UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

F-16CM, T/N 88-0479

35TH FIGHTER SQUADRON
8TH FIGHTER WING
KUNSAN AIR BASE, REPUBLIC OF KOREA

LOCATION: KUNSAN AIR BASE, REPUBLIC OF KOREA

DATE OF ACCIDENT: 11 DECEMBER 2023

BOARD PRESIDENT: COLONEL PHILIP D. LANCASTER

Conducted IAW Air Force Instruction 51-307

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

JUL 2 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 11 December 2023, Class A mishap, occurring near Kunsan Air Base, South Korea, involving an F-16CM, T/N 88-0479, assigned to the 35th Fighter Squadron, substantially complies with applicable regulatory and statutory guidance and on that basis is approved.

LAURA L. LENDERMAN
Lieutenant General, USAF
Deputy Commander, Pacific Air Force

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

F-16CM, T/N 88-0479
KUNSAN AIR BASE, REPUBLIC OF KOREA
11 DECEMBER 2023

On 11 December 2023 at 08:23 hours local (L) time, the mishap pilot (MP) assigned to the 35th Fighter Squadron (FS), "Pantons", took off for a local training flight in mishap aircraft (MA) F-16CM, tail number (T/N) 88-0479, assigned to the 80th Fighter Generation Squadron (FGS), with both squadrons being assigned to the 8th Fighter Wing (FW), Kunsan Air Base (AB), Republic of Korea (ROK). At approximately 08:42L while transiting through the local training airspace, the MP ejected from the MA with no injuries. The MA impacted the water approximately 81 nautical miles (NM) west of Kunsan AB in the Yellow Sea and was destroyed. The mishap resulted in the loss of a $28,259,045.00 United States Air Force Aircraft. The Crash Survivable Memory Unit (CSMU), commonly called the "blackbox", containing all MA forensic information, is not available at the time of this report.

The mishap flight was planned and authorized as a defensive counter air (DCA) training mission within the local training airspace. The MP was flying as number three of a formation of four F-16s. Observed conditions in the training areas were worse than forecasted, with dense cloud coverage throughout.

At approximately 08:37L, while transiting through the training airspace in instrument meteorological conditions (IMC), in clouds, the MP lost the primary instrument that indicated where the horizon was relative to his aircraft, called an "attitude indicator". This instrument operates based on information provided by an embedded global positioning system inertial navigation system (EGI), which failed. The MP immediately transitioned to the only remaining attitude information available, the standby attitude indicator (SAI). Earlier in the flight, the MP observed slight pitch and bank errors on the SAI, increasing the difficulty of reconciling attitude from the SAI with the MA airspeed and attitude information, exacerbating overall disorientation. With the help of a wingman flying in trail, communicating navigation and altitude information, the MP started a descent to expected cloud free sky based on briefed weather. Still in IMC at 3,000 ft mean sea level (MSL), the MP attempted to level off, but became further disoriented. The MP's confidence in the MA's attitude continued to decrease, now nearing the water, and the decision was made to eject.

I find, by a preponderance of evidence, the cause of the mishap was an EGI failure while in IMC. The malfunctioning EGI led to a loss of primary flight and navigation instruments. I also find by a preponderance of the evidence that the subsequent reliance of the MP on the MA's SAI, which previously displayed abnormal indications, and the spatial disorientation of the MP, substantially contributed to the mishap.

SUMMARY OF FACTS AND STATEMENT OF OPINION
F-16CM, T/N 88-0479
KUNSAN AIR BASE, REPUBLIC OF KOREA
11 DECEMBER 2023

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ACRONYMS AND ABBREVIATIONS

AB – Air Base
ACES II – Advanced Concept Ejection Seat Two
ADI – Attitude Indicator
AFB – Air Force Base
AFE – Aircrew Flight Equipment
AFMAN – Air Force Manual
AFTO – Air Force Technical Order
AIB – Accident Investigation Board
ARB – Air Reserve Base
ARMS – Aviation Resource Management
ATAGS – Advanced Technology Anti-Gravity Suit
BP – Board President
BPO – Basic Post-Flight
Capt – Captain
CDU – Center Display Unit
CG – Coast Guard
CMR – Combat Mission Ready
Cobra – Airspace Tactical Control Agency
Col – Colonel
CSMU - Crash Survivable Memory Unit
CT – Continuation Training
DCA – Defensive Counter Air
DoD – Department of Defense
EFB – Electronic Flight Book
EGI - Embedded Global Positioning System Inertial Navigation System
EOR – End of Runway
FDP – Flight Duty Period
FDR - Flight Data Recorder
ft – Feet
FS – Fighter Squadron
FW – Fighter Wing
GPS – Global Positioning System
HAOP – Handbook of Aerospace Physiology
HFACS – Human Factor Analysis Classification Systems
HIS – Horizontal Situation Indicator
HMCS – Helmet Mounted Cueing System
HUD – Heads Up Display
IAW – In Accordance With
IMC – Instrument Meteorological Conditions
IMDS – Integrated Maintenance Data System
KEAS – Knots Equivalent Air Speed
kts – Knots
L – Local Time
LA – Legal Advisor
MA – Mishap Aircraft
MEF – Mission Execution Forecast
MF – Mishap Flight
MF1 – Mishap Flight Lead
MFL – Maintenance Fault List
MMC – Modular Mission Computer
MP – Mishap Pilot
MQT – Mission Qualification Training
MSL – Mean Sea Level
NM – Nautical Miles
OPS-PEC – Pilot Entered Coordinates
ORM – Operational Risk Management
PACAF – Pacific Air Forces
PC – Physiological Conditions
PE – Physical Environment
PFL – Pilot Fault List
PHA – Periodic Health Assessment
PLB – Personnel Locator Beacon
PR – Pre-Flight
PRD – Pilot Reported Discrepancy
QA – Quality Assurance
RATD – Radar Assisted Trail Departure
ROK – Republic of Korea
SAI – Standby Attitude Indicator
SAR – Search and Rescue
SCU – Software Capability Upgrade
SIB – Safety Investigation Board
SJA – Staff Judge Advocate
SK – Somaek
SM – Statute Miles
SME – Subject Matter Expert
SMSgt – Senior Master Sergeant
SrA – Senior Airman

SSgt – Staff Sergeant
T/N – Tail Number
TAF – Terminal Aerodrome Forecast
TCTO – Time Compliance Technical Orders
TO – Technical Order
Top 3 – Squadron Supervision
USINDOPACOM – United States Indo-Pacific Command
VMC – Visual Meteorological Conditions
WAI – Walk-Around Inspections
Z – Zulu Time

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 19 January 2024, Lieutenant General James A. Jacobson, Deputy Commander, Pacific Air Forces (PACAF), appointed Colonel (Col) Philip D. Lancaster to conduct an aircraft accident investigation, under the provisions of Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations* (Tab BB-1), of the 11 December 2023 mishap of an F-16CM aircraft at Kunsan Air Base (AB), Republic of Korea (ROK). (Tab Y-1). The convening order included Col Lancaster as the Board President (BP), a Captain (Capt) Legal Advisor (LA), and a Senior Airman (SrA) Recorder. (Tab Y-1). Part One of the Safety Investigation Board (SIB) was given to the Accident Investigation Board (AIB) on 28 January 2024 at Kunsan AB, ROK. The appointed member present for the hand-off was the LA. A Senior Master Sergeant (SMSgt) maintenance member was appointed to the AIB as a Subject Matter Expert (SME) Board Member, by the Staff Judge Advocate (SJA), PACAF, on 31 January 2024. (Tab Y-2). A Captain weather SME and a Staff Sergeant (SSgt) Aircrew Flight Equipment (AFE) SME were detailed by the SJA, PACAF, on 31 January 2024. (Tab Y-2). A Captain aerospace physiologist SME and a civilian F-16 aircraft SME were detailed by the SJA, PACAF, on 6 February 2024. (Tab Y-3). SIB Tabs A-S were given to the AIB on 7 February 2024. The board conducted the accident investigation at Kunsan AB, ROK, from 8 February 2024 to 1 March 2024.

b. Purpose

In accordance with AFI 51-307, *Aerospace and Ground Accident Investigations*, (Tab BB-1), this Accident Investigation Board 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.

