Operational Risk Management
OPR	Officer Performance Report
PA	Public Affairs
PARS	Pilot Activated Recovery System
PACAF	Pacific Air Forces
P&W	Pratt and Whitney
PAO	Polyalphaolefin
PACAF	Pacific Air Forces
PE	Physical Environment
PHA	Periodic Health Assessment
PLB	Personal Locator Beacon
PMP	Packaged Maintenance Plan
PFL	Pilot Fault List
PR	Pre-Flight
PRD	Pilot-Reported Discrepancy
PSI	Pounds Per Square Inch
QA	Quality Assurance
RTB	Return-To-Base
RWD	Right Wing Down
SAI	Standby Attitude Indicator
SAR	Search and Rescue
SAT	Surface Attack Tactics
SD	Spatial Disorientation
SEPT	Simulator Emergency Procedures Training
SGP	Chief of Aerospace Medicine
SII	Special Interest Item
SME	Subject Matter Expert
SOF	Supervisor of Flying
SrA	Senior Airman
SSgt	Staff Sergeant
SW	Switch
SXP	Sniper Targeting Pod
TCTO	Time Compliance Technical Order
TSgt	Technical Sergeant
T/N	Tail Number
TO	Technical Order
TOD	Tech Order Data
UFC	Up-Front Controls
U.S.	United States
VVI	Vertical Velocity Indication
WAI	Walk-Around Inspection
WOW	Weight Off/On Wheels
Z	Zulu

STATEMENT OF OPINION

F-16C, T/N 88-0549
OSAN AB, SOUTH KOREA
6 MAY 2023

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

On 6 May 2023, the mishap pilot (MP), flying a F-16C, tail number (T/N) 88-0549, assigned to the 80th Fighter Squadron, "the Juvats," 8th Fighter Wing, Kunsan Air Base, South Korea, conducted a routine training sortie as part of the wing's local readiness exercise BEVERLY HERD. Two minutes and forty-one seconds after a 09:27 a.m. Korea Standard Time takeoff, the MP ejected from the mishap aircraft (MA) with minor injuries. The MA was destroyed upon impact in an agricultural field at approximately 09:30 a.m. Korean Standard Time, 8 nautical miles (nm) south of Osan Air Base. The mishap resulted in the loss of a $29,387,925.00 United States government asset.

The mishap flight was planned and authorized as a training mission within the local training airspace. The MP was flying as the second aircraft in a 4-ship formation. The prevailing weather at the airfield, and in the surrounding area, was clouds obscuring the horizon beginning at 1,400 feet up to 17,000 feet. While in the clouds, approximately 11 seconds after takeoff, a partial electrical power loss resulted in an inaccurate horizon, or attitude, information being indicated by the MP's flying instruments with no failure indications. As such, the MP was unable to tell where the horizon was located. The subsequent degradation and mismatch in data between the primary and standby horizon indicator instruments caused the pilot to become spatially disoriented and he ended up flying inadvertently to a very low altitude. The MP descended to 720 feet mean sea level where he did not have enough altitude to recover the aircraft without crashing into the ground, and chose to eject, which was successfully accomplished at 710 feet above ground level.

The MP was an F-16C pilot with 423.4 total flying hours, and 123.6 hours flying in the F-16. The MP was current and qualified for all elements of the mission to be flown. This was the MP's first flight in three days and the MP was the sole pilot of the MA. The mishap resulted in the loss of a $29,387,925.00 United States government asset.

I find, by a preponderance of the evidence, the cause of the mishap was the combination of two factors. First, the MA experienced a permanent or momentary partial electrical power loss. The power loss caused a cascading failure or restart of the MP's primary flight and navigation instruments. Due to the power loss, while the primary horizon indicator (ADI) was still moving in relation to the pilots flying inputs, the ADI continued to display unreliable and inaccurate data without a fault or failure indication telling the pilot to disregard the primary display and transition to his standby, or backup horizon attitude indicator (SAI) for horizon reference. Second, the weather conditions at the time of the power disruption caused the MP to rely solely on his primary and standby flight instruments to maintain aircraft control during a critical phase of flight. The mismatch in data provided by the primary and standby attitude indicators, due to the power disruption, caused the MP to become spatially disoriented and unable to maintain aircraft control in the weather and at a low altitude. The absence of either factor may have prevented this mishap.

I developed my opinion by carefully considering the standard of proof for the preponderance of the evidence and the requirements for causes and substantially contributing factors. I analyzed available flight data, the Lockheed Martin (LM) crash report, the mishap animation, witness testimonies, engineering analysis, Air Force technical orders, and other information provided by technical and subject matter experts (SMEs).

2. CAUSES

a. Primary Attitude Instruments Power Loss

The data gathered from the crash survivable memory unit (CSMU) and digital flight control computer (DFLCC) provides definitive evidence of a power disruption in the MA approximately 11 seconds after take-off. However, the total destruction of the aircraft significantly limited the ability to analyze physical evidence, and therefore, I could not determine the cause of the power disruption. While the cause of the electrical malfunction is inconclusive, the power disruption caused a partial electrical power loss to the attitude and navigation equipment in the cockpit resulting in invalid embedded global positioning inertial navigation system (EGI) data. At the time of the power disruption, the MA reported a failure in the air to ground collision avoidance system (AGCAS), which rendered the Pilot Activated Recovery System (PARS) inoperable; however, the MA did not report a failure of the navigation or attitude equipment. As reported by the MP, 30-45 seconds later, the head-up display (HUD) horizon indication lines, or pitch ladders, disappeared. One minute and nine seconds after the initial power disruption, the pitch and roll values displayed on the ADI changed to zero, and immediately after, the pitch attitude made an 18.2 degree increase in less than one second, completely counter to the pilot’s command input of nose down at the time. Four seconds later, the heading display indicator froze leading to the pilot having no reference of his heading. Primary pitch, roll, and heading displays from this time forward were unreliable.

The partial electrical power loss led to the failure of the MPs primary flight and navigation instruments without corresponding failure indications and was causal in this mishap.

b. Weather Conditions

The weather condition at the time of the mishap was clouds beginning at 1,400 feet all the way up to 17,000 feet. At the time of the partial electrical power loss, the MP was transitioning to flying into the clouds, taking a radar lock on the mishap flight lead (MFP), and flying a radar assisted instrument trail departure. While executing the radar assisted trail departure, the MP expedited a climb to avoid simulated exercise threats, and approximately 30-45 seconds later, the horizon display disappeared in the HUD and the MP began a greater than desired angle of climb that resulted in a precipitous decrease in airspeed. Upon recognition, the MP executed a recovery he was trained to execute if he ever found himself with his nose too high for the given airspeed or circumstances to safely prevent an out-of-control flight condition and return the aircraft back to safe flying parameters. He used his primary horizon display, that was beginning to fail, to execute this maneuver.

