UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

RQ-4B BLOCK 40, T/N 08-2035

348TH RECONNAISSANCE SQUADRON
319TH RECONNAISSANCE WING
GRAND FORKS AIR FORCE BASE, NORTH DAKOTA

LOCATION:
6.8 MILES NORTH OF GRAND FORKS AIR FORCE BASE, NORTH DAKOTA

DATE OF ACCIDENT: 6 AUGUST 2021

BOARD PRESIDENT: COLONEL GEOFFREY S. FUKUMOTO

Conducted in accordance with Air Force Instruction 51-307

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR COMBAT COMMAND

AIR COMBAT COMMAND
1992 - 2022

OFFICE OF THE DEPUTY COMMANDER
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APR 15 2022

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 August 2021 mishap involving a RQ-4B Block 40, T/N 08-2035, operated by the 384th Reconnaissance Squadron, complies with applicable regulatory and statutory guidance, and on that basis it is approved.

RUSSELL L. MACK
Lieutenant General, USAF
Deputy Commander

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

RQ-4B BLOCK 40, T/N 08-2035
6.8 MILES NORTH OF GRAND FORKS AIR FORCE BASE, NORTH DAKOTA
6 AUGUST 2021

On 6 August 2021, at 0727 local (L) time, an RQ-4B Global Hawk, tail number (T/N) 08-2035, impacted terrain 6.8 miles north of Grand Forks Air Force Base (GFAFB), North Dakota (ND), while conducting a local flying mission. The mishap remotely piloted aircraft (MA) was flown by the 348th Reconnaissance Squadron (348 RS), a unit assigned to the 319th Operations Group, 319th Reconnaissance Wing, GFAFB, ND. The mishap crew members were assigned to the 348 RS for flying and were all active duty United States Air Force members. The mishap did not result in any injuries. The MA, valued at approximately $64 million, was destroyed.

On 6 August 2021, the MA was flying a mission in a local military operating area (MOA) when the mishap mission control element (MMCE) experienced a workstation lockup, ultimately resulting in the MA's return to base on an autonomous, preprogrammed route. The preprogrammed route returned the MA from the MOA to GFAFB via a descent and approach, but the MA did not initially descend as the preprogrammed route required since the mishap mission control element pilot (MMP) failed to sever the MMCE control link with the MA. The MA was too high at the final approach fix (FAF) and commenced a go-around/missed approach route. Once the MMP severed the MMCE control link, and while the MA was on the go-around/missed approach route, the mishap pilot (MP) and mishap instructor pilot (MIP) gained control of the MA with the mishap launch and recovery element (MLRE). Instead of commanding a new flight route to the MA, the MP commanded an altitude override command to the MA, which resulted in the MA being approximately 4,000 feet too high at the FAF. The MP and MIP were not aware of the altitude deviation. At that FAF, the MA's go-around/missed approach route logic commenced an approach to land at GFAFB, but, because it was 4,000 feet too high, the MA overshot and crashed into a farm field 6.8 miles north of the runway.

The Accident Investigation Board (AIB) president found, by a preponderance of the evidence, the cause of the mishap was the MP's incorrect selection of aircraft flight commands resulting in the MA's controlled flight into terrain. Further, the AIB president found, by a preponderance of the evidence, the cause of the mishap was the MIP's failure to provide sufficient inputs to the MP to prevent the MA's controlled flight into terrain. Additionally, the AIB president found, by a preponderance of the evidence, the MMP failed to follow established procedures, resulting in the MA's delayed descent and preprogrammed selection of a go-around/missed approach route, significantly contributing to the mishap. Finally, I find, by a preponderance of the evidence, the pilot workstation lockup, including the lack of documented procedures regarding requesting numerous detailed status requests within a short timeframe, resulted in the MMP's inability to positively control the aircraft resulting in the MA's execution of preprogrammed logic and return to base, significantly contributing to the mishap.

SUMMARY OF FACTS AND STATEMENT OF OPINION
RQ-4B BLOCK 40, T/N 08-2035
6.8 MILES NORTH OF GRAND FORKS AIR FORCE BASE, NORTH DAKOTA
6 AUGUST 2021

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ACRONYMS AND ABBREVIATIONS

319 AMXS	319th Aircraft Maintenance Squadron
319 OG	319th Operations Group
319 RW	319th Reconnaissance Wing
319 SFS	319th Security Forces Squadron
348 RS	348th Reconnaissance Squadron
4 RS	4th Reconnaissance Squadron
AC1	Mission Plan Route
ACC	Air Combat Command
ADO	Assistant Director of Operations
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFMAN	Air Force Manual
AFPET	Air Force Petroleum Office Laboratory
AFSEC	Air Force Safety Center
AFTO	Air Force Technical Order
AGL	Above Ground Level
AIB	Accident Investigation Board
AMXS	Aircraft Maintenance Squadron
AOL	America Online
AOR	Area of Responsibility
ATC	Air Traffic Control
ATCA	Air Traffic Control Area
BACN	Battlefield Airborne Communication Node
BAFB	Beale Air Force Base
BPO	Basic Post-Flight
C0	Contingency 0
C1	Contingency 1
C2	Command and Control
C4	Contingency 4
CA	California
CAG	Commander's Action Group
CC'd	Carbon Copied
CCIR	Commander's Critical Information Request
CDL	Common Data Link
CENTCOM	US Central Command
CGS	Common Ground Station
CMR	Combat Mission Ready
COA	Course of Action
COMSEC	Communications Security
COVID	Coronavirus
CRM	Crew Resource Management
CRT	Crash Recovery Team
CRTL	Crash Recovery Reach Lead
CT	Continuation Training
DDO	Deputy Director Operations
DME	Distance Measuring Equipment
DNIF	Duty Not Involving/Including Flying
DO	Director of Operations
ENDEX	End Exercise
EP	Evaluator Pilot
EP	Emergency Procedure
ER	Exceptional Release
FA	Flight Authorizations
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FCIF	Flight Crew Information File
FOL	Forward Operating Location
FSR	Field Service Representative
FTS	Flight Terminate System
FTU	Formal Training Unit
GCI	Ground Communications Interface
GFAFB	Grand Forks Air Force Base
GHOC	Global Hawk Operations Center
GMTI	Ground Moving Target Indicator
GNC00	Guidance Navigation Control
GPS	Global Positioning System
GUI	Graphics User Interface
GYMBG	Navigational Waypoint
HPRE	Horizontal Position Reference Error
HQ	Headquarters
HVAC	Heating Ventilation and Air Conditioning
IAF	Initial Approach Fix
IC	Incident Command
IFE	In-Flight Emergency
IMDS	Integrated Maintenance Data System
IMMC	Integrated Mission Management Computer
INMARSAT	International Maritime Satellite Terminal

INS	Inertial Navigation System
IP	Instructor Pilot
IQT	Initial Qualification Training
ISR	Intelligence, Surveillance, and Reconnaissance
ITS	Individual Training Summary
JCN	Job Control Number
Ku	frequency band
L	Local Time
L3	L3Harris Technologies, Inc.
LAKOT	Navigational Waypoint
LOS	Line of Sight
LRE	Launch and Recovery Element
LSUS	Left Suspend
MA	Mishap Aircraft
MC	Mishap Crew
MCE	Mission Control Element
MIMMC	Mishap Integrated Mission Management Computer
MIP	Mishap Instructor Pilot
MLRE	Mishap Launch and Recovery Element
MMA	Microwave Modem Assembly
MMCE	Mishap Mission Control Element
MMP	Mishap Mission Control Element Pilot
MMSO	Mishap Mission Control Element Sensor Operator
MOA	Military Operating Area
MOC	Maintenance Operations Center
MOS	Mishap Operations Supervisor
MOVINT	Movement Intelligence
MP	Mishap Pilot
MP-RTIP	Multi-Platform Radar Technology Insertion Program
MQT	Mission Qualification Training
MR	Mission Ready
MTI	Moving Target Indicator
NAV	Navigation
NAV PT	Navigation Waypoint
ND	North Dakota
NDI	Nondestructive Inspection
NG	Northrop Grumman
NOTAMS	Notices to Airmen
OG	Operations Group
OGM	Operational Guidance Mode
OJT	On the Job Training
Ops Sup	Operations Supervisor
ORM	Operational Risk Management
PACOM	Pacific Command
PCS	Permanent Change of Station
PEX	Patriot Excalibur
PFD	Primary Flight Display
PIC	Pilot in Command
PLI	Pre-Launch Inspection
PPP	Point-to-Point Protocol
PR	Pre-Flight
PUM	Periodic Uplink Message
QA	Quality Assurance
QRC	Quick Reaction Checklist
R2'd	Remove and Replace
RAID	Redundant Array of Independent/Inexpensive Disks
RAP	Ready Aircrew Program
RAPCON	Radar Approach Control
RED FLAG	Military Exercise
RF	RED FLAG
RICO25	Mishap Aircraft Air Traffic Control Call Sign
RM	Risk Management
RPA	Remotely Piloted Aircraft
RQ-4	RQ-4B Block 40
RTM	Ready Aircrew Program Training Message
RVR	Runway Visual Range
SA	Situational Awareness
SAR	Search and Rescue
SARM	Security Assistance Resource Management
SATCOM	Satellite Communication
SIB	Safety Investigation Board
SIM	Simulator
SIPR	Secret Internet Protocol Router
SMU	Stores Management Unit
SO	Sensor Operator
Sortie	Flying Mission
T/N	Tail Number
TAP	Terminal Area Procedures
TFR	Temporary Flight Restriction
Tiger	Military Operating Area
TLE	Target Location Error
TO	Technical Order