2. ACCIDENT SUMMARY

On 11 December 2023, at 08:23 hours local (L) time, the mishap pilot (MP) assigned to the 35th Fighter Squadron (FS), "Pantons", took off for a local training flight in mishap aircraft (MA) F-16CM, tail number (T/N) 88-0479, assigned to the 80th Fighter Generation Squadron (FGS), both squadrons assigned to the 8th Fighter Wing (FW), Kunsan AB, ROK. (Tabs K-1; AA-2). At approximately 08:42L while transiting through the training airspace the MP ejected from the MA, resulting in no injuries. (Tab DD-5). The MA impacted the water and was destroyed approximately 81 nautical miles (NM) west of Kunsan AB in the Yellow Sea and is awaiting recovery at the time of this report. (Tab Z-4). The mishap resulted in the loss of a $28,259,045.00 United States government asset. (Tab P-1).

3. BACKGROUND

a. Pacific Air Forces (PACAF)

Headquartered at Joint Base Pearl Harbor-Hickam, PACAF's primary mission is to provide the United States Indo-Pacific Command (USINDOPACOM) with continuous unrivaled air, space, and cyberspace capabilities to ensure regional stability and security. (Tab CC-1).

b. 8th Fighter Wing (8 FW)

Headquartered at Kunsan AB, ROK, the 8th FW, otherwise known as the "Wolf Pack", is a "resilient warfighting wing ready to deliver combat airpower at a moment's notice; honoring our legacy by fostering an evironment of teamwork, dignity, and respect; enhancing the Wolf Pack culture of innovation, compliance, and excellence…1 year tour with a 10 year vision". (Tab CC-2).

c. 35th Fighter Squadron (35 FS)

Headquartered at Kunsan AB, ROK, the 35 FS, otherwise known as the "Pantons", provides combat-ready F-16C/D fighter aircraft to conduct air operations throughout the Pacific theater as tasked by United States and coalition combatant commanders. The squadron performs air and space control and force application roles including counter air, strategic attack, interdiction, and close-air support missions. It employs a full range of the latest state-of-the-art precision ordinance, day or night, all weather. (Tab CC-3).

d. 80th Fighter Generation Squadron (80 FGS)

Unofficial Mission Statement: Headquartered at Kunsan AB, ROK, the 80 FGS provides combat-ready F-16 C/D fighter aircraft to conduct air operations throughout the Pacific theater as tasked by United States and coalition combatant commanders. Airmen assigned to the 80 FGS perform pre-flight inspections on F-16 fighter aircraft. The maintainers' key responsibility is to inspect, maintain, and repair mechanical and electrical components of the F-16 before and after flight. (Tab CC-4).

e. F-16, Fighting Falcon

The F-16 Fighting Falcon is a compact, multi-role fighter aircraft. It is highly maneuverable and has proven itself in air-to-air combat and air-to-surface attack. It provides a relatively low-cost, high-performance weapon system for the United States and allied nations. The 'M' following the 'C' in F-16C denotes the aircraft has been modified with a modular mission computer. (Tab CC-5).

4. SEQUENCE OF EVENTS

a. Mission

The mishap flight (MF) was a formation of four F-16CM, callsign Somaek (SK), numbered 11 through 14. (Tab K-1). The MP/MA was number three in the MF (MF3), call-sign Somaek 13 (SK13). This was the first flight of the day for all pilots in the MF and was a continuation training (CT) sortie executing a defensive counter air (DCA) mission scenario in the local training airspace with a planned return back to Kunsan AB. (Tab K-1). The MF's training scenario involved defending a portion of the training airspace from a second formation of four F-16s, Ares flight, also from the 35 FS, simulating adversary aircraft. (Tab K-1). A 35 FS flight commander authorized the mission on an Aviation Resource Management (ARMS) Fighter Flight Authorization Form. (Tab AA-2).

b. Planning

The MP arrived at the squadron before the scheduled brief time of 0510L, completed the operational risk management (ORM) form, checked the AFE gear, and checked the weather. (Tabs K-1; V-1). Overall, the ORM process assigns points for weather/environmental factors (temperature, day/night, icing etc.), mission factors (location, number of aircraft, munitions, etc.), and human factors (rest, experience level, recency of flying, etc.). The more points, the more elevated the ORM. The MP noted a "light" fatigue level on the ORM form, while the remainder of the MF noted "well-rested". (Tab K-1). During interviews, the MP was not concerned about the fatigue level, attributing it to the early show time and the transition from 0800 brief times the week prior. (Tab V-1). Neither members of the MF, nor the squadron supervision (Top 3), noted any concerns with MP fatigue. The MF's ORM was "HIGH" due to various weather factors in the training airspace, the training scenario involving more than four aircraft, and multiple sorties planned by the MF for the day. (Tab K-1). In this context, "high risk" is expected to drive mission preparation and mitigation measures/discussions, not risk to mission scenario objectives. The Top 3 obtained deputy group commander approval of the ORM. (Tab K-1).

The MP continued pre-flight actions noting no abnormalities with AFE gear, then checked the airfield and airspace weather. (Tab V-1). The largest airfield weather impact forecasted was light rain and mist causing a wet runway, potentially increasing stopping distance on landing. The forecasted training airspace weather was worse but still operable with clear air below 1,500 ft mean sea level (MSL) and clouds up to 35,000 ft with some bands of clear air, specifically between 14,000 ft and 30,000 ft MSL. (Tabs F-1; W-1).

The MF completed the remaining pre-flight requirements, ensuring everything was in order before the flight briefing. The mishap flight lead (MF1 or Somaek 11), who was the overall mission lead, then briefed the MF on specific mission execution, addressing the ORM factors noted above. (Tabs K-1; V-3). MF1 emphasized the airspace weather. The flight expected to conduct the majority of their training in the forecasted clear air bands. MF1 emphasized and briefed instrument meteorological condition (IMC) training rules, which describe maneuver restrictions pilots must follow when flying in or near clouds. (Tab V-3).

c. Preflight

The MP donned required flight equipment, to include a helmet mounted cueing system (HMCS) capable helmet, harness, advanced technology anti-gravity suit (ATAGS), and survival vest. (Tabs J-1; V-1). Additionally, due to the low water temperature, the MP wore an anti-exposure suit or dry suit. (Tabs J-1; V-1). The MP was assigned an MA from 80 FGS, while the remainder of the MF flew 35 FGS aircraft. (Tab AA-2). The 8 FW calls the sustained utilization of sister maintenance squadron aircraft by an FS "green operations" and is a routine practice at Kunsan AB. According to the MP and Top 3 testimonies, 80 FGS aircraft were delayed approximately 40 minutes due to Air Force Technical Order (AFTO) 781 form approval. (Tabs V-1; V-8). The AFTO 781 documents all aircraft maintenance and approval and is required prior to aircraft flight. While awaiting approval, the MP conducted the aircraft walk-around, which involves checking the exterior of the aircraft. (Tab V-1).