No failure indication of the MA's primary ADI warned the MP that his instruments were displaying invalid information. The MP states after recognizing the airspeed and altitude did not correspond to the displayed attitude, he broke out of the weather for a few seconds into a small pocket of clear air where he could see the ground. The MP attempted to set his aircraft wings level attitude based on visual cues from the ground prior to reentering the weather. The MP then referenced his standby attitude indicator (SAI) to determine the aircraft attitude, which showed all black representing a nose low attitude, which was contradictory to the primary ADI displaying a nose high attitude, and also in contradiction with the visual cues he saw during the break in the clouds. Multiple attempts to cross-check between the primary and SAI were unsuccessful in resolving the mismatch between the different instrument-based cues, and therefore, insufficient in discerning the proper aircraft orientation.

The MP fought through several human factors while attempting to maintain aircraft control and determine which instruments were providing accurate information. The MP recognized he was spatially disoriented and attempted to use his instruments to resolve this disorientation. While the ADI and heading display showed inaccurate information, and the standby ADI disagreed with the primary display information, when the pilot entered a momentary break in the weather, he was able to input flight controls to regain control, but without further outside visual references due to flying in the clouds, the MP could not resolve the mismatch between the primary and standby horizon indicators and therefore discern an accurate.

The weather denied the MP the opportunity to gain an accurate visual reference to confirm the MA orientation and flight profile at low altitude and was causal in this mishap.

3. SUBSTANTIALLY CONTRIBUTING FACTOR

I did not find any act, omission, condition, or circumstance that played an important role, directly or indirectly, where its correction, elimination, or avoidance would not by itself, have prevented the mishap.

4. CONCLUSION

I find, by a preponderance of the evidence, the cause of the mishap was the combination of two factors. First, the MA experienced a partial electrical power loss. The power loss caused a cascading failure of the MP's primary flight and navigation instruments. Due to the loss of power, the primary attitude, or horizon direction indicator continued to display unreliable data without failure indications and prevented the MP from transitioning fully to the standby attitude indicator for attitude reference. Second, the weather conditions at the time of the power disruption forced the MP to rely on his primary and standby flight instruments to maintain aircraft control during a critical phase of flight. The mismatch in data provided by the primary and standby attitude indicators, due to the power disruption, caused the MP to become spatially disoriented and unable to maintain aircraft control in the weather and at low altitude. I do not find the MP to be causal, nor do I find any other factors that substantially contributed to the mishap.

[redacted]

19 December 2023

LYNN E. SAVAGE, Colonel, USAF
President, Accident Investigation Board

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 23 June 2023, Lieutenant General James A. Jacobson, Pacific Air Forces (PACAF) Deputy Commander, appointed Colonel Lynn E. Savage as president of this Accident Investigation Board (AIB) to investigate the subject mishap under the provisions of AFI 51-307, *Aerospace and Ground Accident Investigations* (Tab Y-3). On 23 June 2023, other members were appointed to this AIB, including a Captain Legal Advisor and a Senior Airman Recorder (Tab Y-3). On 12 July 2023, a Technical Sergeant Aircrew Flight Equipment Expert and a Staff Sergeant Maintenance Expert were appointed as additional members of the AIB (Tab Y-5). Additionally, on 14 July 2023, a Lieutenant Colonel Medical Expert and Major Pilot Board Member were appointed to this AIB (Tab Y-7). They conducted this investigation at Osan Air Base (AB), South Korea from 1 August 2023 through 10 August 2023.

b. Purpose

In accordance with (IAW) AFI 51-307, this Accident Investigation Board conducted a legal investigation to inquire into all 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.

2. ACCIDENT SUMMARY

On 6 May 2023, at approximately 09:30 a.m. Korean Standard Time, an F-16C Block 40, tail number (T/N) 88-0549, crashed 8 miles south of Osan AB (Tabs U-6, U-8, and U-18). Both the Mishap Pilot (MP) and Mishap Aircraft (MA) were assigned to the 80th Fighter Squadron (80 FS), 8th Fighter Wing (8 FW), Kunsan AB, South Korea (Tabs K-5 and U-6). The MP was number two of a four-ship, taking off from Osan AB on a local training mission in support of a local exercise (Tabs K-3 to K-4, and V-1.5). Approximately 11 seconds after take-off, during the transition from flying visually with reference to the ground and the horizon, to flying the aircraft with an artificial horizon instrument because the clouds hide the ground or horizon from the pilots view, the mishap aircraft (MA) experienced a partial electrical power loss, which interrupted power to the MA's instruments making them inaccurate for flying in relation to the horizon. (Tab U-6). These failures, coupled with being in the clouds and close to the ground, resulted in recognized spatial disorientation (i.e. where the MP knew he did not know which way was the ground and which way was the sky) and the MP deemed he was unable to recover his aircraft before he would crash into the ground (Tab V-1.8). The MP successfully ejected, and the MA impacted in an agricultural field (Tabs U-6 and V-1.3). The MA, valued at $29.4 million, was completely destroyed (Tabs P-3 to P-4).

3. BACKGROUND

a. Pacific Air Forces

PACAF's primary mission is to deliver rapid and precise air, space, and cyberspace capabilities to protect and defend the United States, its territories and our allies and partners; provide integrated air and missile warning and defense; promote interoperability throughout the Pacific area of responsibility; maintain strategic access and freedom of movement across all domains; and posture to respond across the full spectrum of military contingencies in order to restore regional security (Tab CC-3 to CC-5).The command's vision is to provide combat-ready American Airmen who are the foundation of Pacific stability and security (Tab CC-3 to CC-5). PACAF's area of responsibility is home to 60 percent of the world's population in 36 nations spread across 53 percent of the Earth's surface and 16 time zones, with more than 1,000 languages spoken (Tab CC-3 to CC-5).The unique location of the Strategic Triangle (Hawaii-Guam-Alaska) gives our nation persistent presence and options to project U.S. airpower from sovereign territory (Tab CC-3 to CC-5).

b. 7th Air Force (7 AF)

The men and women of 7 AF and Air Component Command are privileged to serve in Korea as a key part of a proud and powerful joint/combined team (Tab CC-7 to CC-9). The mission of 7 AF is to employ airpower to deter aggression and maintain the Armistice, Defend South Korea, and Defeat any attack against the Alliance (Tab CC-7 to CC-9). 7 AF provides "ready to fight tonight" air power, precise, intense, and overwhelming; whenever and wherever needed (Tab CC-7 to CC-9).