UAV	Unmanned Aerial Vehicle
UCF	Uniform Configuration File
UHF	Ultra High Frequency
USAF	United States Air Force
VOC	Vader Operations Center
VVI	Vertical Velocity Indication
WAI	Walk-Around Inspection
Wifi	Wireless Fidelity
WS	Work Station
Z	Zulu

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 27 September 2021, the Air Combat Command (ACC) Deputy Commander, Lieutenant General Russell L. Mack, appointed Colonel Geoffrey S. Fukumoto to conduct a legal investigation into the 6 August 2021 crash of an RQ-4B Block 40 Global Hawk aircraft (RQ-4), tail number (T/N) 08-2035 that occurred 6.8 miles north of Grand Forks Air Force Base (GFAFB) (Tabs J-7 and Y-3). The investigation was conducted by an accident investigation board (AIB), pursuant to Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations* (Tab Y-3). The investigation was conducted at GFAFB, ND, from 21 October 2021 to 19 November 2021 (Tab Y-3). A legal advisor (Major), maintenance member (Major), pilot member (Captain), and recorder (Technical Sergeant) were appointed as board members (Tab Y- 3).

b. Purpose

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

2. ACCIDENT SUMMARY

The mishap remotely piloted aircraft (MA) was an RQ-4, T/N 08-2035, assigned to Air Combat Command (ACC) (Tab U-76). The MA was operated by the 348th Reconnaissance Squadron (348 RS), one of the wing's units under the 319th Operations Group (319 OG), 319th Reconnaissance Wing (319 RW), GFAFB, ND (Tabs K-3, CC-7, and CC-8). On 6 August 2021, the MA was flying a mission in the military operating area (MOA) labeled "Tiger" when the mishap mission control element (MMCE) experienced a workstation lockup, ultimately resulting in the MA's return to base on an autonomous, preprogrammed route (Tabs J-10 and R- 57). However, the MA remained at 54,000 feet due to a previously selected altitude override command and delayed decision to shut down the ground communications interface (GCI) (Tabs J -10 to J-11, L-123, V-6.2 to V-6.3, and V-6.5). On its way back to land, the MA flew a preprogrammed approach to land, executed a go-around/missed approach due to being too high on approach, and then performed another approach to land (Tabs J-10 to J-11, AA-6 to AA-9). The mishap crew (MC) established control of the MA with a launch and recovery element (LRE) shelter a few minutes prior to the MA's second autonomous attempt to land on the GFAFB runway (Tabs J-15, L-3 to L-4 and R-8 to R-9). The MA continued its second approach, overshot the airfield, and impacted farmland 6.8 miles north of the runway at approximately 0727 local (L) time (Tabs J-7, J-12, and V-11.4). The MA, valued at approximately $64 million at acquisition, was destroyed (Tabs CC-13, S-3 to S-7, S-9, and V-11.5).

3. BACKGROUND

a. Air Combat Command (ACC)

ACC's primary mission is to organize, train, and equip Airmen who fight in and from multiple domains to control the air, space, and cyberspace (Tab CC-3). As the lead command for fighter, command and control, intelligence, surveillance and reconnaissance, personnel recovery, persistent attack and reconnaissance, electronic warfare, and cyber operations, ACC is responsible for providing combat air, space, and cyber power and the combat support that assures mission success to America's warfighting commands (Tab CC-3).

b. 319th Reconnaissance Wing (319 RW)

The 319 RW is responsible for the infrastructure and operational support to the 319 OG RQ-4 mission (Tab CC-7). The 319 RW provides decisional advantage to warfighters and national leaders through support of our Nation's RQ-4 High Altitude intelligence, surveillance, and reconnaissance (ISR) mission (Tab CC-7). The 319 RW ensures strategic command and control through operation of the Nation's High Frequency Global Communication System (Tab CC-7). The 319 RW affords Combatant Commanders mission-ready Airmen anytime, anywhere. The wing provides Airmen and families of the GFAFB team, to include geographically separated units, with responsive, tailored, and mission-focused support (Tab CC-7).

c. 319th Operations Group (319 OG)

The 319 OG, headquartered at GFAFB, ND, takes care of 1,423 Airmen across the world (Tab CC-9). With four Reconnaissance Squadrons, a Maintenance squadron with a Maintenance Detachment, and a Formal Training Unit, the 319 OG completes worldwide continuous operations (Tab CC-9). The group has units located at: Robbins Air Force Base, Georgia; Andersen Air Force Base, Guam; Naval Air Station Sigonella, Italy; Beale Air Force Base (BAFB), California; and GFAFB, ND (Tab CC-9). The 319 OG runs the RQ-4 maintenance squadron, which is the largest squadron in the 319 RW, located at GFAFB and at BAFB (Tab CC-9).

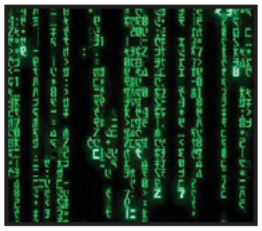
d. 348th Reconnaissance Squadron (348 RS)

The 348 RS is located at GFAFB (Tab CC-10). The 348 RS is one of the mission control locations for worldwide operations (Tab CC-9). The 348 RS operates the Block 40 variant of the RQ-4 (Tab CC-9).

e. RQ-4B Block 40 Global Hawk (RQ-4)

The RQ-4 is a high-altitude, long-endurance, remotely piloted aircraft with an integrated sensor suite that provides global all-weather, day or night ISR capability (Tab CC-11 to CC-12). The RQ-4's mission is to provide a broad spectrum of ISR capability to support joint combat forces in worldwide peacetime, contingency, and wartime operations (Tab CC-11 to CC-12). The RQ-4 provides persistent near-real-time coverage using imagery intelligence, signals intelligence, and moving target indicator (MTI) sensors (Tab C-11 to CC-12).

f. Navigation and Altitude Programing Logic



The RQ-4 navigates autonomously after engine start through takeoff taxi, takeoff, mission execution, landing, landing taxi, and shutdown (Tab BB- 12). The aircraft's integrated mission management computer (IMMC) provides aircraft control and mission management through the program software and the loaded mission plan (Tab BB-12). The IMMC monitors aircraft systems, sends faults to the common ground station (CGS), and initiates contingency operations (Tab BB-12). A preplanned mission navigation plan loaded during preflight provides the aircraft route of flight from mission start to mission end (Tab BB-12). The route of flight is composed of navigation waypoints (NAV PT) and action points (Tab BB-12). A NAV PT is a predetermined geographical position (preprogrammed or special use) associated with the mission navigation plan (Tabs AA-5 and BB-12). Action points are associated with NAV PTs and provide aircraft flight parameters and equipment settings (Tab BB-12). The aircraft is monitored and controlled from a CGS, either an LRE or mission control element (MCE), utilizing various data links (Tab BB-12). During autonomous navigation, the IMMC tells the RQ-4 to follow the NAV PTs and actions in the mission navigation plan route (Tab BB-15). Under certain emergency or abnormal conditions, the IMMC can change the operational mode and stop aircraft taxi, abort takeoff, or start navigation on a contingency route to respond to the emergency (Tab BB-17). A contingency operation provides aircraft actions to allow programmed deviation from the primary mission for aircraft recovery (Tab BB-17). The mode change or contingency operation depends on the nature of the failure and the aircraft's operating condition when the failure occurs (Tab BB-17). The IMMC selects and initiates the appropriate operation, and the RQ-4 responds accordingly (Tab BB-17). The IMMC can initiate contingency procedures at any position on the route of flight (Tab BB-17). Contingencies are prioritized from highest to lowest: Contingency 3, emergency landing; Contingency 4 (C4), abort, go-around/takeoff abort; Contingency 2, return to base; and Contingency 1 (C1), lost communication with CGS (Tab BB-29 to BB-30). C1 is initiated after the C1 timer expires as a result of communication loss with all in-control data links between the RQ-4 and MCE or LRE (Tab BB- 29 to BB-30). An unresponsive aircraft can be forced into a C1 state (and desired pre-planned logic) through a manual disconnect of the MMCE control link (GCI) with the MA (Tab BB-26).

4. SEQUENCE OF EVENTS

a. Mission

The MA was an RQ-4, T/N 08-2035, assigned to ACC and operated at the 319 RW, GFAFB, ND (Tab U-76 and U-104). As of 5 August 2021, the MA's airframe had 198 landings and 3,183.4 flight hours (Tab D-13). During this mission, the MA was scheduled to participate in a Red Flag (RF) exercise and then conduct a target location error (TLE) mission while flying in the Tiger MOA (Tabs R-57 and U-105).

The MC included a MIP and a MP assigned to the 348 RS, GFAFB, for flying (Tabs R-3, R-24, and CC-8 to CC-9). The MC were both active duty United States Air Force (USAF) Airmen (Tab R-3 and R-24). The MC were operating the mishap launch and recovery element (MLRE) (Tab R-26). Other personnel involved included a mishap MCE pilot (MMP) and a mishap MCE sensor operator (MMSO) positioned inside the MMCE, and a mishap operations supervisor (MOS) who oversaw flight operations in the global hawk operations cell (GHOC) (Tab R-57, R-60, and R-64). The MMP, MMSO, and MMCE were also active duty USAF Airmen assigned to the 348 RS at GFAFB (Tabs G-39, G-59, G-75, and R-80).

b. Planning

On 6 August 2021, the MP and MIP were scheduled for MCE flight duties to support the TLE portion of the mission (Tabs K-14, R-5, and R-26). The MP and MIP arrived around 0600L to complete mission planning and their flight briefing (Tabs G-17 and R-26). The MP was the planned aircraft commander (Tab R-11). The MIP was scheduled to perform instructor duties by assisting the MP as needed (Tab R-29). The MP and MIP briefed the mission using 348 RS standard briefing procedures, following Air Force Manual (AFMAN) 11-2ERQ-4V3 for MCE flights (Tabs V-1.4 and BB-78 to BB-79). No squadron supervisory personnel attended the briefing (Tab V-2.7).

c. Preflight

On 5 August 2021, preflight and takeoff of the MA were performed by maintenance with no discrepancies noted (Tab D-13). During taxi there was a low hydraulics fluid fault observed during ground operations (Tab R-98). Upon investigation by the ground crew, the hydraulic fluid levels were determined to be within tolerances and the MA took off as planned at 1625L on 5 August (Tabs D-60, R-98, and U-105).