Once the MA AFTO 781 forms were approved, the MP climbed into the aircraft to continue to prepare it for flight. (Tab V-1). The MP properly strapped into the ejection seat and secured the electronic flight book (EFB) to the MP's leg. (Tab V-1). The MP does not recall checking the position of the rocker switch assembly on the seat for the AN/URT-46 beacon, which is designed to send post-ejection alerts, although it was found in the correct position of "automatic" during recovery. *See Figure 1 below.* (Tabs V-1; Z-7).

Figure 1. Beacon in Automatic Position. (Tab Z-7).

Despite being delayed, the MP testified to not feeling rushed while completing required checklist procedures before leaving parking. These procedures were mostly routine. (Tab V-1). Due to the inability of the MA to receive Global Positioning System (GPS) reception while parked in the GEN 15 hangar, as well as a lack of GPS repeater operation, after the flight control built in test was completed, the MP conducted a Shelter OPS-PEC (Pilot Entered Coordinates) of the embedded GPS and inertial navigation system (EGI). (Tabs V-1; Z-1). In accordance with technical order (TO) 1F-16CM-1, the MP removed GPS input from the EGI to not induce errors based on lack of satellite reception, and then manually entered the aircraft location. *See Figure 2 below.* (Tabs V-1; Z-1; BB-7). The GPS coordinates the MP entered were displayed on the wall inside the hangar. *See Figure 2 below.* (Tab Z-1). The MP noted the MA did not have GPS keys and received a GPS re-key by an 80 FGS specialist, allowing the MA's GPS to receive the encrypted precision code. (Tab V-1). The re-key process is routine, and the EGI will function without a re-key.

Figure 2. Coordinates of GEN 15 Hangar. (Tab Z-1).

Once pre-taxi checks were completed, the MP taxied the MA out of the hangar stopping on the adjoining parking area, where the GPS input to the EGI was enabled. (Tab V-1). While stationary, the MP executed the instrument cockpit check, noting navigation and EGI operations were acceptable. (Tab V-1). During the remainder of time prior to taxiing to the runway, the MP did not note any additional maintenance fault lists (MFL), pilot fault lists (PFL), or any other malfunctions with the MA. All applicable checklist and/or directive items were completed. (Tab V-1).

While taxiing to the end of runway (EOR), the MP noted the standby attitude indicator (SAI) had precessed (drifted off the correct setting) and was indicating slight pitch and bank errors. *See, e.g., Figure 3 below.* (Tabs V-1; Z-8 to Z-10; BB-7). Note that most of the pilots interviewed testified to routinely seeing poorly performing SAIs (Tabs N-1; V-1; V-3 to V-5; V-8). Once stationary at EOR, the MP re-caged the SAI, correcting the errors. (Tab V-1). The correction was applied more than two minutes prior to takeoff in accordance with (IAW) TO 1F-16CM-1. (Tabs V-1; BB-7). The MP was ready for takeoff at 08:20:21. (Tab Z-6).

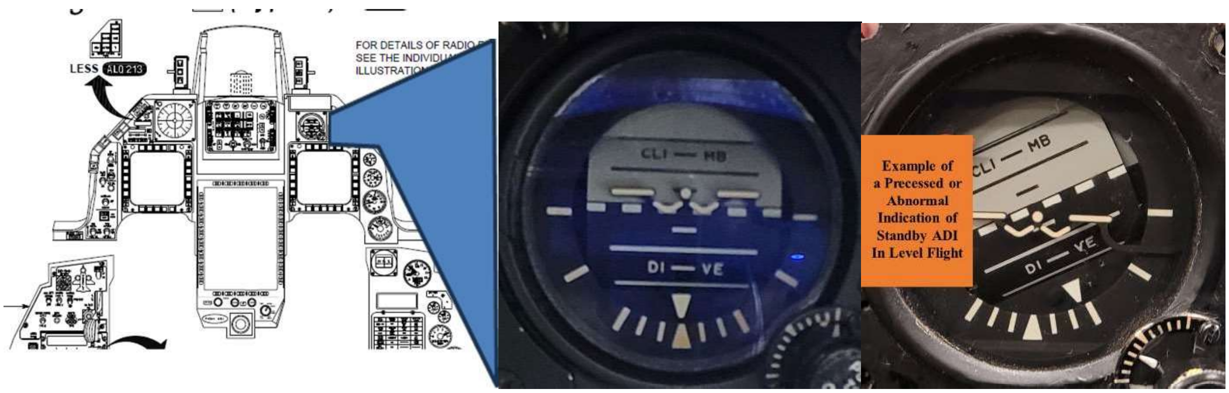

Figure 3. Cockpit Arrangement, Normal SAI, and Precessed SAI. (Tabs Z-8 to Z-10).

At 08:23:27L the MF was cleared for takeoff, nearly 45 minutes later than the planned departure time. (Tabs K-1; Z-13). Due to airfield weather preventing the MF from maintaining visual contact with one another once airborne, MF1 directed the MF to conduct a radar assisted trail departure (RATD). During a RATD, each member of the MF flies 2-3 NM in trail of the preceding aircraft, using the on-board aircraft sensor information to maintain spacing and deconfliction. The MF flew the directed departure to navigation point "CONAN" and then turned onto local training airspace "Highway 8". (Tab Z-13). The take-off and departure were IAW applicable checklists and directives. During departure, the MP noted a slight pitch and bank error on the SAI, planning to adjust it once the MF leveled off, as required by the TO 1F-16CM-1. (Tab BB-7). TO 1F-16CM-1 describes a known four-degree difference in pitch angle between the ADI and SAI based on the SAI mounting angle. (Tabs V-1 to V-4; Z-13; BB-7). The MF remained in IMC and RATD until just prior to landing at Kunsan AB. (Tabs V-1 to V-4; Z-13).

d. Summary of Accident

The flight was uneventful until 08:34:04L, when Somaek 12 (MF2) communicated an engine anomaly to MF1. (Tab V-4). MF1 and MF2 discussed the engine issue as the MF continued on Highway 8 in RATD in IMC. (Tab Z-13). During this time, the MP was focused on assisting MF2 with their engine issue. (Tab V-1).

At 08:36:47, the MP communicated "three's MMC fail" (Tab Z-13). A Modular Mission Computer (MMC) fail results in the removal of information from the heads up display (HUD) and some center display unit (CDU) information, among other cockpit indications. (Tab BB-7). In particular, an MMC fail removes radar information from the pilot. Therefore, the MP discontinued the RATD with MF1 and MF2, and immediately established 1,000 feet (ft) of altitude between the elements of MF1/MF2 and MF3/MF4 since they were still in IMC. (Tab Z-13). MF4 remained in RATD with the MP. (Tab Z-13).

An EGI failure is similar to an MMC failure with a notable difference; during EGI failure the attitude indicator (ADI) and horizontal situation indicator (HSI) are replaced with the word FAIL on the CDU. *See Figure 4 below.* (Tabs BB-11; Z-11 to Z-12). During the interview, the MP stated having experienced MMC fails in the past and how that experience and the MA's history of MMC malfunctions influenced the initial diagnosis. (Tab V-1). After further analysis, the MP recognized the loss of HSI and ADI information on the CDU in addition to attitude information, pointing towards EGI failure. (Tab V-1).