c. 8th Fighter Wing

The 8 FW is responsible for conducting air-to-ground and air-to-air missions in the 45 F-16s assigned to the wing (Tab CC-11 to CC-12). Its mission includes air interdiction, close air support, counter air, and air superiority. (Tab CC-11 to CC-12). Kunsan AB, South Korea, is home to the 8 FW, known as the "Wolf Pack" (Tab CC-11). Located seven miles west of Gunsan City, the base is on the west coast of the peninsula near the Kum River estuary (Tab CC-11). Kunsan AB has approximately 2,800 Air Force members, 110 Army soldiers and 20 U.S. civilians assigned (Tab CC-11). In addition, the base employs more than 420 local national appropriated and non-appropriated employees (Tab CC-11). The base is known as one of the Air Force's last "warrior bases," and an assignment to the installation is typically a one-year unaccompanied tour (Tab CC-11). This means members are assigned to the base without their families. All military members live on base in dormitories (Tab CC-11).

d. 80th Fighter Squadron

The 80 FS flies the F-16 Fighting Falcon out of Kunsan AB, South Korea, and is one of two fighter squadrons assigned to the 8 FW, the Wolf Pack (Tab CC-13). The 80 FS stands ready to conduct counter-air, air interdiction, close air support, and forward air controllers missions in both day and night conditions (Tab CC-14). The 80 FS is prepared to execute immediate air combat operations in support of Combatant Command (COCOM) theater wide taskings to dominate any aggressors threatening U.S. or South Korean interests (Tab CC-13 to CC-14).

e. F-16C Fighting Falcon

The F-16 Fighting Falcon is a compact, multi-role fighter aircraft (Tab CC-17). It is highly maneuverable and has proven itself in air-to-air combat and air-to-surface attack (Tab CC-17). It provides a relatively low-cost, high-performance weapon system for the United States and allied nations (Tab CC-17). In an air combat role, the F-16's maneuverability and combat radius (distance it can fly to enter air combat, stay, fight, and return) exceed that of all potential threat fighter aircraft (Tab CC-17). It can locate targets in all weather conditions and detect low flying aircraft in radar ground clutter (Tab CC-17). In an air-to-surface role, the F-16 can fly more than 500 miles (860 kilometers), deliver its weapons with superior accuracy, defend itself against enemy aircraft, and return to its starting point (Tab CC-17). An all-weather capability allows it to accurately deliver ordnance during non-visual bombing conditions (Tab CC-17).

4. SEQUENCE OF EVENTS

a. Mission

The mishap sortie (MS) was planned and briefed without incident and had a valid flight authorization signed off by the designated personnel responsible for plans, operation, and scheduling (also known as “Top 3”) (Tab K-5). The MS involved four F-16C aircraft conducting an air interdiction training exercise in the Western Complex, also known as tactical targeting of enemy targets (Tabs K-3, K-14, and K-43).

b. Planning

Flight products (i.e. required paper documents for the mishap sortie (MS) to include planned route of flight, fuel considerations, and mission coordination with other flights flying in the same airspace) were provided to the MP on the day of the mishap (Tabs K-43 and K-44). Prior to the MS, all flight members attended a mass briefing conducted by the squadron’s operations supervisor and the Mission Commander (Tab V-3.3). The mass briefing adequately covered forecasted weather conditions, notices to airmen (NOTAMS), and other routine items (Tabs K-9 to K-35 and V-1.5). The mishap flight lead (MFP), the pilot in charge of the formation, also conducted a coordination brief and a tactical brief for the MS (Tab V-3.3). An Operational Risk Management (ORM) worksheet was also completed prior to the MS (Tab K-29).

c. Preflight

After the flight briefings, the personnel involved in the MS assembled at the 80 FS operations desk and received a preflight briefing from the operations supervisor prior to proceeding to their assigned aircraft (Tabs K-9 to K-28, R-78, V-2.2, and V-3.3). During this brief, the operations supervisor provided updated information on items pertinent to flying that day and assigned them their aircraft (Tab K-9 to K-28). The MP's preflight inspection, engine start procedures, and ground operations were uneventful and IAW the applicable checklist (Tab V-1.8 to V-1.9). The MP noted no significant maintenance fault lists (MFLs), (i.e. errors displayed to the pilot in the form of specific system failure and fault number), and verified all instrumentation was working normally prior to takeoff (Tab V-1.8 to V-1.9 and DD-47).

d. Summary of Accident

The flight taxied within five minutes of each other (Tabs V-3.3, V-4.2, and V-4.3). The flight departed with MP getting airborne at 09:27 a.m. Korean Standard Time (Tab U-16). At 09:27 a.m. Korean Standard Time the crash survivable memory unit (CSMU) reported the landing gear handle up (Tab U-16) and the MP stated he successfully took a radar lock (i.e. used his radar to tell him where his flight lead was because he could not see the aircraft in front of him due to the clouds), on MFP and called in the radio, "2s tied" (to let the MFP know the second aircraft successfully established a radar lock on MFP's aircraft) to assist him in trailing the aircraft in front of him (Tabs DD-25, V-3.2, and V-4.2).

According to the CSMU, at approximately 11 seconds after take-off, during the transition to flying in the clouds, the MA experienced a power disruption causing a partial or momentary electrical power loss which closely corresponds with gear retraction (Tabs U-6 and U-16). The event affected multiple essential navigation systems, preventing the pilot from being able to accurately tell where the horizon (i.e. wings level attitude) is with his primary horizon display, prevented the pilot from changing his navigation equipment settings, and preventing the pilot from initiating an automatic aircraft recovery. Specifically, the Inertial Navigation System (INS), (i.e. which displays flight data such as aircraft heading and relation to the horizon, also called attitude), became invalid, resulting in the Attitude Indicator (ADI) (i.e. primary horizon display) being unreliable (Tabs U-6, U-11, U-16, V-1.2, and DD-47). Also, the Air to Ground Collision Avoidance System (AGCAS) failed, (i.e. an automatic function of the aircraft that takes over to prevent it from crashing into the ground) (Tabs U-6, U-11, U-16, V-1.2, and DD-47). Due to AGCAS failing, the Pilot Activated Recovery System (PARS) was also unavailable (i.e. the ability of the pilot to manually initiate AGCAS when desired) (Tabs U-6, U-11, U-16, V-1.2, and DD-47). In addition, the Data Entry Display (DED) went blank (i.e. the screen that displays data the pilot is inputting), preventing the pilot from seeing what communication and navigational data he was entering (Tabs U-6, U-11, U-16, V-1.2, and DD-47). Next, the horizon or attitude indication lines, also called pitch ladders, were blanked from the Heads Up Display (HUD) (i.e. the display the pilot predominately uses for navigation and attitude while flying), making it impossible for the pilot to determine the horizon through his HUD (Tabs U-6, U-11, U-16, V-1.2, and DD-47). Finally, at approximately 39 seconds after take-off, the MA reported, and the MP verified, a failure that prevented the pilot from being able to communicate outside of his aircraft (Tabs U-11 and V-1.4).