On 6 August 2021, the MC arrived to work at 0600L to brief and fly the TLE portion of the flight (Tabs G-17 and R-26). By the time the MC arrived, the MA had been flying almost 14 hours (Tab J-10). Following the MC briefing, the mission changed from the planned TLE flight to a flight in the terminal area (Tab R-8, R-29, and R-35). The terminal area is a general term used to describe airspace surrounding the airfield in which approach control service or airport traffic control service is provided (Tab AA-4). The MC's plan changed because the workstations in the MMCE locked up (Tabs R-8, R-11, R-29, R-35 and V-10.10). The MA was autonomously returning to GFAFB on a preprogrammed route, so the MOS ordered the MC to change their plan, step to the MLRE, connect to the MA, and fly the MA back to the Tiger MOA (Tabs J-10 to J-11, R-30, and R-64).

The MP and MIP had an abbreviated conversation to discuss the changes to the mission and then stepped to the MLRE (Tabs R-30, R-34, R-35, V-1.4, and V-2.8).

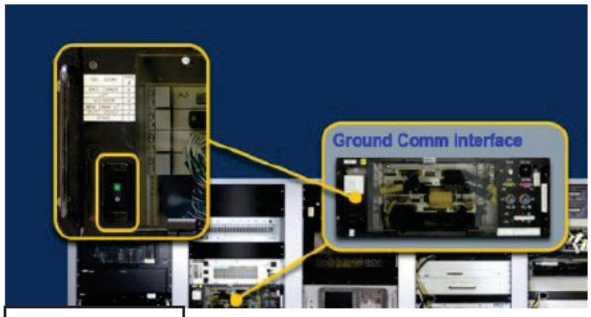
On 6 August 2021, the MLRE shelter was originally scheduled to support another mission (Tab U-104 and V-8.3). As the MA returned to base, the MLRE was retasked to support the MA's flight in order to get a CGS linked to the MA and take control of its flight (Tab V-2.12 to 2.13 and V- 8.3). The MC took control of the MA with the MLRE at 0719L (Tab J-15).

d. Summary of Accident

The MA took off on 5 August 2021 at 1625L for a scheduled 23-hour flight (Tabs D-60 and U- 105). During this flight, the MA was scheduled to support a TLE mission until 1500L on 6 August 2021 (Tab U-105). At 0615L the MMP requested seven status updates on the MMCE pilot workstation, conducting a normal systems check of the MA (Tabs J-10, L-131 to L-132, and R-57). At 0616L, after approximately 14 hours of flight, with the MA at an altitude of 54,000 feet and flying in the Tiger MOA, the MMCE pilot workstation locked up (Tab J-9 to J-11). The MA, with its control link intact, continued flying on its preprogrammed route and departed the assigned MOA, returning to GFAFB (Tabs J-10 to J-11 and R-57).

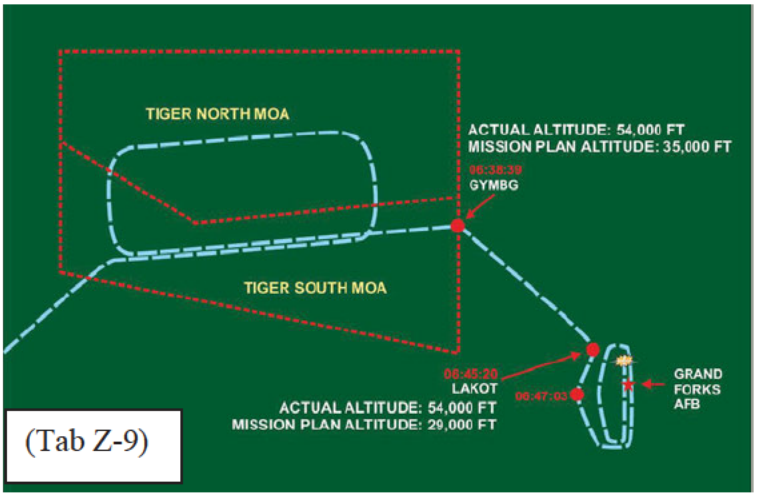
(Tab Z-16)

In accordance with procedures, if the pilot is unable to maintain assigned airspace, the RQ-4 technical order (TO) directs the pilot to turn off the GCI, using a cockpit toggle switch (Tab BB- 18 and BB-23). These procedures are found in the RQ-4 "Pilot Workstation Lockup or Log Out" checklist and the CGS "Forced Contingency 1 – Lost Communication" checklist (Tab BB-18 and BB-23). The "Forced Contingency 1 – Lost Communication" checklist clearly states that if another link, workstation, or CGS is unavailable, turn off the GCI using the toggle switch to sever all links between the CGS and aircraft (Tab BB- 18). Turning the GCI off interrupts all data links and starts the C1 timer (Tab BB-26). If an in control data link is not reestablished when the timer expires, the aircraft starts navigation on the mission's preprogrammed C1 route (Tab BB-26).



(Tab Z-6)

The preprogrammed C1 route for the MA's flight had the MA departing the Tiger MOA at NAV PT L782, called GYMBG, at an altitude of 35,000 feet and continuing a descent to cross the initial approach fix (IAF) at 9,000 feet (Tab K-32 to K-33). Upon reaching the IAF, the preprogrammed C1 route had the aircraft commence the approach, fly a route to arrive at the final approach fix (FAF) at 2,962 feet, and land at GFAFB (Tab K-33). The aircraft can execute this entire mission autonomously and safely land at its programmed destination (Tab V-2.15 to V-2.16). This preprogrammed C1 route ensured that the aircraft would comply with the routing and altitude specifications found in the certificate of authorization from the Federal Aviation Administration regarding RQ-4 operations (Tab BB-108 and BB-114). While on a C1 route, upon hitting the IAF, an aircraft will descend and orbit as required to meet the preprogrammed approach altitudes along the route to land (Tab BB-33).



(Tab Z-9)

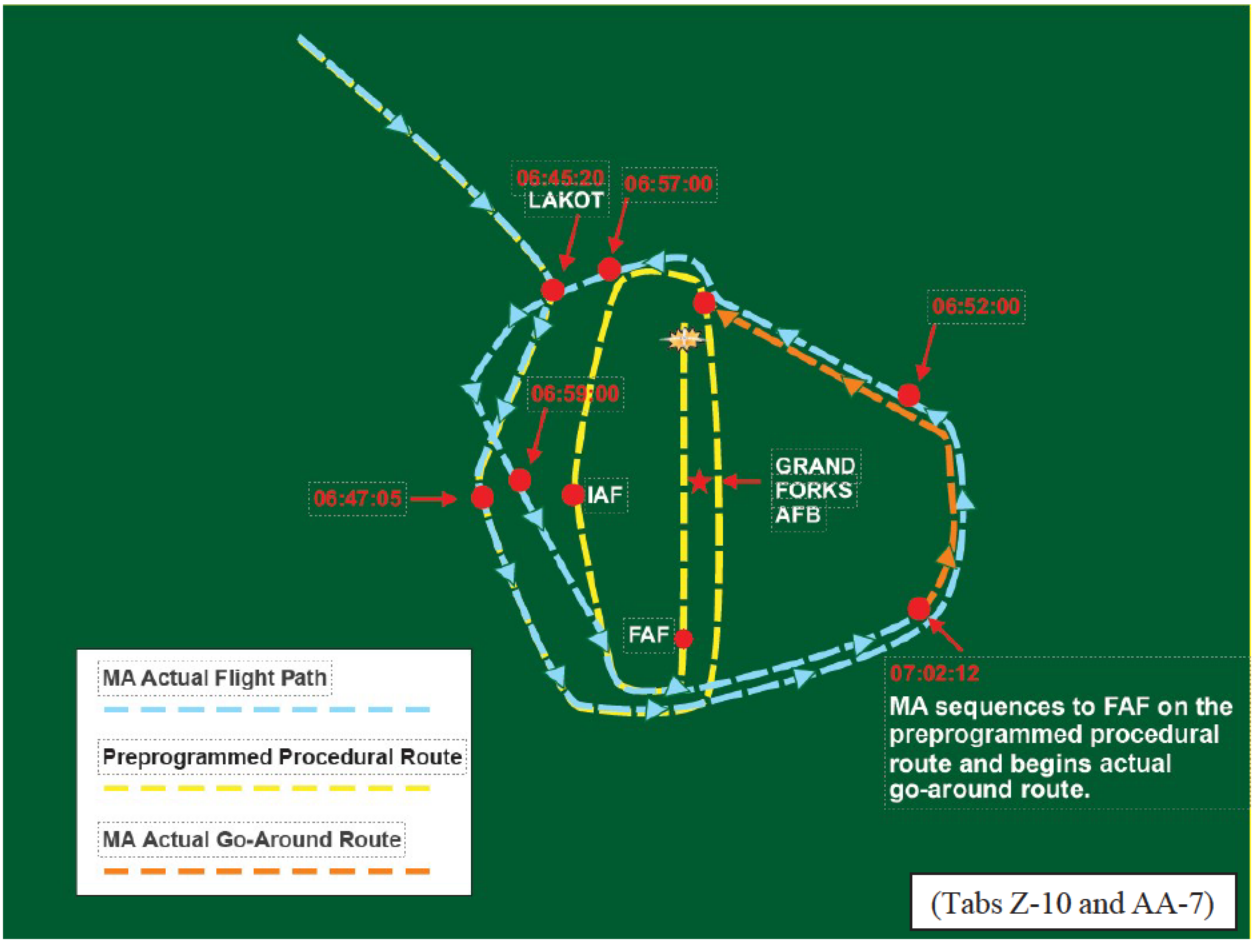
During the actual mishap flight, when the MMCE workstation locked up at 0616L, it prevented the MMP from giving commands to the MA (Tab J-10). The MMP began to troubleshoot the workstation lockup and called the field service representative 1 (FSR1) to the MMCE for assistance (Tabs R-57 and V-10.2). Earlier in the mishap flight, at 0454L, the MMP commanded an altitude override of 54,000 feet to the MA (Tab L-123). When the MMP workstation locked up, the MA was flying with this override command (Tab J-10 and L-123). As the MA departed the Tiger MOA, it was flying 19,000 feet too high and did not comply with procedural altitude requirements (Tabs K-32 to K-33, AA-6, BB-108, and BB-114). There was no other link, workstation, or CGS available at the time to command an altitude change (Tabs V-5.8, V-5.12, V- 10.2 to V-10.4, V-10.6, V-10.10, and BB-18). At this time, with the MMCE's workstations still inoperable, turning off the GCI with the toggle switch was the only option available to ensure the MA met the route's preprogrammed altitudes for the procedural descent and approach into GFAFB (Tab V-6.5, BB-18, BB-108, and BB-114). Additionally, the MMP had 13 minutes from the time the MA departed the Tiger MOA to sever the links to the MA, trigger its C1 state, and prevent the MA from going into a go-around/missed approach route (AA-6 to AA-8 and AA-11 to AA-19). Instead, the MMP did not execute the GCI checklist procedures until after the MA hit the FAF (Tabs V-4.2, AA-8, and AA-17 to AA-27). This delay resulted in the MA's selection of a go-around/missed approach route at the FAF (Tabs AA-7, AA-17, and BB-31).