Figure 4. Normal CDU and Example of EGI Fail CDU. (Tabs Z-11 to Z-12; BB-11).

At 08:37:33L the MP communicated, "I've lost my CDU". (Tabs V-1; Z-13). During testimony, the MP stated that based on the additional circumstances of the MF (MF2's engine issue and poor weather) communication of a CDU failure was a succinct way to communicate the seriousness of the MP's challenges when combined with the prior MMC fail communication. (Tab V-1).

At 08:38:13L the MP communicated to the MF "on my standby", meaning the only attitude reference was the SAI. The MP then told MF4 to remain in radar trail and to monitor airspeed and altitude as the MP began a "shallow descent". (Tabs V-1; Z-13). According to the MP, this communication was meant to underscore the seriousness of the MA issues and indicates when the MP confirmed EGI failure. Indications noted by the MP at this time were "EGI NAV FAIL PFL" on the PFL display, and "HSI and ADI display FAIL" on the CDU, along with an inoperable auto-pilot. There was no attitude information on the HUD, although airspeed and altitude were available on the HUD and CDU (Tab V-1). MF3 and MF4 continued on a stable westerly heading, remaining in IMC, as MF4 called out MP's altitude in the descent. (Tab V-2). The MP testified to being task saturated maintaining aircraft control. (Tab V-10).

At 08:38:58L near the tail of a lengthy administrative communication exchange between Ares 11, another flight of F-16s, and the airspace tactical control entity (Cobra), MF2 communicated hearing “two pops” from their aircraft and having difficulty maintaining altitude and airspeed at the current power setting. (Tabs V-3 to V-4; Z-13). It is near this time that MF1 and MF2 changed radio frequencies and discontinued supporting MF3 and MF4 due to the perceived severity of MF2’s engine issue. (Tabs V-1 to V-4; Z-13).

At 08:39:23L, now on a separate frequency from MF1, the MP communicated a gameplan to descend below the weather, and for MF4 to “rejoin to chase”, a position approximately 500 ft distance and in visual contact with the MA. (Tabs V-1; Z-13). TO 1F-16CM-1 has procedures to correct an EGI failure, but it is unclear if they apply in this mishap scenario. The MP prioritized finding cloud free sky and/or a rejoin with MF4 versus executing corrective actions.

The MP chose to find cloud free sky for the following reasons. Based on MP recollection of the forecast (clear sky below 3,500 ft MSL), the MP thought it was possible to do so. (Tab V-10). Additionally, the TO seems to require maintaining straight and level flight for EGI failure correction, which the MP was unable to do using only the SAI. (Tab BB-7). Finally, to reach the EGI control switch in the cockpit, the MP would be required to release the control stick and turn the torso and head to the right. *See Figure 5 below*. (Tabs Z-14; BB-7). This body movement would be disorienting, particularly while in IMC and relying on the SAI. For these reasons, the MP chose to descend, and MF4 continued to call out the MP’s altitude and airspeed in the descent. (Tab Z-13). MF4’s radar information alone does not provide enough information for the MP’s spatial awareness.

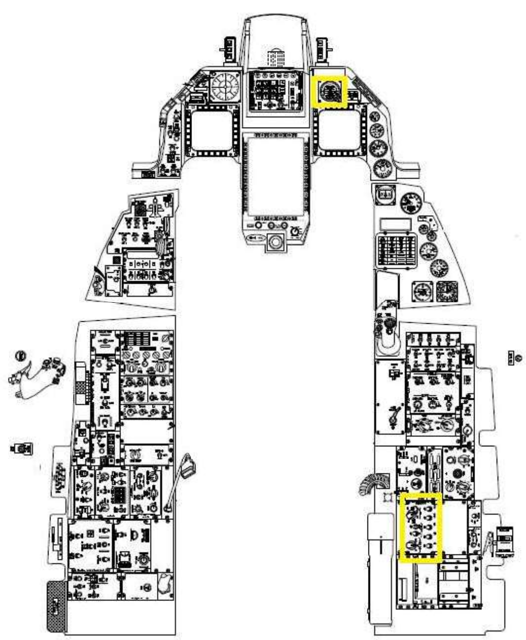

Figure 5. F-16 Cockpit Avionics Panel, with EGI Control (Lower Right) and SAI (Upper Right) Highlighted in Yellow. (Tabs Z-14; BB-7).

At 08:41:00L, MF4 stated that MP was at 3,000 ft. The MP communicated the intent to level off and appeared to do so according to MF4's radar information. (Tab Z-6). However, the MP stated the SAI indicated a climb, but the airspeed indicator (increasing airspeed) and altimeter (decreasing altitude) indicated a descent, not leveling, of the MA. (Tab V-1).

At 08:41:39L, the MP directed a frequency change to Kunsan AB approach control. The MP did not recall directing the frequency change. This is the last communication from the MP. (Tabs V-2; Z-6).

e. Impact

At 08:41:56L, according to MF4's radar information, the MA began a slight climb. (Tab Z-13). According to the MP, the SAI indicated a nose high attitude, but the altitude kept decreasing. (Tab V-1). When the MP saw 2,300 ft MSL the decision was made to eject. (Tab V-1). According to MF4's radar, at 08:42:10L the MA appeared to enter a left turn and rapid descent and eventually MF4's radar lost track of the MA at 08:42:22L. (Tab Z-13). The data recorder on the seat sequencer shows an approximate ejection altitude of 1,731 ft MSL. (Tab L-2). Without information from the Crash Survivable Memory Unit (CSMU), commonly called the "blackbox", it is not possible to determine exactly when ejection was initiated, nor the attitude of the MA. *Figure 6* below shows underwater debris of the MA, note the low in-water visibility.

Figure 6. Underwater Debris of MA. (Tab S-1).

f. Egress and Aircrew Flight Equipment (AFE)

Ejection was initiated at approximately 0842L by pulling the ejection handle with the parameters approximated above. (Tab Z-6). Once the seat was in the airstream during the ejection process, the seat slowed and the seat sequencer determined that the parameters were within the "mode 1" operation of the advanced concept ejection seat two (ACES II). (Tab L-1). Mode 1 is used for ejections with speeds less than 250 knots equivalent airspeed (KEAS) and altitudes between sea level and 15,000 ft MSL. (Tab BB-2). During a mode 1 ejection, the jet is at a low enough speed and altitude that the seat will not deploy the drogue (small) parachute installed for seat stabilization during ejection. (Tab BB-2). The seat operated properly during ejection. (Tab V-1). The egress system was inspected per the 30-day, 12-month, and 36-month requirements. (Tab DD-1). The MP was current and qualified in AFE training, to include AFE local procedures, 120-day fit check, egress ejection training, and water survival training. (Tab DD-4). The seat was equipped with a personnel locater beacon (PLB), and the beacon was found to be in the automatic mode when the seat was recovered. *See Figure 1.* (Tab Z-7). The beacon is designed to transmit a warning tone on various frequencies. Beacon transmission could not be verified. (Tab BB-6). There are no other AFE issues pertinent to this investigation.