While flying the radar assisted trail departure and climbing (i.e. flying away from the ground with the nose of the aircraft pointed upward) at a greater angle than normal to gain a higher altitude faster to avoid simulated ground exercise threats, the MP began to climb at an angle greater than desired resulting in an undesired decrease in airspeed (Tab V-1.2). Upon recognition of his climb being at too great an angle, the MP executed a recovery he was trained to execute if he ever found himself with his nose too high for the given airspeed to safely prevent an out-of-control flight condition and return the aircraft back to safe flying parameters. He used his primary horizon display, that was beginning to fail, to execute this maneuver (Tab V-1.2).

No faults were recorded by the CSMU that would have affected the primary ADI warning the MP that his instruments, to include his primary horizon display, was displaying invalid information (Tabs U-10, U-11, and U-14). The MP stated that after the recovery, he recognized the airspeed and altitude did not correspond to the displayed attitude and what he should have expected for a successful recovery. At this point, and for a few seconds, he flew through a small piece of airspace that did not have any clouds, where he was able to momentarily see the ground and fly visually in relation to the ground. (Tab V-1.3). The MP attempted to fly level with the horizon using the ground-available visual cues prior to immediately reentering the weather (Tab V-1.3). After establishing level flight visually, the MP noticed his primary horizon display was wrong, and so he followed his training and referenced his back up horizon display, called the Standby Attitude Indicator (SAI), to determine how the aircraft was flying in relation to the horizon. The SAI showed the airplane flying at an angle directed towards the ground which the pilot knew was not happening as he just corrected visually with the ground-available visual cues while flying through the small piece of airspace without clouds (Tab V-1.3). Multiple attempts to try and determine where the horizon was by cross-checking between the primary and standby ADI were unsuccessful. The MP was unable to determine the real location of the horizon because when he provided flight control inputs based on either the primary or standby ADI, the aircraft airspeed and altitude (i.e. performance indicators of the aircraft attitude in relation to the horizon) were not responding as they should when referencing those artificial horizons (Tab V-1.3) (e.g. when you push on the gas in a car and expect the speed to go up, but the speed goes down).

Exiting the clouds at close proximity to the ground, the MP assessed he was too steep and too close to the ground to safely continue flying without crashing into the ground (Tab V-1.3). At approximately two minutes and 41 seconds after take-off, the MP commanded an ejection at 720 mean sea level (MSL), 710 feet above ground level (AGL), and 316 knots (Tab U-18).

e. Impact

The MA crashed 8 nautical miles at a direction of 167-degrees (i.e. 0 degrees is directly north and 180 degrees is directly south) from Osan Air Base (Tabs U-8 and DD-48). Due to the low altitude at which the ejection was initiated, the MA crashed in close proximity to where the MP landed safely (Figure 1) (Tab U-8). The canopy and ejection seat were located relatively near the MA along its direction of travel (Tab U-8). Crash site examination and video surveillance video revealed a shallow, upright and right wing low high-speed impact in an open agricultural land impacting at an approximate heading of 210 degrees (Figure 2) (Tab U-7 to U-8).

Figure 1. Aerial view of impact location (Tab U-8)

The majority of the MA was at the impact crater, with debris fanned toward the south-southwest an estimated 300 yards in an approximate 45-degree fan (Tab U-8). A narrow secondary debris field was adjacent to the impact crater, perpendicular to the MA direction of travel, and extending an estimated 50 feet (Tab U-8). There was a significant localized post-impact fire at the impact crater (Figure 3) (Tab U-6). The impact resulted in zero casualties or fatalities (Tab DD-32).

Figure 2: Surveillance Footage prior to MA Impact (Tab S-9)

Figure 3 and Figure 4: Surveillance Footage of MA at Impact (Tab S-10 to S-11)

f. Egress and Aircrew Flight Equipment (AFE)

The MP commanded ejection by pulling the handle at 09:30 a.m. Korean Standard Time (Tab U-18). The MA was traveling at 316 knots at 720 feet MSL (Tab U-18). Milliseconds after ejection, the airspeed and altitude were within the mode 1 operation for the advanced concept ejection seat two (ACES II), used for ejections with speeds less than 250±25 knots and altitudes between sea level and 15,000 feet MSL (Tab J-4 and DD-47). During the mode 1 ejection, the pilot parachute deploys immediately in order to reduce time required for the pilot parachute to deploy and inflate (Tab H-4). Additionally, the MA parameters at the time of the ejection were within a successful ejection envelope (Tab H-4 and H-48). The canopy and ejection seat landed within close proximity of the MA and MP (Figure 5) (Tab U-8). Analysis of the escape system shows the seat operated properly, with one exception of the beacon not operating (Tab J-39). It is unclear if the seat was in manual or automatic seat beacon position (Tab J-39). The MP was current and qualified in aircrew flight equipment (AFE) training, to include AFE fit check, Egress, and Emergency Parachute Training (Tab G-4). The seat kit was equipped with a personnel locator beacon (PLB), but the beacon failed to activate as designed when the seat separated from the pilot after safely exiting the aircraft (Tab H-31). There are no other AFE issues pertinent to this investigation. All flight and survival equipment had current inspections and performed as designed (Tab H-53 to Tab H-76). The survival vest and seat kit records indicated nothing was expired (Tab H-53 to Tab H-59).

Figure 5: Canopy, Seat, Chute, and MA points of impact (Tab S-4)

g. Search and Rescue (SAR)

The MA impacted an agricultural field at approximately 09:30 a.m. Korean Standard Time, with the impact captured on closed circuit television (CCTV) surveillance (Figure 2) (Tab U-18). Shortly after landing and assessing his status, MP sent out a message via the *Slack* Application that he had ejected and was "ok" (Tab R-48). At 09:49 a.m. Korean Standard Time, a Captain Flight Surgeon received the *Slack* message and sent out an In-Flight Emergency (IFE) message to command notifications on Osan AB (Tab R-48). The flight surgeon, along with a Staff Sergeant Independent Duty Medical Technician (IDMT), Lieutenant Colonel Chief of Aerospace Medicine (SGP), and two Senior Airman Base Operations Medical Cell (BOMC) personnel left for the impact site to assist MP, arriving one hour after being notified of pilot ejection (Tab V-5.3). They arrived on scene and were able to assist the MP, who was still in the agricultural field, but able to walk and move about (Tab V-5.1 to V-5.3). After initial onsite medical survey, the MP was transported via ambulance back to Osan AB for further assessment and care (Tab R-49).