Thus, the MA continued to autonomously fly its preprogrammed route, without descending, exiting the Tiger MOA at NAV PT A2494 at 54,000 feet (Tabs J-10, K-19, L-123, and AA-6). The FSR1 continued to troubleshoot the MMCE workstation lockup, and the MOS entered the MMCE to assess the situation (Tab V-10.3). In order to salvage the mission, the MOS wanted another CGS set up and connected to the MA so the MA could be flown back to the Tiger MOA to continue the TLE mission (Tab R-30 and R-64). With the MLRE already prepared, the MOS

ordered it to be retasked to fly the MA and returned to the GHOC to find the scheduled MP and MIP to execute this change (Tab R-64).

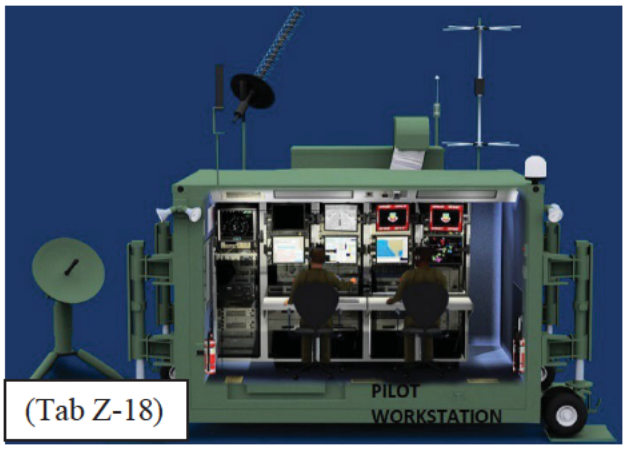
Concurrently, the MP and MIP arrived to work at 0600L to brief and fly the TLE portion of the flight (Tabs G-17 and R-26). They completed their briefing around 0640L with the intention of stepping to the MMCE to fly (Tab V-1.5). However, during the step process, the MOS ordered the MP and MIP to change their plan and to step to the MLRE, connect to the MA, and fly the MA back to the Tiger MOA (Tabs R-64, V-1.4, and V-5.18). The MP and MIP adjusted their plan, quickly discussed the changes to the mission, and stepped to the MLRE (Tabs R-30, R-35, V-1.4, and V-1.6).

In the MMCE, as FSR1 continued to troubleshoot the workstations, the MA continued on the preprogrammed route to the IAF, but the MA remained at an altitude of 54,000 feet, 45,000 feet too high due to the altitude override (Tabs K-19, V-10.4, AA-6 to AA-7, and AA-15). The MA's flight path did not match the preprogrammed flight path along the ground due to its altitude being too high, which increased its turn radius (Tabs K-19 and AA-6). Upon hitting the IAF, the mishap integrated mission management computer (MIMMC) on the MA removed the locked altitude command in accordance with its programming, and the MA commenced a descent in an attempt to rejoin the preprogrammed mission altitude for the approach to GFAFB, heading for the FAF (Tabs AA-7, AA-15, and BB-14).



(Tabs Z-10 and AA-7)

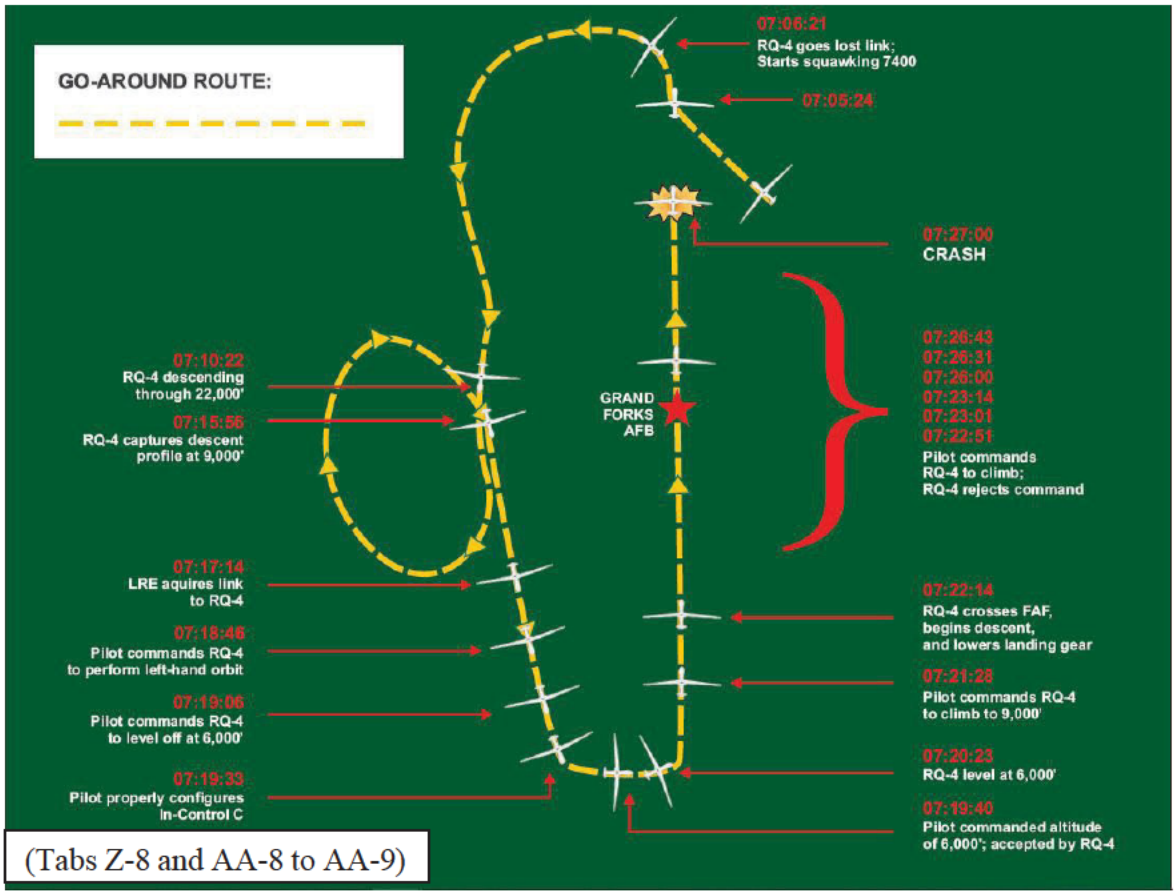
Upon hitting the FAF, the MA began to execute a go-around/missed approach route due to being too high and out of FAF preprogrammed altitude tolerances (Tabs AA-7, AA-17, and BB-31). While the MA was passing over the vicinity of the GFAFB airfield, the MMP directed the MMSO to turn off the GCI with the toggle switch to cut links with the MA, and the MA continued on its go-around/missed approach route to the west of the airfield in a descent (Tabs J-11 to J-12, V-4.2, V-6.2, AA-8, AA-17 to AA-27, and BB-18). Once the C1 timer expired and shortly after passing 34,200 feet, the MA transitioned to a lost link state, continued to descend, and automatically changed its squawk to 7400 (Tabs AA-8, AA-18, and BB-32). While completing the go- around/missed approach route, the MA arrived at the IAF (G1530) (Tabs J-12, AA-8, and AA- 19). The MA, still too high at 22,000 feet, performed a right-hand orbit to lose altitude and intercept the IAF at the assigned IAF altitude of 9,000 feet (Tabs K-20, AA-8, and AA-19 to AA- 20). After performing the turn, the MA intercepted the IAF at the required 9,000 foot altitude, commenced the approach, and lowered the landing gear in accordance with its programming (Tabs AA-8, AA-20, and BB-14).