Figure 7. Ejection Seat. (Tab Z-5).

g. Search and Rescue (SAR)

The MA impacted the Yellow Sea approximately 81 NM west of Kunsan AB. (Tabs V-7; Z-13). At 08:42:41L, MF4 reported to Cobra a "possible bailout". (Tab Z-6). Cobra initiated their SAR checklist at 08:43:23 based on communication from MF4 combined with the loss of their own radar information on the MA. MF4 became the initial on-scene commander (Tab V-7). The weather was approximately 500 ft MSL in the crash location, which made locating the MP from airborne fighter aircraft difficult. (Tab V-1). Approximate MP location was determined by MF4 and numerous additional Osan AB and Kunsan AB based aircraft who aided in the recovery efforts. (Tabs V-6 to V-7). The closest recovery asset to the mishap was a ROK Navy ship, which was coincidentally 10 NM from the SAR area. (Tabs V-7; AA-3). The ship arrived at the MP location at 10:29L and the MP was rescued at 10:31L. (Tabs V-7; AA-4). Once on the ROK navy ship, the MP was treated for hypothermia and stabilized. (Tab V-1). The MP was transported to Kunsan AB via a ROK Coast Guard (CG) helicopter at approximately 11:22L, arriving at Kunsan AB at approximately 12:01L. (Tabs V-7; AA-4 to AA-5).

h. Recovery of Remains

There were no casualties in this mishap, therefore this section is not applicable.

5. MAINTENANCE

a. Forms Documentation

The AFTO 781 series forms collectively provide a maintenance, inspection, service, configuration, status, and flight record. The AFTO 781 forms, in conjunction with the Integrated Maintenance Data Systems (IMDS), provide a comprehensive database used to track and record maintenance actions and flight activity, as well as schedule future maintenance. (Tabs BB-8 to BB-9).

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. (Tabs U-6 to U-8; U-9; U-11). Of note, the MA received recent TCTOs, upgrading the MMC and the CDU. (Tab U-9). Subsequent follow-on inspections and operational checks were appropriate, conducted, and documented without discrepancy. (Tabs U-7; U-11; U-12). A thorough review of the active AFTO 781 forms and IMDS historical records for the 105 days preceding the mishap revealed a Pilot Reported Discrepancy (PRD) resulting in unscheduled maintenance performed on the MMC. This included line replaceable module replacements within the MMC related to fault isolation and troubleshooting for persistent MMC related PRDs. AFTO 781 forms and IMDS were properly referenced, and corrective actions in accordance with prescribed TOs were appropriately conducted and properly documented. (Tabs U-6 to U-8; U-11). Additionally, records reviews revealed the EGI was removed and reinstalled on 08 September 2023 to facilitate other maintenance. Subsequent follow-on operational checks were appropriate, conducted, and documented without discrepancy. (Tabs U-7; U-11; U-12). Lastly, records reviews did not reveal any PRDs related to the SAI within a year prior to the mishap. The last noted PRD related to the SAI was on 02 December 2022. (Tabs U-4 to U-5). The MA was operating as designed and there was no indication of mechanical, electrical, or structural failure prior to the mishap. (Tabs B-1; U-6 to U-8; U-9; U-11).

b. Inspections

The Pre-Flight (PR) Inspections and Basic Post-Flight (BPO) Inspections include visually examining the aircraft and operationally checking certain systems and components to ensure no serious defects or malfunctions exist. Walk-Around Inspections (WAI) are abbreviated PR inspections, completed as required prior to launch, in accordance with applicable TOs. (Tab BB-9).

The total airframe time of the MA at takeoff was 8,716.9 hours. (Tab U-6). The last BPO inspection occurred on 07 December 2023 at 12:30L with discrepancies noted during a Quality Assurance (QA) inspection. These discrepancies were unrelated to the cause of the mishap, were immediately corrected according to applicable TO guidance, and were properly documented. (Tabs U-2; U-6 to U-8). The MA did not fly between 08-10 December 2023. (Tab U-13). PR inspections were completed on 11 December 2023 at 0100L prior to flight with no discrepancies noted. (Tabs U-6; U-8; U-13). The on-shift Production Superintendent performed the WAI on 11 December 2023 at 0430L with no discrepancies noted. (Tabs U-6; U-8). Prior to the mishap, the MA had no relevant reportable maintenance issues, and all inspections were satisfactorily completed. (Tabs U-6; U-8; U-13).

c. Maintenance Procedures

A review of the MA's active and historical AFTO 781 series forms and IMDS revealed that all maintenance actions complied with standard approved maintenance procedures and TOs. (Tabs U-6 to U-8; U-9).

d. Maintenance Personnel and Supervision

The 80 FGS maintenance personnel performed all required inspections, documentation, and servicing for the MA prior to flight. A detailed review of maintenance activities and documentation did not reveal any discrepancies between the AFTO 781 forms and IMDS. (Tabs U-6 to U-8; U-9). Personnel involved in the MA's preparation for flight had proper and adequate training, experience, expertise, and supervision to perform their assigned tasks. (Tabs U-1; U-10 to U-11).

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

Due to the nature of the impact, all aircraft fluid samples were destroyed and are not testable. The CSMU and Flight Data Recorder (FDR) were not recovered from the MA. It is unknown if the fuel system, hydraulic system, and engine were all operating and responding to MP's inputs just prior to ejection. A sample of the hydraulic fluid recovered from the hydraulic test stand recently used on the MA to perform unrelated follow-on operational checks, was analyzed, and was found to be within particulate limits for a hydraulic test stand per TO requirements. (Tabs J-4 to J-5; BB-10). Fuel samples from the fuel truck, tank, and fill-stand that serviced the MA were tested with no discrepancies reported. (Tabs J-1 to J-3). Oil samples from the oil cart were tested with no discrepancies reported. (Tab J-7). Liquid Oxygen samples from the servicing cart were tested with no discrepancies reported. (Tab J-6).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

Very little wreckage is recovered to date. *See Figure 8 below.* (Tabs Z-2 to Z-3). The right rear of the aircraft contains the CSMU. A portion of the right rear of the aircraft was recovered, but the CSMU was not attached. No portions of the EGI were recovered. The EGI for the MA was manufactured by Northrop Grumman. (Tab AA-7).

The SAI is an electrically powered gyroscope that is mechanically positioned. (Tab BB-7). The 2.4-inch instrument is original equipment to the F-16 fleet of aircraft, the industry standard has been updated to a 3+ inch display. (Tab AA-8). While the SAI has an OFF flag (orange tab that appears on the face of the SAI), the flag denotes a loss of electrical power, it is not displayed for indication errors. (Tab BB-7). TO 1F-16CM-1 briefly describes how the indicator can develop errors, but the discussion is limited to errors caused by aerobatic maneuvering. (Tab BB-7). Most of the pilots interviewed testified to routinely seeing poorly performing SAIs not limited to aerobatics (Tabs N-1; V-1; V-3 to V-5; V-8). However, acceptable performance criteria for the SAI is not published, and is subjective.

Figure 8. MA Wreckage. (Tabs Z-2 to Z-3).

b. Evaluation and Analysis

The ejection seat data recorder was the only item available for analysis. According to the data recorder on the seat sequencer, approximate altitude at ejection was 1,731 ft. (Tabs L-1 to L-3). The airspeed data was too corrupted to approximate an airspeed.

c. Simulation Data

In a simulated replication of the mishap, once airborne and in IMC, simulator cockpit indications of the EGI failure matched indications described in TO 1F-16CM-1, as well as the indications the MP described. (Tabs V-1; BB-7). The following were observed.