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

The Air Force Technical Order (AFTO) 781 series of forms collectively document maintenance actions, inspections, servicing, configurations, status, and flight activities (Tab D-12 to D-21). The AFTO 781 forms, in conjunction with the Integrated Maintenance Data System (IMDS), provide a comprehensive database used to track and record maintenance actions and flight activity, and to schedule future maintenance (Tabs D-24 to D-30 and D-45 to D-46).

A comprehensive review of the active AFTO 781 forms and IMDS revealed no discrepancies, overdue inspections, or overdue Time Compliance Technical Orders (TCTOs) that would ground the MA from flight operations (Tabs D-12 to D-30, D-45 to D-46, and D-183 to D-203). A thorough review of the active AFTO 781 forms and IMDS historical records for the 40 days preceding the mishap revealed no recurring maintenance (Tabs D-12 to D-30 and D-183 to D-203). Additionally, the MA was operating as designed, and there was no indication of mechanical, electrical, and structural failure prior to MA take-off (Tab V-1.9).

b. Inspections

The Pre-Flight (PR) inspection and Basic Post-Flight (BPO) inspection include visually examining the aircraft and operationally checking certain systems and components to ensure no serious defects or malfunctions exist (Tab BB-4). Walk-Around Inspections (WAI) are an abbreviated PR inspection and are completed as required prior to launch IAW the applicable AFTOs (Tab BB-4).

The total airframe operating time of the MA at takeoff of the MF was 8047.1 hours (Tab D-12). The last PR/BPO inspection occurred on 27 April 2023 at 12:30 a.m. Korean Standard Time with no discrepancies noted (Tab D-141). PR inspections were completed on 01 May 2023 at 08:00 a.m. Korean Standard Time and 05 May 2023 at 04:00 p.m. Korean Standard Time with no discrepancies noted on either inspection (Tab D-12 and D-141). A WAI occurred on 24 April 2023 at 01:00 a.m. Korean Standard Time with no discrepancies noted (Tab D-129). Prior to the mishap, the MA had no relevant reportable maintenance issues, and all inspections were satisfactorily completed (Tabs D-12 to D-30 and D-45 to D-46).

c. Maintenance Procedures

A review of the MA's active and historical AFTO 781 series forms and IMDS revealed all maintenance actions complied with standard approved maintenance procedures and AFTOs (Tabs D-16 to D-18, D-132 to D-138, D-144 to D-165, and D-172 to D-203).

d. Maintenance Personnel and Supervision

The 80th Aircraft Maintenance Unit (80th AMU) personnel performed all required inspections, documentation, and servicing for the MA prior to flight (Tab D-12 to D-18). Personnel involved with the MA's preparation for flight had proper and adequate training, experience, expertise, and supervision to perform their assigned tasks (Tab D-205 to D-247).

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

Due to the nature of impact, all fluid samples were destroyed and not testable (Tab D-249). CSMU and DFLCC data obtained from the MA indicated the fuel system, hydraulic system, and engine were all operating and responding to the MP's inputs prior to ejection and through time of impact (Tabs U-6 and L-3 to L-632). A sample of hydraulic fluid recovered from the servicing was analyzed with no discrepancies reported (Tab D-119 and D-122). Fuel samples from the fuel storage tank and fuel truck that serviced the MA were tested with no discrepancies reported (Tab D-115 to D-117).

f. Unscheduled Maintenance

Unscheduled maintenance is any maintenance action taken that is not the result of a scheduled inspection (Tabs BB-4 and D-172 to D-182). This is normally the result of a pilot-reported discrepancy (PRD) during flight operations, or a condition discovered by ground maintenance personnel (Tab D-172 to D-182). There were several unscheduled maintenances performed prior to the most recent scheduled inspection (Tab D-146 and D-148 to D-159).

First, on 27 April 2023, MA experienced a NO AGCAS fail along with Flight Control System (FLCS) MFL 088/089 (Tab D-148). The corrective action for the MFL 088/089 discrepancy involved replacing the embedded global positioning system inertial navigation systems (EGI) batteries and operationally verifying they checked good (Tab D-148). On 27 April 2023, personnel performed maintenance correctly IAW applicable TOs and the batteries checked good and the MA functioned as expected following this replacement (Tab D-148). This write up was repeated on the MS (Tab U-11).

Second, on 26 April 2023, the NLG WOW SW (Nose Landing Gear, Weight Off/On Wheels, Switch) was found to be loose (Tab D-146). The corrective action for this discrepancy was tightening said switch which occurred on 26 April 2023 (Tab D-146). The MA functioned as expected following this replacement and personnel performed maintenance IAW applicable AFTOs (Tab D-146).

Third, on 27 April 2023, there was an excessive fuel drip from the right wing near station-9 that required tightened screws and injection (Tab D-148 to D-158). The corrective action for this discrepancy was performed IAW applicable AFTOs on 28 April 2023 (Tab D-148 to D-158). The MA functioned as expected following this replacement (Tab D-148 to D-158).

Lastly, on 1 May 2023, there was an exchange of the Multifunction Information Distribution System (MIDS) batteries for the 180-day inspection (Tab D-159). Personnel performed maintenance IAW applicable AFTOs and MA functioned as expected following the MIDS batteries exchange (Tab D-159).

Additionally, there were no recurring maintenance problems with the MA prior to the MS (Tab D-16 to D-18, D-132 to D-138, D-144 to D-165, D-172 to D-203). There was, however, a reconfiguration on the right hardpoint since the last inspection on the MA, as well as the reconfiguration on Station 4 and 6 (Tab D-175 to D-176 and D-181). Maintenance personnel installed a SXP (Sniper Targeting Pod) and SXP Pylon IAW appropriate AFTOs (Tab D-181). The installation of both left (Station 4) and right (Station 6) external wing fuel tanks were IAW appropriate AFTOs (Tab D-175 to D-176). There is no evidence to indicate that any of the unscheduled maintenance items were relevant to the mishap.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

The MA impacted an open, wet (but not flooded) agricultural field in an upright, right wing low shallow angle crashing into the ground in the direction of travel, approximately at a 210 degree direction of travel (Tab U-7 to U-8). The majority of the MA was at the impact crater, with debris spread out from the point of impact then towards the south-southwest in the same direction of travel as the impact, an estimated 300 yards in an approximate 45-degree fan (Tab U-8). A narrow secondary debris field was adjacent to the impact crater, perpendicular to the MA direction of travel, and extending an estimated 50 feet (Tab U-8). There was a significant localized post-impact fire at the impact site (Tab U-6). The majority of the MA was broken into pieces ranging in size from a few inches to a few feet (Tab S-8). The largest debris recovered was approximately three to five feet long as seen in Figure 6 (Tab S-8).