(Tab Z-18)

While the MA flew the go-around/missed approach route sequence, the MP and MIP stepped to the MLRE to configure the workstation for flight (Tab R-8). Upon stepping to the MLRE, the MIP and MP expected the MA to be orbiting in the Tiger MOA, but were surprised to find it on a C4 route between the IAF and FAF (Tab V-2.18). The MIP realized they did not have the appropriate materials for local area operations, stepped back to the GHOC to obtain them, and left the MP alone in the MLRE for ten minutes to complete his set up of the MLRE pilot workstation (Tab R-30 to R-31). Upon the MIP's return to the MLRE, the MIP and MP began their attempt to gain control of the MA (Tab R-31). The MLRE acquired a command and control (C2) data link with the MA around NAV PT G1531 at 0717L, when the MA was between the IAF and FAF, and as the MA continued its descending approach to GFAFB (Tab J-13 and J-14). The MP commanded the MA to perform a left suspend, a left-hand turning orbit, in an attempt to take the MA off of its go- around/missed approach route and stop the MA's descent (Tabs J-13 and R-48). Despite the MLRE having a control link with the aircraft, this command attempt failed because the MP had not configured an "in control C" before making the command (Tab J-14). When set, the "in control C" tells the aircraft to receive and implement commands, and the pilot is unable to command an aircraft without it (Tab BB-27). This suspend command was accepted, but not implemented, because there was no valid "in control C" link selected (Tab J-14). Without an "in control C" set in the MLRE, the MA remained on its autonomous go-around/missed approach route (Tab J-14). The MP sent another command to the MA to level-off at 6,000 feet to stop the MA's descent, but the command was rejected again because no "in control C" had been configured (Tab J-14).

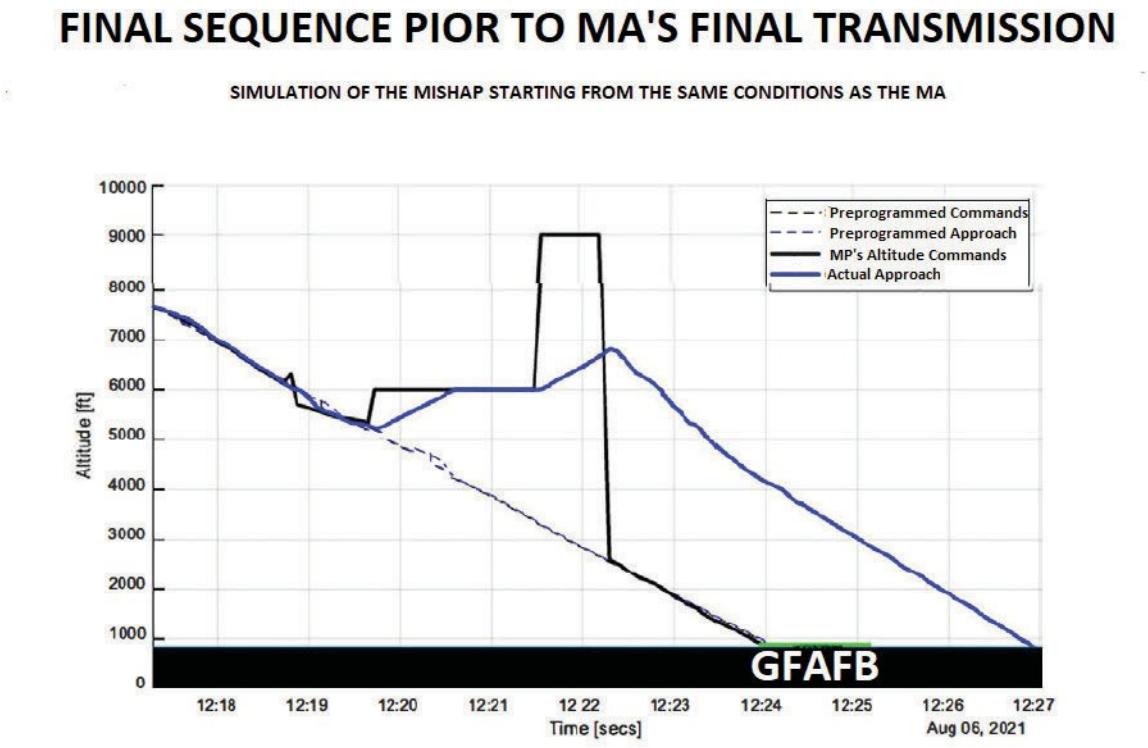
At 0719L, the MP realized he had not properly configured the "in control C" with the MA and proceeded to send the "in control C" (Tab J-15). The MP again commanded the MA to fly at an altitude of 6,000 feet (Tab J-15). The MIP continuously instructed the MP to issue an altitude command to the MA (R-32). With the proper control setting selected, the MA accepted the altitude command, stopped its descent at approximately 5,400 feet and, began to climb, but continued on the approach to land routing (Tab J-15). Upon reaching 6,000 feet the MA crossed NAV PT G1533, 1,504 feet above the route's preprogrammed altitude (Tab J-15). The MP then commanded the MA to climb to 9,000 feet and to retract the gear (Tab L-4). The MA complied; it began the climb to 9,000 feet and retracted the gear (Tab J-16 and L-4). Notably, both the MIP and MP stated they did not think the MA accepted any altitude commands and remained in a constant descent (Tab R-20 and R-32). In the commanded climb to 9,000 feet, the MA crossed the FAF at 7,000 feet, over 4,000 feet higher than the preprogramed route altitude (Tab J-16 and J-17). Since the MA had been executing a go-around/missed approach route, the MA continued to execute its preprogrammed route, lowered the gear again, and began a descent in an attempt to land at the touchdown NAV PT G1536 (Tab J-16 and J-17).



(Tabs Z-8 and AA-8 to AA-9)

The MP and MIP were not aware of the go-around/missed approach logic even though they were aware the MA was on a go-around/missed approach route (Tabs R-31, V-1.13, and V-2.23). Simultaneously, the MLRE experienced a short command link interruption at the FAF, but this was momentary and the link was restored (Tabs L-4, V-1.9, V-2.26, and V-13.8 to V-13.9). The MP attempted to give the MA an altitude command to arrest the MA's descent, but the command was rejected by the MA in accordance with its programming, and it continued descending (Tab

J- 17). The MIP continuously instructed the MP to issue an altitude command to the MA (R-32). The MP attempted to give the MA five more altitude commands, but the commands were rejected (Tab J-19). The MP and MIP believed that the MA had an incomplete link with the MLRE, causing it to not accept the MLRE commands (Tab V-1.9 and V-2.26). However, the MA was receiving the commands, but rejecting them due to the MA's preprogrammed go-around/missed approach route (Tab L-4 and BB-21). An aircraft on a go-around/missed approach route will fly the route and commit to landing on the second approach, unless another route is commanded (Tabs V-12.1 and BB-31). After crossing the FAF, the MA's programming attempted to steer the aircraft down at a steeper angle to meet the required landing waypoint on the airfield (Tab J-17). However, the maximum descent rate of 1,800 feet per minute was not sufficient to account for the MA's 4,000- foot altitude deviation at the FAF (Tab J-17). The MA, having no additional preprogrammed go-around/missed approach route options, continued in its maximum descent rate, overflew the GFAFB airfield, and impacted the ground 6.8 miles north of the GFAFB airfield along the runway centerline (Tab J-17 and J-21).



(Tabs J-18 and Z-20)

e. Impact

At approximately 0727L, the MA impacted the terrain 6.8 miles north of GFAFB, ND (Tab J-7). The MA had its gear extended on descent, encountered and clipped the top portion of a tree line, and impacted the terrain immediately north of the tree line (Tabs L-4, V-11.6, and Z-3 to Z-4).

f. Egress and Aircrew Flight Equipment (AFE)

This section is not applicable as the RQ-4 is not equipped with an egress system or AFE.

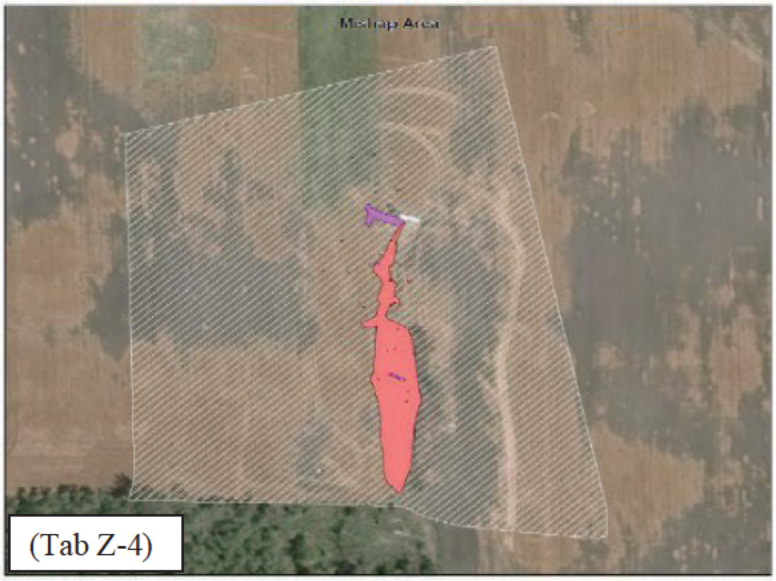
g. Search and Rescue (SAR)

On 6 August 2021 at approximately 0710L, before impact, an in-flight emergency (IFE) was declared via the primary crash phone for the MA (Tab DD-7). GFAFB Fire Department (GFAFB FD) responded to their standby locations on the airfield and waited for further information (Tab DD-7). Heavy fog reduced visibility on the airfield (Tab DD-7).