1. Master Caution Light – On.
    a. Corresponding AVIONICS FAULT light on the caution panel.
2. PFL displayed on Pilot Fault List Display – EGI NAV FAIL among numerous other PFLs.
3. HUD – attitude information blank, airspeed, and altitude available.
4. CDU
    a. ADI – FAIL.
    b. HSI – FAIL.
    c. Airspeed and altitude information available.

   d. Angle of Attack – available.
5. Multi-Function Displays – navigation information missing or unobserved.
6. SAI – functioning. Note the MP observed a slight mis-match in pitch and bank between primary attitude reference prior to EGI failure.
7. Engine Instruments – normal or unobserved. (Tab AA-6).

The simulator cannot replicate a malfunctioning SAI, nor the same level of spatial disorientation experienced by the MP. During the simulation, which had a perfectly functioning SAI, precise airspeed, heading, and altitude control was difficult. These fluctuations would contribute to spatial disorientation. Because the simulator is fixed and does not move, the disorientation caused by roll, bank, acceleration, and/or body movement are difficult to simulate. (Tab AA-6).

7. WEATHER

a. Forecast Weather

Airfield Weather at Kunsan AB (at takeoff): The valid terminal aerodrome forecast (TAF) was issued on 11 December 2023 at 0100L. (Tab W-1). The forecast was northeasterly winds at 9 kts, horizontal visibility of 6 statute miles (SM) due to light rain and mist, with scattered-low clouds at 2,000 ft MSL and a broken ceiling, meaning a predominantly cloud-filled sky, starting at 3,000 ft MSL. (Tab W-1). There were no amendments made to this TAF prior to takeoff. (Tab F-1).

Airspace Weather: The valid Mission Execution Forecast (MEF) was issued on 11 December 2023 at 0500L. (Tab W-1). The forecast was a broken ceiling from 1,500 ft to 5,000 ft, clear air between 5,000 ft and 6,000 ft, a second broken ceiling from 6,000 ft to 14,000 ft, clear air from 14,000 ft to 30,000 ft, then a third broken ceiling from 30,000 ft to 35,000 ft. Overall visibility was forecasted as less than 3 SM but greater than 1 SM. Light mixed icing between 8,000 ft MSL and 18,000 ft MSL were also briefed. (Tab W-1). There were no amendments made to this MEF prior to takeoff.

b. Observed Weather

Airfield Weather (at takeoff): The prevailing conditions for the MP's takeoff at Kunsan AB were measured at 0820L and depicted northeasterly winds at 6 kts, horizontal visibility of 10 SM with light rain, and an overcast ceiling at 7,500 ft MSL. (Tab W-1).

Airspace Weather: MF4 reported ceilings as low as 500 ft MSL and visibility less than 1/4 SM near the suspected ejection site. "No clear air at any altitude in the airspace" was reported by MF1. (Tab V-3). Another flight of F-16s in the airspace noted broken clouds up to between 35,000-36,000 ft MSL. (Tab V-9).

Flight-level winds measured in the airspace by MF4's aircraft revealed significant clockwise directional change with height (from direction 130 at 3,500 ft MSL to direction 230 at 12,000 ft MSL) and maintaining approximate speeds of 30 kts, indicating that the airspace was behind an active warm front with notable warm air advection. This level of variation is typically associated with stronger precipitation and low visibilities, matching the testimony of pilots who flew near the time of the mishap. Icing was not observed by any member of the MF. (Tabs V-1 to V-4).

It is unlikely the MP would have been able to climb or descend into cloud free sky. Using available radar data and trigonometry, dense cloud and precipitation are shown to almost certainly be present between 795 ft MSL and 3,800 ft MSL in the vicinity of the mishap. (Tab W-1). Based on testimony and this replication, the MP would have had difficulty descending to cloud free air. The tops of the clouds were reported to be 35,000-36,000 by a flight of F-16s airborne at the time of the mishap. (Tab V-9). Based on this testimony, the MP would have had difficulty climbing to cloud free air.

c. Space Environment

The solar environment was benign on 10-11 December 2023, with no suspected impacts to high/ultra-high frequency radio equipment or GPS. (Tab W-1).

d. Operations

The MP was on a DCA training mission and was briefed “Amber” flying conditions by the weather forecaster. (Tab W-1). Amber conditions equate to IMC flying with ceilings as low as 1,000 ft MSL, with visibilities between 1 SM and 3 SM, and at least 4,000 ft of clear air in the airspace. (Tab BB-5). Based on testimony and the above analysis, the MP likely flew in “Red” conditions (ceilings below 1,000 ft MSL, visibility less than 1 SM, and less than 4,000 ft of clear airspace). (Tabs V-1 to V-4; W-1).

8. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was a current and qualified combat mission ready (CMR) F-16 four-ship flight lead with 364.9 hours in the F-16C/D. (Tabs G-1; K-1). The MP obtained initial qualification in the F-16 at Holloman Air Force Base (AFB), NM in MMC aircraft in the Summer/Fall of 2021, then proceeded to Homestead Air Reserve Base (ARB), FL, where the F-16s are Block 30 and equipped with Software Capability Upgrade (SCU) and CDU. (Tabs G-1; V-1). The MP completed Mission Qualification Training (MQT) to become a certified wingman in January of 2022 and became certified as a flight lead later in the assignment at Holloman. (Tab G-1).

The MP’s first flight in the 8 FW at Kunsan AB was on 23 October 2023. (Tab T-3). All 8 FW aircraft are Block 40 and MMC. The MP was aware of the differences between Block 30 and Block 40 and between SCU and MMC, with no additional training documented on aircraft differences after arrival at Kunsan AB. (Tabs G-1; V-1). The 8 FW is in the process of conducting an aircraft modification which installs a CDU along with other modifications. At the time of the mishap, the 8 FW had five aircraft with CDU, four in the 35 FGS and one from the 80 FGS (the MA). (Tab U-13). Since arriving at Kunsan AB, the MP logged seven flights in IMC (Tab T-3). The MP’s most recent flight prior to the mishap was on 07 December 2023, and his last 90 days of flying are listed in Figure 9 below. (Tab T-3).

MP	Total Hours	Instrument Hours	Sorties
Last 30 Days	21.6	1.2	16
Last 60 Days	31.2	3.3	23
Last 90 Days	35.5	3.5	27

Figure 9. MP's 90-Day Flight History. (Tab T-3).

9. MEDICAL

a. Qualifications

At the time of the mishap, the MP was medically qualified for flying duty and required no aeromedical waivers. (Tab T-1).

b. Health

The MP's most recent periodic health assessment (PHA) was on 06 March 2023. (Tab T-1). The MP had no disqualifying conditions or pre-existing medical conditions that could have affected the outcome of the mishap. (Tab T-1). When interviewed, the MP reported no recent illness that could have affected reactions during the mishap. (Tabs T-1; V-1).

Post-ejection, the MP's medical examination revealed minor soreness and stiffness related to the mishap. The post-accident medical exam was otherwise normal. (Tab T-1). There was no evidence of any serious injuries or of any conditions that could have contributed to the mishap. The MP was returned to flight status and full flying duties on 29 December 2023. (Tabs T-1 to T-2).

c. Toxicology

The toxicology screen showed nothing of relevance. (Tabs G-2; T-1).

d. Pathology

Not applicable.

e. Lifestyle

Based on the MP interview, as well as a review of the MP's past year's medical records, the 72-hour, and the 7-day history record, there is no evidence to suggest lifestyle factors contributed to the mishap. (Tab T-1).

f. Crew Rest and Crew Duty Time

Crew rest and crew duty time requirements are detailed in Air Force Manual (AFMAN) 11-202, Volume 3, Pacific Air Forces Supplement, *Flying Operations* (Tab BB-4). Commanders and supervisors will ensure aircrew are provided a 12-hour rest opportunity prior to beginning the flight duty period. Crew rest is free time and includes time for meals, transportation, and an opportunity for at least 8 hours of uninterrupted sleep. Crew rest cannot begin until after the completion of official duties. 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. Mission execution FDPs for a single piloted aircraft are not to exceed 12 hours. (Tab BB-4).