Figure 6: MA Impact site with example of debris (Tab S-8)

b. **Evaluation and Analysis**

(1) MA Crash Survivable Flight Data Recorder (CSFDR)

The CSFDR system consists of two units. The first is the CSMU, which contains non-volatile memory and was recovered from the site (Tab U-6 and U-9). The second component of the system is the Signal Acquisition Unit (SAU), which contains engine data, and service live monitoring, which was also recovered (Tab U-9). Of the seven chips within the CSMU, three had usable data for investigation reconstruction, recording the mishap sequence beginning prior to the EGI failure through ejection (Tab U-10 to U-11). While the recovered CSMU data was not complete, by comparing the data to the Digital Flight Control Computer (DFLCC) data, which is the brain of the Flight Control System, the terminal portion of sequence of events of the MA were recovered (Tab U-11).

(2) MA Digital Flight Control System (DFLCC) Data

There were no indications of a degraded FLCS electrical or hydraulic power or any DFLCC system failures to suggest a controllability problem occurred (Tab U-6). However, at 09:29 a.m. Korean Standard Time, the DFLCC recorded that the EGI data was lost or stale (Tab U-14 and DD-47).

This lost or stale data means the information used to display the primary horizonal display was inaccurate (Tab U-14).

(3) MA Flight Control Surfaces

There is no data to suggest indications of degraded or inoperable flight control surfaces (i.e. the pilot was always able to put in inputs to fly the airplane) (Tab U-6).

(4) MA Engine

The engine was completely destroyed on impact into the agricultural field. Factual parametric data from the CSMU displayed a normal operating engine throughout the flight (Tab L3 to L-632). Additionally, there were no recorded engine faults from on-board recorders (Tabs S-8, U-6, and U-10).

(5) Hydraulic System

Based on the CSMU data, both hydraulic systems were pressurized and providing hydraulic power at the time of impact (Tab U-6 and U-14).

(6) Electrical System

Aircraft power is furnished internally by an alternating current (AC) power generation subsystem (Tab U-22 to U-24). Internal AC power is furnished by the main generator under normal conditions, and the standby generator if the main generator fails (Tab U-22 to U-24). The emergency generator provides power if both the main and standby generator systems are unable to supply power or a failure occurs in the hydraulic system (Tab U-22 to U-24). External power is provided via an external power receptacle and monitor (Tab U-22 to U-24).

The CSFDR data showed a partial electrical power loss in the MA that resulted in the loss of the EGI data, which probably occurred approximately 11 seconds after take-off (Tab U-6 and U-18). No other piece of electrical equipment displayed the effect of the partial power loss (Tab U-25). Given the lack of available evidence, and the many potential causes of the partial electrical failure, to include any piece of electrical equipment or any stretch of wiring, it is not possible to determine the actual cause of the electrical power loss (Tab U-25).

(7) Escape System

The MA was equipped with an ejection seat actuated by the pilot pulling the ejection handle located on the forward part of the seat (Tab J-3). Once this occurs, the canopy separates from the aircraft and the ejection seat leaves the aircraft milliseconds later (Tab J-3). The escape system functioned as designed (Tab J-11).

(8) MA Navigational Instruments

Following gear retraction, MP states the DED (i.e. the display showing radio frequency and navigation inputs) went blank (Tab V-1.2). Sometime later, the MP recognized the indications in his HUD that shows him the artificial horizon, known as pitch ladders, had disappeared from the HUD (Tab V-1.2). At 9:29 a.m. Korean Standard Time, without any pilot input, the primary ADI display (i.e. the display of the aircraft's x and y axis in relation to the horizon) abruptly rolled left to a wings level attitude then was immediately followed by an abrupt climbing attitude (Tab U-19 and DD-47). At 9:29 a.m. Korean Standard Time the electronic Horizontal Situation Display (EHSI) (i.e. the display that shows aircraft direction of flight) froze (Tab U-18). The main ADI continued to respond as pilot pitch and roll inputs were made; however, the displayed data did not correspond to the actual attitude of the aircraft (Tab U-19).

(9) Automatic Ground Collision Avoidance System (AGCAS)/ Pilot Activated Recovery System (PARS)

AGCAS is mode selectable function that provides an automatic recovery when an imminent ground collision is predicted (Tab U-26). When a collision is predicted, the flight control computer will take control of the aircraft and perform its designed automatic recovery consisting of an abrupt roll to wings level followed by a nominal 5g pull to clear the threatening terrain by a predetermined amount of altitude clearance depending on the pilot's inputted preference before the flight (Tab U-26). PARS is a manually initiated, automatic recovery system designed to return the aircraft to straight and level flight (Tabs U-26). During the MS, the MP did not try to activate the PARS (Tab V-1.3). CSMU data showed at 09:28 a.m. Korean Standard Time an AGCAS Fail MFL and at 09:29 a.m. Korean Standard Time a built in test for "EGI AND/OR CADC MUX DATA BAD" was set and remained set for the remainder of the MS (Tabs U-11 and U-14). The MA was equipped with AGCAS and PARS, but it did not operate to return the aircraft to straight and level flight, due to the AGCAS Fail and the EGI being offline (Tab U-27).

7. WEATHER

a. Forecast Weather

On 6 May 2023, the forecast for Osan AB had winds out of the northeast at 12 knots, gusting to 18 knots, scattered clouds at 1,000 AGL, a broken cloud ceiling at 2,000 AGL, an overcast cloud ceiling at 2,500 AGL with the top of the clouds at 17,000 feet MSL and visibility of 4,800 meters (Tab F-3). The forecast hazards included rain over the airfield, light turbulence surface to 6,000 AGL, and light icing, flight level (FL) 140 through FL 240 (Tab F-3). Additionally, the forecast had a temporary forecast of a broken cloud ceiling at 1,000 AGL and an overcast cloud ceiling at 2,000 AGL (Tab F-3).

b. Observed Weather

A Meteorological Aerodrome Report (METAR) was generated at 2355 ZULU (0855L) reporting the winds out of the northeast at 11 knots gusting to 20 knots, light rain and mist, few clouds at 1,400 AGL, scattered clouds at 1,800 AGL, a broken cloud ceiling at 2,100 AGL, an overcast cloud ceiling at 3,700 AGL and 9,000 meters of visibility (Tab F-7). The flight reported the ceiling between 1,000 AGL and 1,500 AGL (Tabs V-1.2, R-79 and R-81). Post-mishap weather remained unchanged (Tab F-46).

c. Space Environment

Not Applicable.

d. Operations

The MP was operating within the prescribed weather requirements for category 3 Pilot Weather Category (PWC) minimums (Tab G-3).

8. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was a current, Non-Combat Mission Ready (N-CMR) F-16 pilot (Tab G-3). With training dating back to 2019, the MP completed Air Force Undergraduate Pilot Training (UPT) and Introduction to Fighter Fundamentals (IFF), obtained initial qualification in the F-16, and then proceeded to his first overseas assignment at Kunsan AB (Tabs G-17 and G-65). The MP completed Mission Qualification Training (MQT) to become a certified pilot who could fly alongside other pilots into combat on 19 January 2023, with average progression throughout the program (Tabs G-13 and T-3). The MP flew at an inexperienced CMR rate, but due to recent vacation time the month prior, and missed flying opportunities, the MP was currently N-CMR and placed on regression status and required to fly back at a CMR rate for the month of May to regain CMR status (Tabs G-3 and V-1.10).

During the month of May, he was always qualified to fly the F-16, and fly as a wingman, but would not have been eligible to fly into combat until he flew the requisite number of CMR sorties in a month. The MP received navigation system failure training during his May simulator emergency procedures training (SEPT) and as part of yearly instrument proficiency training and certification, but the training was limited to frozen or failed systems, never an operating, but inaccurate, navigation system (Tabs G-58 and V-1.7). The MP was weather category 3 qualified, and therefore, qualified to fly instrument approaches with weather better than or equal to clouds at 500 AGL and visibility of 1.5 miles (Tab G-3). His total time was 423.4 hours, with 123.6 hours in the F-16 (Tab G-11 and G-12).

Recent flight time is as follows (Tab K-41):

MP	Hours	Instrument Hours	Sorties
Last 30 days	4.3	1.3	4
Last 60 days	23.3	4.1	17
Last 90 days	33.6	5.3	25

The MP's most recent flight prior to the mishap was on 3 May 2023, where he executed a training surface attack mission with him navigating to and from the field with the weather at 500 AGL up to 10,000 MSL (Tabs G-21 and V-1.6). He was scheduled to execute another training sortie in support of the exercise after the MS, but it was never accomplished because of the mishap (Tab K-3 and K-6).

b. **Other USAF Pilots**

Not applicable.

9. MEDICAL

a. MP Qualifications

At the time of the mishap, the MP was medically qualified for flying duty (Tabs K-5, G-17 and DD-29).

b. MP Health Prior to Mishap

The MP's most recent periodic health assessment (PHA) was on 10 November 2022 (Tab G-17). The MP had no disqualifying conditions or pre-existing medical conditions that could have affected the outcome of the mishap (Tab DD-29). When interviewed, the MP reported no recent illness that could have affected his reactions during the mishap (Tab V-1.7).

c. **Pathology**

Not applicable.

d. **Toxicology**

Toxicology samples were obtained and submitted to the Armed Forces Medical Examiner System, Division of Forensic Toxicology for analysis (Tab DD-30). The MP and all mishap air crew maintenance members were tested, and the toxicology screens showed nothing of relevance (Tab DD-30).

e. Lifestyle

Based upon the interview with the MP, as well as a review of the past year's medical records, there is no evidence to suggest lifestyle factors contributed to the mishap in any way (Tab DD-30 and V-1.7).

f. **Crew Rest and Crew Duty Time**

Crew rest and crew duty time requirements are detailed in AFM 11-202V3, *Flight Operations*, dated 10 January 2022 (Tab BB-5). 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 (FDP) begins (Tab BB-5). Crew rest is defined as free time and includes time for meals, transportation, and rest (Tab BB-5). Crew rest time must include an opportunity for at least 8 hours of uninterrupted sleep (Tab BB-5). Aircrew members are individually responsible to ensure they obtain sufficient rest during a crew rest period (Tab BB-5). The MP had more than 12 hours of crew rest prior to the mishap FDP, and also had the opportunity for at least 8 hours of uninterrupted sleep, IAW AFM requirements (Tab V-1.4).

MP met crew rest and crew sleep requirements prior to the mishap (Tab V-1.4). MP stated fatigue did not affect reaction time or decision-making abilities (Tab V-1.4). MP obtained 8 hours of sleep prior to the mishap, had slept continuously and well, and felt well rested the day of the mishap (Tab V-1.4).

g. **Maintenance Personnel Rest Periods and Health Review**

Medical records for the prior year, 72-hour and 7-day histories, and toxicological analysis were reviewed. Nothing was identified that could have led, or contributed to, the mishap (Tab DD-30).

10. OPERATIONS AND SUPERVISION

a. Operations

The operations tempo during a readiness exercise attempts to replicate a wartime situation with combat focused mission planning, briefings, and flight execution (Tab K-25). As in wartime, pilots fly longer sorties and multiple times a day (Tab K-3). The day of the mishap was the first day of the exercise and the MF was the first flight of the day (Tab K-3 to K-4). The MP previously flew on the 1st, 2nd, and 3rd of May after returning from leave (Tab G-21). The MP attended a mass briefing prior to the first take-off of the day and received a coordination briefing from the Mission Commander (MC) for the first go of the day (Tabs K-7 to K-27, V-1.7, and V-4.2). MF was briefed IAW AFM guidance (Tabs V-1.7 and V-4.2).

b. Supervision

MFP and the squadron supervision, or Top 3, on duty noted all members of the MF were fit to fly (Tabs K-5, V-2.3, and V-4.2). The ORM process in the squadron identified the risk for the mission to be in the "green" or deemed low risk (Tab K-29). The Top 3 approved the sortie based on their risk assessment, with no other supervisory approval required (Tab K-29). The ORM assessment worksheet recognized flying in clouds as a risk and the MFP addressed mitigation techniques for it in his flight brief (Tabs V-4.2, K-29, and DD-47). The supervisor of flying in the control tower and squadron supervision in the flying squadron worked with weather personnel to ensure the weather reporting was accurate and above the minimums required for all pilots planning to fly (Tab K-11 to K-13).