At 0728L the tower notified GFAFB FD that the MA appeared stationary with a last known location of approximately 6 miles north of the airfield (Tab DD-7). At 0731L, GFAFB FD left base to search for the MA in its last known direction (Tab DD-7). Heavy fog reduced visibility to under 100 feet (Tab DD-7).

At 0744L, GFAFB FD contacted civilian fire departments and the Grand Forks Sheriff's office to assist with the search (Tab DD-7). At 0747L, initial coordinates were given by the tower as the last known location of the MA (Tab DD-7). At 0754L, 319th Security Forces Squadron (SFS) units were sent off base to assist with the search (Tab DD-7). At 0821L, US Customs and Border Protection was contacted to request search assistance utilizing their unmanned aerial vehicle assets, but the request was denied due to heavy fog conditions preventing an aircraft launch (Tab DD-7). At 0821L, GFAFB FD reported black smoke spotted near 27th Ave NE between the cities of Gilby and Mekinock, due north of base (Tab DD- 7).


(Tab S-9)

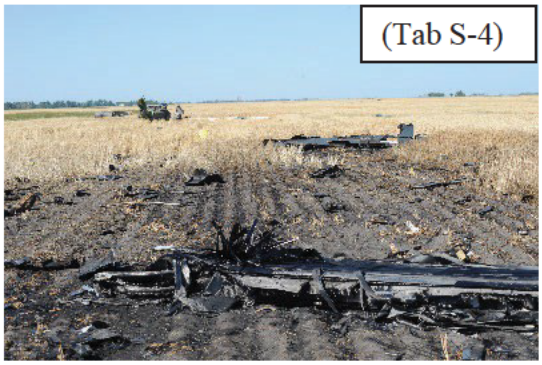


(Tab Z-4)

At 0829L, GFAFB FD confirmed two fires with black smoke approximately 8 miles west of initial coordinates and were attempting to access the site of the fires (Tab DD-8). The actual impact site was non-government property, specifically a barley farm field, and a National Defense Area was initiated (Tab V-11.2 to V- 11.3, V-11.11 to V-11.14, and DD-11). After arriving, GFAFB FD established incident command (IC), and civilian fire departments aided (Tab DD-8). 319 SFS established a perimeter and control of the perimeter so no other agencies or non-GFAFB personnel were allowed within the crash site (Tab V-11.3). An entry control point was established at the intersection of 28th St NE and 26th Ave NE, and there was only one road of ingress/egress (Tabs V-11.12 to V-11.13 and DD-8).


(Tab S-5)

At 0907L, GFAFB FD began fire suppression efforts (Tab DD-8). The crash site was approximately 300 feet east to west by 450 feet north to south, with a secured perimeter of 1000 feet around (Tab V-11.7 and DD-8). The MA made impact with a line of trees at the south end of the site before impacting the ground (Tab V-11.6 to V-11.7). By 0925L, the main sections of the aircraft fire were extinguished and attention was placed on cooling smaller aircraft pieces within the debris field (Tab DD-8). At 1255L, Bioenvironmental arrived to monitor the air and environment (DD-8). At 1406L, the crash recovery team arrived on scene (Tab DD-8).


(Tab S-4)

The GFAFB crash recovery team lead (CRTL), assigned to 319th Aircraft Maintenance Squadron (319 AMXS), originally received a notification about the mishap at 0800L on 6 August 2021 (Tab V-11.1 and V-11.2). The CRTL assembled a five to ten person crash recovery team (CRT) to respond to the aircraft incident over a sixteen-day period and make the scene of impact safe for recovery operations (Tab V-11.8). The CRT sprayed the entire crash site, and an additional 100 feet in every direction, with an acrylic floor wax-water mixture to control composite fibers from the MA; secured the safety of the mishap site; prevented further spread of MA

materials; wrapped and procured MA pieces; and transported MA pieces back to GFAFB (Tab V- 11.4 to V-11.6, and V-11.10).

The CRT used the following equipment during the recovery process: two all-terrain forklifts capable of 10,000 pounds, two tractor trailer flatbeds, a Kubota, a 30 gallon sprayer, four wooden crates, and self-contained breathing apparatuses (Tabs V-11.8 to V-11.10, and V-11.14 and DD-8). Over the 16 days, a number of rain days caused the CRT to experience some difficulty during the recovery efforts because of the mud at the crash site (Tab V-11.9). Recovery operations were concluded by 2 September 2021 (Tab DD-14).

h. Recovery of Remains

This section is not applicable as there were no fatalities (Tab X-3).

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 BB-6). 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 (Tab BB-6 to BB-7).

A comprehensive review of the historical AFTO 781 forms and IMDS revealed no discrepancies, overdue inspections, or overdue time compliance technical orders (TCTO) that would ground the MA, MMCE, and MLRE from flight operations (Tab D-3 to D-43, D-45 to D-59, U-3 to U-54, U- 98 to U-103). A thorough review of the AFTO 781 forms and IMDS historical records for the MA, MMCE and MLRE for the 30 days preceding the mishap revealed no recurring maintenance problems (Tab D-3 to D-43, D-45 to D-59, U-3 to U-54, U-98 to U-103).

b. Inspections

The pre-flight (PR) inspection and basic post-flight (BPO) inspection include visually examining the aerospace vehicle and operationally checking certain systems and components to ensure no serious defects or malfunctions exist (Tab BB-4 to BB-5). An exceptional release (ER), which includes a walk-around inspection (WAI), is an abbreviated PR inspection and are completed as required prior to launch in accordance with the applicable TOs (Tab BB-4 and BB-8).

The last BPO/PR inspection on the MA occurred on 4 August 2021 at 0930L with no discrepancies noted (Tab D-13). An ER on the MA occurred on 5 August 2021 with no discrepancies noted (Tabs D-9). The last BPO/PR inspection for the MMCE occurred on 5 August 2021 at 0845L with no discrepancies noted (Tabs D-32 and D-37). A Pre-Launch Inspection (PLI) occurred on 5 August 2021 at 0905L with no discrepancies noted (Tab D-32 and D-37). The last BPO/PR inspection for the MLRE occurred on 5 August 2021 at 1710L with no discrepancies noted (Tabs D-50 and D-53). Prior to the mishap, the MA, MMCE, and MLRE had no relevant reportable maintenance issues and all inspections were satisfactorily completed (Tabs D-3 to D- 43, D-45 to D59, U-3 to U-54, and U-98 to U-103). There is no evidence that inspections were a factor in the mishap (Tabs D-3 to D-43, D-45 to D59, U-3 to U-54, and U-98 to U-103).

c. Maintenance Procedures

Personnel assigned to the 319 AMXS performed all required inspections, documentations, and servicing for the MA, MMCE, and MLRE prior to flight (Tabs D-3 to D-43, D-45 to D59, U-3 to U-54, and U-98 to U-103). A detailed review of maintenance activities and documentation revealed no errors (Tabs D-3 to D-43, D-45 to D59, U-3 to U-54, and U-98 to U-103).

d. Maintenance Personnel and Supervision

Personnel assigned to the 319 AMXS performed all required inspections, documentations, and servicing for the MA, MMCE, and MLRE prior to flight (Tabs D-3 to D-43, D-45 to D59, U-3 to U-54, and U-98 to U-103). A detailed review of maintenance activities and documentation revealed no errors (Tabs D-3 to D-43, D-45 to D59, U-3 to U-54, and U-98 to U-103). Personnel involved with the MA, MMCE, and MLRE preparation had proper and adequate training, experience, expertise, and supervision to perform their assigned tasks (Tab U-78 to U-97).

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

Fuel samples of all base fuel tanks and the MA's fuel servicing truck were shipped to Headquarters (HQ) Air Force Petroleum Office (AFPET) Laboratory at Wright-Patterson Air Force Base (AFB) as well as the AFPET Laboratory at Vandenberg AFB (Tab U-60 to U-75). The AFPET reported the fuel analysis showed no detectable contamination (Tab U-60 to U-75). Oil samples taken prior to the mishap from the oil servicing carts and MA were tested by the local nondestructive inspection (NDI) shop and showed no detectable contamination (Tab U-55 to U-59). There is no evidence that the condition of the fuel or oil were a factor in the mishap (Tab U-60 to U-75).

f. Unscheduled Maintenance

Unscheduled maintenance is any maintenance action taken that is not the result of a scheduled inspection and normally is the result of a pilot-reported discrepancy during flight operations or a condition discovered by ground personnel during ground operations (Tab BB-10). There was one unscheduled maintenance action on the MA since the last scheduled inspection, which required minor engine oil servicing prior to flight (Tab D-9). There were no unscheduled maintenance actions on the MMCE and MLRE since the last scheduled inspection (Tab D-23 to D-42 and D-45 to D-53). There is no evidence that unscheduled maintenance was a factor in the mishap (Tabs D-3 to D-43, D-45 to D59, U-3 to U-54, and U-98 to U-103).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

The engine, fuselage and various airframe sub-components were recovered and returned to GFAFB (Tabs S-3 to S-7 and V-11.10 to V-11.11). Due to a fuselage fire, the integrated mission management computer (IMMC) was rendered unusable; however, the stores management unit (SMU) was sent to Northrop Grumman (NG) for further analysis (Tabs J-28 to J-34 and S-3 to S- 7). NG was unable to retrieve any usable data from the SMU due to severe heat damage caused by a fuselage fire (Tabs J-28 to J-34). Due to a corrupted drive and the loss in communication with the MA there were limited MMCE C2 system logs for review (Tabs U-100 and V-8.12). The available logs from the MLRE and MMCE showed no faults indicating structural failure or abnormal aircraft behavior (Tab L-3 to L-12). The MA's impact with the ground and the subsequent fuselage fire resulted in significant damage to the airframe (Tab S-6 and S-7). The available evidence indicates no inflight damage to the aircraft structure, or primary or secondary control surfaces (Tab J-20).