Despite noting "Light Fatigue" on the ORM form, the MP stated in the interview that fatigue did not affect reaction time or decision-making abilities. (Tabs K-1; T-1; V-1). The MP obtained 7-7.5 hours of continuous and average sleep prior to the mishap and felt well-rested the day of the mishap. (Tab T-1). Between the time MP reported for duty at 04:45L and the time of the ejection, MP was on duty for approximately 3 hours and 57 minutes. (Tab T-1). The MP had more than 12 hours of crew rest prior to the mishap FDP and had the opportunity for at least 8 hours of uninterrupted sleep IAW AFMAN requirements. (Tab V-1).

10. OPERATIONS AND SUPERVISION

a. Operations

The 11th of December 2023 was a Monday and no flying occurred over the weekend. The week prior, flight brief times were at 08:00L. (Tab AA-1). The week of the mishap, the squadron transitioned to 05:00L briefs. (Tab K-1). The MP was prepared for the transition (Tab V-1).

b. Supervision

MF1 and the Top 3 on duty noted all members of the MF were fit to fly. (Tab K-1). The 8 FW was executing "green operations". Green operations occur when the two FGSs pool available aircraft for the fighter squadrons, increasing the likelihood of flying the type/number of planned sorties. (Tab V-5). The MP was the only pilot in the Somaek flight flying an 80 FGS aircraft. (Tab AA-2). Pilot aircraft write-ups are shared between squadrons, and the MP was briefed on MMC issues in the MA's pilot write-up history. Due to the AFTO 781 delays, the MP jointed the MF at the EOR.

11. HUMAN FACTORS

a. Introduction

The Department of Defense (DoD) *Human Factors Analysis and Classification System (HFACS) 8.0* lists potential human factors that can play a role in aircraft mishaps and identifies potential areas of assessment during an accident investigation. (Tab BB-12). The mishap involved physical environmental (weather and vision limitations) and technological environmental (electrical and instrumentation failures) factors as well as sensory misperception factors that cumulatively manifested as pilot-recognized spatial disorientation. Relevant factors are discussed below.

b. Physical Environment (PE) 101 – Environmental Conditions Affecting Vision

HFACS code PE101, *Environmental Conditions Affecting Vision,* describes conditions such as lighting/illumination, physical obstructions, rain, snow, spray, fog, haze, darkness, smoke, dust, sand, other particulates, etc., which impede clear viewing/vision, negatively affect performance, and result in hazardous conditions or unsafe acts. (Tab BB-12).

According to MP testimony, and as stated in section 7a. & b. above, the training airspace had little to no clear air, requiring instrument flight. (Tabs V-1 to V-4). When a pilot has a wide, clear view, vision is a dominant input, overriding all other sensory input in importance. When visual contact with the horizon is lost, the vestibular system becomes unreliable, and can result in sensory illusions unless overridden by another visual cue from instrument information. (Tab O-1). The absence of visual cues while flying in IMC conditions, as encountered by the MP, while only using the small, unreliable SAI, makes reliance on instrumentation essential to override the inherent, normal sensory illusions of motion, orientation, and acceleration.

c. PE 202 – Instrumentation and Warning System Issues

HFACS code PE202, *Instrumentation and Warning System Issues*, describes workspace/cockpit instrument or warning system elements (design, reliability, lighting/backlighting, audible cues, location, symbology, size, display, etc.) issues which negatively affect performance, which result in a hazardous condition or unsafe acts. (Tab BB-12).

The MP experienced the loss of primary attitude information systems. (Tab V-1). With the loss of the ADI and HUD, the MP was only able to determine the MA's attitude utilizing a smaller SAI, previously noted to have errors. (Tab Z-6). The MP was unable to cross-check between the SAI and actual aircraft orientation due to flying in IMC. (Tab Z-6). Flying while in IMC, with a lack of a reliable back up attitude information, led to the MP's ejection.

d. Physiological Condition (PC) 321 – Spatial Disorientation

HFACS code PC321, *Spatial Disorientation*, describes situations when an individual fails to correctly sense a position, motion, or attitude of the aircraft or his/herself, within the fixed coordinate system provided by the surface of the Earth and the gravitational vertical position (e.g., visual, vestibular, kinesthetic, or auditory/sound illusions), which results in a misjudgment and unsafe acts. (Tab BB-12).

The loss of key navigational components used to build a pilot's internal (cerebral, trained) self-generated construct of location in air and space relative to Earth, make a pilot susceptible to erroneous perceptions of orientation, motion, or acceleration. (Tab BB-12). The body uses three integrated systems that work together to ascertain orientation and movement in space. Vestibular system-organs found in the inner ear that sense position by the way we are balanced; somatosensory system-nerves in the skin, muscles, and joints that, along with hearing, sense position based on gravity, feeling, and sound; and visual system-eyes, which sense position based on what is seen. While all three systems work together, the visual system, if available, is dominant, either in actual visual conditions or as a visual construct built from instrument information. Without visual references outside the aircraft, there are many situations in which combinations of normal motions and forces create convincing illusions. (Tab O-1). 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. If the pilot loses the instruments, in addition to having no visual, then they lose the visual information necessary to build the visual-dominant, artificially generated three-dimensional orientation construct in space.

In this mishap, the MP's spatial disorientation during IMC flight was caused by failure of primary attitude information, and reliance on secondary flight instruments known by the MP to be slightly in error. (Tab V-1).

e. PE 204 – Controls and/or Switches are Inadequate

HFACS Code PE204, *Controls and/or Switches,* describes the location, shape, size, design, reliability, or other aspect of controls and/or switches negatively affected performance and result in a hazardous condition or unsafe acts. In this case, in order for the MP to attempt to correct the failed EGI, the MP would have to reach behind and/or turn around while seated in the cockpit to reset the EGI switch, which could increase risk for spatial disorientation. (Tab BB-12). The MP was aware of the risk of spatial disorientation with EGI failure, therefore focused on keeping the head level and maintaining orientation. (Tab V-1).

f. PC 103 – Task Saturation

HFACS Code PC103, *Task Saturation,* occurs when the quantity of information an individual is processing exceeds his or her mental resources in the amount of time available, and results in a hazardous condition or unsafe acts. (Tab BB-12). In other words, there is simply too much to accomplish with not enough time or resources. The task loading could be real or imagined but can result in errors performance and/or judgment and decision-making errors. (Tab BB-12). The MP was likely task saturated for the following reasons: IMC flight, flight in a formation of four F-16s, MF2's engine anomaly, and the amount of communication occurring at/near the time of mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publicly Available Directives and Publications Relevant to the Mishap

(1) AFI 51-307 *Aerospace and Ground Accident Investigations.* (Tab BB-1).
(2) AFI 90-204 *Safety Investigations and Reports.* (Tab BB-3)
(3) AFMAN 11-202, Vol. 3, PACAF Supp., *Flying Operations*. (Tab BB-4).
(4) 8FWI 15-101 *Weather Support Document.* (Tab BB-5).