11. HUMAN FACTORS ANALYSIS

a. Introduction

The AIB considered all human factors as prescribed in the Department of Defense Human Factors Analysis and Classification System 7.0 (HFACS 7.0). The mishap involved physical environmental (weather, vision limitations) and technological environmental (electrical and instrumentation failures) factors as well as sensory misperception factors that cumulatively manifested as pilot-recognized spatial disorientation (SD) (Tabs V-1.2, V-1.3, and U-6). Relevant factors are discussed below.

b. **PE101 Environmental Conditions Affecting Vision**

HFACS Code PE100, Physical Environment, refers to factors such as weather, climate, fog, brownout (dust or sandstorm) or whiteout (snowstorm) that affect the actions of the individual (Tab DD-10). Furthermore, HFACS Code PE101, Environmental Conditions Affecting Vision, 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 DD-10).

The weather on 6 May 2023 for the time-period of the flight was few clouds at 1,400 AGL, scattered clouds at 1,800 AGL, a broken ceiling at 2,100 AGL, an overcast ceiling at 3,700 AGL and 9,000 meters of visibility, requiring instrument flight (Tab F-7). When a pilot has a wide, clear view, vision is a dominant input, overriding all other sensory inputs in importance. When visual contact with the horizon is lost, the inner ear system we use for balance and awareness of our reference with being level becomes unreliable and can result in sensory illusions to the pilot, unless overridden by another visual cue from instrument information (Tab DD-40). The absence of visual cues while flying, like the conditions encountered during the MF, makes reliance on aircraft instrumentation absolute, to override the inherent, normal sensory illusions of motion, orientation, and acceleration (Tab DD-40).

c. **PE202 Instrumentation and Warning System Issues**

HFACS Code PE202, Instrumentation and Warning System Issues, is a factor when instrument factors such as design, reliability, lighting, location, symbology, size, display systems, auditory or tactile situational awareness or warning systems create an unsafe situation (Tab DD-11).

The MP reported the lighting in his cockpit was adequate (Tab V-1.4). From recovered CSFDR data and the interview, the MP experienced inaccurate primary flight and navigation systems without corresponding fault or failure indications (Tab U-11). From the available data, and his interview, it is clear the primary ADI was displaying an inaccurate attitude reference, to include displaying a continual 20° – 60° nose high attitude, despite his actual flight path during that time being a climbing and descending flight path (Tabs U-15, U-19, and V-1.2 to V-1.3). Because there were no fault or failure indications of the primary ADI warning him that his instruments were wrong, he was only able to determine his aircraft attitude from his SAI (Tab U-11 and V-1.3). When the MP referenced the SAI, it was showing all black, nose low attitude, which was in complete contradiction to his ADI (Tab V-1.3). Multiple attempts to cross-check between the primary and SAI were also unable to resolve the mismatch between visual and conflicting instrument-based cues and discern proper aircraft orientation (Tab V-1.3).

d. **PC508 Spatial Disorientation (SD)**

HFACS Code PC500, Sensory Misperception, refers to multiple factors resulting in degraded sensory inputs (visual, auditory or vestibular) that create a misperception of an object, threat, or situation (Tab DD-14). Specifically, PC508, Spatial Disorientation (SD), is a factor when an individual fails to correctly sense a position, motion, or attitude of the aircraft/vehicle/vessel or of oneself (Tab DD-14). SD may be unrecognized and/or result in partial or total incapacitation (Tab DD-14).

Multiple components of PC500, Sensory Misperception, contribute to PC508, Spatial Disorientation (Tab DD-14). As discussed below, loss of instruments, i.e. loss of key navigational components used to build a pilot's internal (cerebral, trained) self-generated construct of his location in air and space relative to the Earth, make a pilot susceptible to erroneous perceptions of orientation, motion, or acceleration as per PC501, Motion Illusion-Kinesthetic, PC502, Turning/Balance Illusion-Vestibular, which manifest as PC508, Spatial Disorientation (Tab DD-14).

The body uses three integrated systems that work together to ascertain orientation and movement in space (Tab DD-43). Vestibular system-organs found in the inner ear that sense position by the way we are balanced (Tab DD-43). Somatosensory system-nerves in the skin, muscles, and joints that, along with hearing, sense position based on gravity, feeling, and sound (Tab DD-43). Visual system-eyes, which sense position based on what is seen (Tab DD-43). While all three systems work together, the visual system is dominant, if available, either in actual visual conditions or as a visual construct built from instrument information (Tab DD-43). Without visual references outside the aircraft, there are many situations in which combinations of normal motions and forces create convincing illusions (Tab DD-14). If visual cues are compromised, by darkness or weather, normal motion can be misinterpreted as illusions; however, the pilot usually avoids this by using aircraft instruments for orientation (Tab DD-40). If the pilot loses the instruments, then they lose the visual information necessary to build the visual-dominant, artificially generated three-dimensional orientation construct in space (Tab DD-40).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. **Publicly Available Directives and Publications Relevant to the Mishap**

(1) AFI 51-307, Aerospace and Ground Accident Investigations, dated 18 March 2019
(2) DAFI 21-101, Aircraft and Equipment Maintenance Management, dated 8 November 2022
(3) Department of Defense Human Factors Analysis and Classification System 7.0 (DoD HFACS 7.0), available at: https://www.safety.af.mil/Divisions/Human-Factors-Division/HFACS/
(4) Federal Aviation Administration, Pilot's Handbook of Aeronautical Knowledge, FAA, H-8083-25B, 2016, available at: https://www .faa.gov/regulations _policies/handbooks_ manuals/aviation/phak/
(5) DAFI 91-204, Safety Investigations and Reports, dated 10 March 2021

(5) DAFI 91-204, Safety Investigations and Reports, dated 10 March 2021
(6) AFM 11-2F-16V3, F-16 Operations Procedures, dated 4 February 2020, incorporating change 3, dated 13 September 2022, certified current, 13 September 2022
(7) AFMAN 11-202V3, Flight Operations dated 10 January 2022

NOTICE: All directives and publications listed above are available digitally on the Air Force Departmental Publishing Office website at: https://www.e-publishing.af.mil. Other Directives and Publications Relevant to the Mishap

b. **Other Relevant Directives but Not Publicly Available**

(1) 1F-16CM-1, Flight Manual, dated 1 August 2022, Interim Supplement 10 January 2023
(2) 1F-16CM-34-1-1, Avionics and Nonnuclear Weapons Delivery Flight Manual, dated 1 September 2022, Interim Supplement 1 February 2023

[redacted]

19 December 2023

LYNN E. SAVAGE, Colonel, USAF
President, Accident Investigation Board

United States Air Force Accident Investigation Board Report

Class A, Osan AB

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