(1) Mission Control Element (MCE)

The MCE is a portable shelter from which a flight crew remotely operates an RQ-4's ground functions, takeoff, in- flight, and landing operations (Tab BB-38). The MCE is typically used for flights outside of the local area (Tab BB-38). It is equipped with pilot, sensor operator, quality control and communications workstations that are manned by personnel who control and/or monitor RQ-4 operations (Tab BB-38).

(Tab Z-17)

(2) Launch and Recovery Element (LRE)

The LRE is a portable shelter from which a flight crew remotely operates an RQ-4's ground functions, takeoff, inflight, and landing operations (Tab BB-37). The LRE is typically used for flight operations within the local area (Tab BB-37). It is equipped with pilot and communications workstations that are manned by flight crew who control and/or monitor RQ-4 operations (Tab BB-37).

(Tab Z-19)

(3) Integrated Mission Management Computers (IMMC)

The IMMC provides an aircraft with autonomous guidance, navigation, and control to follow the preloaded mission plan or commands from the controlling MCE or LRE (Tab BB-13, BB-37, and BB-38). It talks to the MCE or LRE via data links to control the aircraft, mission equipment, and radar system (Tab BB-13, BB-37, and BB-38). The IMMC controls the aircraft's taxi, takeoff, climb in altitude, cruise at altitude, descent in altitude, landing, and taxi to the mission end waypoint (Tab BB-13). On an approach, the IMMC will command the aircraft to descend, but not

orbit at the IAF if an override altitude is active (Tab BB-16 and BB-33). One of the IMMC's functions is processing a C4 state for the aircraft (Tab BB-13 and BB-30). C4 state processing includes a go-around/missed approach route for the aircraft (Tab BB-31). In processing the go- around/missed approach route, the IMMC sets the aircraft for one additional approach, and the aircraft continues to a landing on the second approach (Tab BB-31). On the second approach, the IMMC cannot command another go-around/missed approach route because it is not available (Tab BB-31).

b. Evaluation and Analysis

(1) Mishap Mission Control Element (MMCE)

On 6 August 2021, at 0616L, almost 14 hours into the flight, all MMCE workstations experienced a lockup (Tabs J-10, V-8.15, and V-10.10). The MMCE logs show no significant faults during the flight prior to the workstation lockup (Tabs D-44 and L-10 to L-132). However, at 0615L the MMP requested seven status updates in the minute immediately prior to the lockup (Tabs J-10 and L-131 to L-132). FSR2 was able to recover data from the logs within the hard drive on workstation 4, which showed the log stopping at 0615L (Tabs V-14.3 and AA-29). Once the workstation power was reset, the log showed the cause of the lockup as a Central Processing Unit (CPU) fatal warning, a fault that results in a workstation lockup (Tabs V-14.3 and AA-29). The log time for the workstation lockup does coincide with the time for the status requests in the MCE logs (Tabs L-131 to L-132 and AA-29). FSR1 was unable to confirm if the MMP's actions definitely caused the workstation lockup; however, FSR1 did note two potential theories or beliefs as to why it may have happened (Tab V-10.7). FSR1 indicated one possibility about pulling multiple detail statuses at the same time (Tab V-10.7). Another possibility could have been a storage issue because a log filled up (Tab V-10.7). For a storage issue, if a process sends a notification over, and over, and over again, it can fill the log, which fills the partition on the hard drive, which then crashes the hard drive and locks the workstation (Tab V-10.7). There is no documented warning or indications for operations that identifies this possible anomaly (Tab AA-31).

Due to system limitations, no further analysis could be performed to confirm whether the multiple detailed status requests definitively caused the workstation lockup (Tab V-14.4). This lockup resulted in all MMCE workstations being unusable and the MA continuing on its preprogrammed and automated flight path (Tabs K-19, L-132, V-4.4, and V-10.10). The maintenance team at the time of the mishap attempted to troubleshoot the error, but were unsuccessful (Tabs D-44 and V-10.2 to V-10.3). The MMSO turned off the GCI switch using the toggle switch, severing the MMCE communication links to the MA, and maintenance began the process of restarting the MMCE (Tab D-44, V-4.2, BB-18, and BB-26). Post-mishap, equipment cooling malfunctions and high heat during the summer months required the MMCE equipment to be shutdown, leading to the loss of data logs and configuration files from the corruption of the redundant array of independent/inexpensive disks (RAID) drive (Tabs U-99 to U100, U-106, and V-8.12). Furthermore, due to the limitations of the workstation software the FSR1 analysis of the system was not able to identify the direct source of the workstation lockup (Tabs J-21, V-8.2, V-10.5, and V-10.7).

(2) Mishap Launch and Recovery Element (MLRE)

The MLRE launched the MA at 1625L, 5 August 2021, and controlled the MA until MMCE took control of the MA at 1648L (Tab D-60). On 6 August 2021, the MLRE was in the process of being powered on to support another flight when the MMCE experienced the workstation lockup (Tabs U-104 and V-8.2). As the MMP, MMSO, and MOS worked through the MMCE workstation lockup, and as the MA began to autonomously return to GFAFB, the MOS decided that the MLRE would be used to regain control of the MA and preserve the mission (Tabs J-11, V-5.17 to V-5.18, and V-8.2). The MLRE established a link with the MA approximately 10 minutes prior to the MA impacting the ground (Tabs J-13 and DD-7). A review of the MLRE data logs show no evidence of MLRE fault or malfunction (Tabs L-3 to L-4 and V-13.8 to V-13.9).

(3) Mishap Integrated Mission Management Computer (MIMMC)

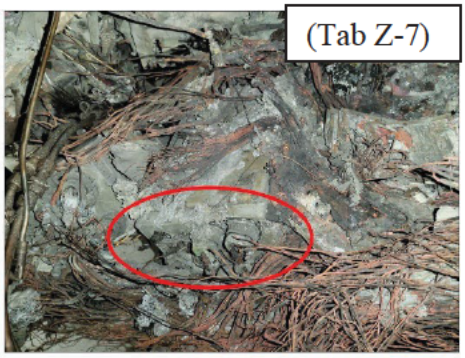
The MIMMC functioned as intended throughout the entire duration of the flight (Tabs D-44 and J-10). The MMP sent the altitude override command to the MIMMC at 0454L, and the aircraft responded (Tab L-123). When the pilot workstation locked up in the MMCE at 0616L on 6 August 2021, the MMP was flying on a preprogrammed navigational route with a commanded altitude at 54,000 feet, overriding the preprogrammed altitude of 65,000 feet (Tabs J-10, K-19, L- 132, and AA-6 to AA-7). When the pilot workstation locked up in the MMCE, the MA continued flying along the preprogrammed navigational route at its commanded altitude until it reached the IAF (Tabs J-10, L-132, and AA-6 to AA-7). At the IAF, the MIMMC removed the locked altitude command of 54,000 feet and began descending, in accordance with its programming, in an attempt to rejoin the preprogrammed mission altitude of 9,000 feet (Tabs K- 19, AA-7, AA-14 to AA-15, and BB-14). The MA crossed the FAF at 0702L (Tab AA-7 to AA-8). The MIMMC, in accordance with its programming, put the MA into a C4 state, triggering the MA's go-around/missed approach route because the MA was too high at an altitude of 49,900 feet to land compared to the preprogrammed FAF altitude of 2,962 feet (Tabs K-19, AA-7, AA- 17, and BB-31).

When the MA was performing its go-around/missed approach route, it descended in an attempt to attain the preprogrammed approach altitude along the go-around/missed approach route (Tabs K- 20, AA-7 to AA-8, and BB-31). As the MA flew in the vicinity of GFAFB, the MMCE GCI switch was toggled off, and all data links between the MIMMC and the MA were severed (Tabs V-6.2 and BB-26). The MA entered lost link status 120 seconds later (Tabs L-116 to L-117 and AA-8). The MA reached the IAF on the go-around/missed approach route at an altitude higher than the preprogrammed IAF altitude; the MIMMC, in accordance with its programming, told the MA to make one right-hand orbit in order to descend to the preprogrammed IAF altitude prior to continuing the go-around/missed approach routing (Tabs AA-8 and BB-33).

At 0717L on 6 August 2021, the MP and MIP gained a link to the MA shortly before the MA was performing its last turn on the go-around/missed approach route (Tabs J-13 and V-5.23). The MP input two separate commands for the MIMMC to tell the MA to perform (Tabs J-13 to J-14 and BB-13). In accordance with its programming, the MIMMC accepted the commands, but did not have the MA perform them because the MP failed to establish an "in control C" with the MIMMC (Tab J-13 to J-14). The MIMMC kept the MA in a lost-link state in accordance with the MIMMC's programming (Tabs J-14, AA-8, AA-18 to AA-27).

At 0719L the MP established an "in control C" with the MIMMC (Tab J-15). The MP then input an altitude command for the MIMMC to tell the MA to climb to an altitude of 6,000 feet of altitude in an attempt to stop the MA's autonomous descent along the go-around/missed approach route (Tabs J-15 and R-8). The MA responded to the input and climbed (Tab J-15). The MP then input a higher altitude command for the MIMCC to tell the MA to climb to 9,000 feet (Tab J-16). The MA responded to the input and climbed (Tab J-16). At 0722L, the MP input a command for the MIMMC to tell the MA to retract its landing gear (Tabs L-4 and R-9). The aircraft responded to the input and retracted its gear (Tab L-4). Less than 10 seconds later, the MA crossed the FAF on the go-around/missed approach route (Tabs K-21, L-4, and AA-8). While the MA was climbing through 7,000 feet, the MIMMC, in accordance with its programming, told the MA to stop its climb, lower the landing gear, and begin its descent to land at the touchdown waypoint (Tabs J- 17, L-4, and BB-28). The MA responded to the MIMMC inputs (Tabs J-17 and L-4).