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.

b. Other Directives and Publications Relevant to the Mishap

(1) TO 1F-16CM-1 *Flight Manual - Interim Operational Supplement.* (Tab BB-7).
(2) TO 1F-16CM-34-1-1 *Avionics and Nonnuclear Weapons Delivery Flight Manual*. (Tab BB-11).
(3) TO 13A5-56-11 *Operation and Maintenance Instructions with Illustrated Parts Breakdown.* (Tab BB-2).
(4) TO 31R4-2URT46-1-1 *Beacon Activation Time.* (Tab BB-6).

(5) TO 00-20-1 *Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures.* (Tab BB-9).
(6) TO 42B2-1-3 *Fluids for Hydraulic Equipment.* (Tab BB-10).
(7) AFTO 781 (Tab BB-8).
(8) DoD Human Factors Analysis and Classification System 8.0 (Tab BB-12).

24 April 2024

PHILIP D. LANCASTER, Colonel, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

F-16CM, T/N 88-0479
KUNSAN AIR BASE, REPUBLIC OF KOREA
11 DECEMBER 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

I find, by a preponderance of evidence, the cause of the mishap was an embedded global positioning and inertial navigation set (EGI) failure while in instrument meteorological conditions (IMC). The malfunctioning EGI led to a loss of primary flight and navigation instruments. I also find by a preponderance of the evidence that the subsequent reliance of the mishap pilot (MP) on the mishap aircraft's (MA) Standby Attitude Indicator (SAI), which previously displayed abnormal indications, and the spatial disorientation of the MP substantially contributed to the mishap. The absence of the EGI failure while in IMC, may have prevented this mishap.

I developed my opinion by carefully considering the standard of proof of preponderance of evidence and the requirements for causes and substantially contributing factors. I analyzed available flight data, witness testimony, Air Force technical orders (TO), three recent/previous F-16 AIB reports involving EGI malfunctions, F-16 simulator data, and other information provided by subject matter experts (SME). The MA's Crash Survivable Memory Unit (CSMU), which houses non-volatile solid-state electronic memory data and maintenance fault list (MFL) recorded during flight, was not recovered from the crash site.

2. CAUSES

a. EGI Failure While in IMC

I concluded that the EGI failed based on MP testimony, TO 1F-16CM-1 (hereafter TO) data, SME information, and an F-16 simulator replication of the event. The MP observed the following indications in the MA cockpit:

1. Master Caution Light – On.
   a. Corresponding AVIONICS FAULT light on the caution panel.
2. Pilot Fault List (PFL) displayed on Pilot Fault List Display – EGI NAV FAIL among numerous other PFLs.
3. Head's Up Display (HUD) – attitude information blank, airspeed, and altitude available.
4. Center Display Unit (CDU)
   a. Attitude Director Indicator (ADI) – FAIL.
   b. Horizontal Situation Indicator (HSI) – FAIL.

c. Airspeed and altitude information available.
d. Angle of Attack – unobserved.

5. Multi-Function Displays – navigation information missing or unobserved.
6. SAI – functioning, though the MP observed a slight mis-match in pitch and bank between primary attitude reference prior to EGI failure.
7. Engine Instruments – normal or unobserved.
8. Auto-pilot – not working.

The MP's observations match the flight manual description of EGI failure. Additionally, considering SME inputs and my own replication of the malfunction in the F-16 simulator, a malfunctioning EGI is readily apparent when the only available instrument to maintain spatial awareness is the SAI. Attitude information is removed from the HUD, and the ADI is replaced with a FAIL on the CDU.

Based on the data available, I could not determine why the EGI malfunctioned. According to the TO, the "most likely" cause of failure is a loss of power which may/may not be visible to the pilot. The MP did not note MA electrical power issues but did observe an EGI NAV FAIL PFL. According to the TO, "the primary cause for this [PFL] is power cycling and transients". EGI malfunctions due to power interruptions are described in three prior F-16 AIB mishap reports. For these reasons, the EGI likely failed due to a power interruption of some kind.

It is unclear if the TO procedures for resolving an EGI failure apply to the mishap scenario. After ensuring Global Positioning System (GPS) reception and turning the EGI off and leaving it off for 30 seconds, the TO directs the pilot to "establish straight, level, and unaccelerated flight". After transitioning to the SAI, the MP had difficulty maintaining level flight and overall spatial orientation due to the weather conditions and a poorly performing SAI, so the MP prioritized a descend below the forecasted ceiling (believed to be 3,500 ft) where clear sky was expected. When unable to find airspace free of clouds at 3,000 ft, the MP attempted to level off, causing further disorientation.

Once achieving straight, level, and unaccelerated flight, the TO seems to direct a four-minute alignment, then prioritizes repeating it, before attempting a less optimal "attitude" alignment obtained in 20 seconds. While flying off the SAI, the MP was unable to verify the MA was straight, level, and unaccelerated. It is unclear from the evidence whether the MP was level or not, but the MP did not think so. Further, only five minutes passed between EGI failure and MP ejection, making the recommended timeline per the TO unrealistic in this scenario to have prevented the mishap. Finally, based on task saturation and increasing spatial disorientation, the MP chose not to attempt an "attitude" alignment since it requires releasing the aircraft control stick and turning the torso and head to the right based on the EGI control switch location. Doing so would increase disorientation potential.

3. SUBSTANTIALLY CONTRIBUTING FACTOR

a. Standby Attitude Indicator Performance & Spatial Disorientation

If the EGI fails while in IMC, the only source of attitude information to the pilot is the SAI until the EGI failure is resolved or the pilot can rejoin with a wingman. Noting SAI errors before takeoff, the MP reset the SAI at least two minutes prior to takeoff as directed in the TO. However, during the first turn after becoming airborne, the MP again observed errors; the SAI displayed a slight mis-match in pitch and bank from the ADI. The TO describes a known four-degree difference in pitch angle between the ADI and SAI based on the SAI mounting angle. While this could explain the slight pitch difference, it does not address the bank difference. SAI bank errors are mentioned in the TO, but only as related to acrobatic maneuvering. Further, performance standards do not exist for the SAI, leaving determination of acceptability to the pilot. The majority of the pilot interviews during the AIB noted observing SAI errors, generally being more critical of SAI performance when IMC flying was expected. Finally, though the MP did not attempt an IMC rejoin with a wingman, in-cloud visibility the day of the mishap would have prevented it.

Following the EGI malfunction, the MP transitioned to the SAI which was previously observed in error. According to MP testimony, the attitude on the SAI never matched the parameters displayed by the airspeed and altitude indicators, or as communicated by the MP's wingman flying in trail. Most notably, as the MP attempted to level off following the failed attempt to descend below the weather, the SAI was showing an increasing climb, while airspeed was increasing, and altitude was decreasing. The extent of this mis-match led to disorientation and subsequent ejection.

The MP was unable to fix the SAI errors while airborne. Like EGI malfunctions, SAI malfunctions require straight, level, and unaccelerated flight. Because the pilot was in IMC, and unable to rejoin with a wingman, SAI errors noted by the MP were unresolvable.

4. CONCLUSION

I find, by a preponderance of evidence, the cause of the mishap was an EGI failure while in IMC. The malfunctioning EGI led to a loss of primary flight and navigation instruments. I also find by a preponderance of the evidence that the subsequent reliance of the MP on the MA's SAI, which previously displayed abnormal indications, and the spatial disorientation of the MP substantially contributed to the mishap. The absence of the EGI failure while in IMC may have prevented this mishap.

24 April 2024

PHILIP D. LANCASTER, Colonel, USAF
President, Accident Investigation Board

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