The MP then input six altitude commands, but the MIMMC, in accordance with its programming, did not accept altitude override commands after the FAF waypoint on a go-around/missed approach route (Tabs J- 17, L-4, and BB-31). In accordance with the MIMMC's programming, the MA continued on a 4.5- degree glideslope all the way to ground impact (Tabs J-18 and BB-34). The MP and the MIP believed that there was not a useful control link from the MLRE to the MA during the mishap flight sequence (Tab V-2.18 to V- 2.19). However, the control link from the MLRE to the MA was functioning properly and as intended (Tabs L-4 and V-13.8).


(Tab Z-7)

MELTED MIMMC

7. WEATHER

a. Forecast Weather

On the morning of the mishap, the forecast for GFAFB had variable winds at six knots, scattered clouds at 5,000 feet above ground level (AGL), with a chance of smoky conditions and a maximum temperature of 25 degrees Celsius (Tab W-7).

b. Observed Weather

The observed weather preceding the mishap at 0655L were no winds and fog with a half-mile horizontal visibility and 100 feet vertical visibility (Tab W-4). The tower reported poor visibility due to fog (Tab R-70). The radar loop indicated insignificant weather in the Tiger MOA and on the MA return route to GFAFB (Tab W-18).

The post-crash weather observation at 0756L were winds out of the Northwest at 3 knots and fog with 1/8 mile visibility and 100 feet vertical visibility (Tab W-4).

c. Space Environment

Space environment had a low probability of impact with RQ-4 satellite communications due to x- ray flares, radio burst, geomagnetic storming, electron fluence, proton flux, and f10.7 flux condition being typical undisturbed space environment (Tab W-21).

d. Operations

General landing weather criteria for RQ-4 operations requires at least a 1,000-foot ceiling and two miles of visibility (Tab BB-77). For the MA's flight, all landings were approved down to zero ceiling and zero visibility (0/0) (Tab BB-72 to BB-73). All other operational weather requirements found in AFMAN 11-2ERQ-4V3 were adhered to (Tabs W-7 and BB-77).

The weather brief revealed that weather was not a factor in this mishap (Tab W-4).

8. CREW QUALIFICATIONS

In general, RQ-4 pilots are trained on go-around/missed approach procedures during Basic Qualification Training, and it is covered again in Initial Qualification Training and Mission Qualification Training (MQT) (Tab V-12.1). During this training, pilots are taught that if the aircraft is on a go-around/missed approach route, the pilot must get the aircraft off the go- around/missed approach route by giving a suspend command or by sending the aircraft another route (Tab V-12.1 to V-12.2). RQ-4 pilots are taught that there is no additional go-around/missed approach option on a go-around/missed approach route (Tab V-12.2). 348 RS squadron leadership expects that all pilots know this, to include instructor pilots (Tab V12.1 to V-12.2). Additionally, pilots are required to meet currency and annual training requirements for the event "Contingency 4A go-around," otherwise known as a go-around/missed approach route (Tab BB-47 and BB-59 to BB-60). In order to satisfy this requirement, the pilot must complete actions associated with an autonomous or pilot commanded go-around/missed approach with completion of the associated checklist (Tab BB-59 to BB-60).

a. Mishap Pilot (MP)

The MP was a current and qualified RQ-4 pilot at the time of the mishap (Tab G4 to G5 and G- 11). The MP completed his instrument qualification on 14 December 2020 and his mission qualification on 19 May 2021 (Tab G-11). The MP was an inexperienced RQ-4 pilot in accordance with AFI 11-2ERQ-4V1 (Tabs G-10 and BB-75). The MP's total RQ-4 primary time was 248.2 hours, which included 167.7 of primary flight hours and 80.5 primary simulator hours (Tab G-10). The MP was current in RQ-4 landings (Tab G-5). Notably, in MQT, during National Airspace Landing training, the MP failed a training event related to the successful recovery of the aircraft (Tab G-12 to G-15). The MP was current in the Ready Aircrew Program (RAP) Tasking Memorandum (RTM) tasked training event "Contingency 4A go-around," which was accomplished on 21 June 2021 (Tabs G-5, BB-47, and BB-59 to BB-60). He had not logged any quarterly emergency procedures training events, but just recently became Combat Mission Ready (CMR) on 27 May 2021 (Tab G-5, G-16, and BB-56). The MP's flight time in the RQ-4 from 8 May 2021 to 6 August 2021 was as follows:

	Hours	Sorties
30 day	48.1	9
60 day	91.8	18
90 day	117.0	25

(Tab G-6 to G-7 and G-83).

b. Mishap Instructor Pilot (MIP)

The MIP was a current and qualified RQ-4 instructor pilot at the time of the mishap (Tab G-22 to G-23 and G-28). The MIP completed his initial instrument qualification on 14 February 2018, initial mission qualification on 18 August 2018, and his instructor qualification on 9 June 2021 (Tab G-28). Notably, the MIP received an "exceptionally qualified" rating on his initial instructor qualification checkride (Tab G-29 to G-30). To earn an exceptionally qualified rating, the instructor must show exceptional skill and knowledge during his evaluation (Tab BB-116). The MIP was an experienced RQ-4 pilot in accordance with AFI 11-2ERQ-4V1 (Tabs G-25 and BB- 75). The MIP's total RQ-4 primary time was 448.9 hours, which included 416.9 hours of primary flight time and 32.0 primary simulator hours, and he had 7.7 hours of instructor time (Tab G-25). The MIP was current in landings and instructor duty (Tab G-22 to G-23). Additionally, he was current in the RTM tasked training event "Contingency 4A go-around," which was accomplished the day prior to the mishap (Tabs G-23, BB-47, and BB-59 to BB-60). However, the MIP had logged only one of the four required quarterly emergency procedures training events and did not meet RAP requirements (Tabs G-23, BB-45, and BB-56). The MIP's flight time in the RQ-4 from 8 May 2021 to 6 August 2021 was a follows:

	Hours	Sorties
30 day	4.0	2
60 day	10.2	4
90 day	19.3	8

(Tab G-24 and G-83).

c. Mishap Mission Control Element Pilot (MMP)

The MMP was a current and qualified RQ-4 pilot at the time of the mishap (Tab G-39 to G-40 and G-46). The MMP completed his initial instrument qualification on 7 March 2021 and his mission qualification on 21 June 2021 (Tab G-46). Notably, on his instrument qualification checkride, he received a downgrade in "steering commands" for executing multiple aircraft override / on-track commands without verifying potential aircraft response that resulted in minor navigation deviations (Tab G-50 to G-51). The MMP was an inexperienced RQ-4 pilot in accordance with AFI 11-2ERQ-4V1 (Tab G-45 and BB-75). The MMP's total RQ-4 primary time was 152.1 hours, which included 76.6 hours of primary flight time and 75.5 hours of simulator time (Tab G-45). The MMP's flight time in the RQ-4 from 8 May 2021 to 6 August 2021 was a follows:

	Hours	Sorties
30 day	25.2	6
60 day	39.2	10
90 day	54.0	14

(Tab G-41 and G-83).

d. Mishap Mission Control Element Sensor Operator (MMSO)

The MMSO was a current and qualified RQ-4 sensor operator at the time of the mishap (Tab G- 59 to G-60 and G-66 to G-67). The MMSO completed his mission qualification on 5 April 2021 (Tab G-66 to G-67). The MMSO's total RQ-4 primary time was 77.9 hours, of which included 0 hours of simulator time (Tab G-65). The MMSO was an inexperienced RQ-4 sensor operator in accordance with AFI 11-2ERQ-4V1 (Tabs G-65 and BB-75). The MMSO's flight time in the RQ- 4 from 8 May 2021 to 6 August 2021 was a follows:

	Hours	Sorties
30 day	30.3	6
60 day	40.6	10
90 day	59.3	17

(Tab G-61 and G-83).

9. MEDICAL

a. Mishap Pilot (MP)

The MP was medically qualified for flight duties (Tab G-8 and G-89). A review of his post-mishap medical examination record did not reveal any factors relevant to the mishap (Tab G-89). Toxicology testing was performed with negative results (Tab G-88). Review of the MP's 7 day and 72 hour histories did not reveal any unusual lifestyle habits, behavior, or stress (Tab G-17 to G-20). In accordance with AFMAN 11-202V3, immediately preceding duty, crew rest for the MP required 12 hours off from work and the opportunity to achieve 8 hours of uninterrupted sleep before showing (Tab BB-81). The maximum allowed flight duty period for the MP was 12 hours (Tab BB-81). Review of the MP's 72 hour history confirms that he met both crew rest and flight duty period requirements (Tab G-17 to G-18).

b. Mishap Instructor Pilot (MIP)

The MIP was medically qualified for flight duties (Tab G-26 and G-89). A review of his post-mishap medical examination record did not reveal any factors relevant to the mishap (Tab G-89). Toxicology testing was performed with negative results (Tab G-88). Review of the MIP's 7 day and 72 hour histories did not reveal any unusual lifestyle habits, behavior, or stress (Tab G-32 to G-37). Review of the MIP's 72 hour history confirms that he met both crew rest and flight duty period requirements (Tab G -32 to G-34).

c. Mishap Mission Control Element Pilot (MMP)

The MMP was medically qualified for flight duties (Tab G-43 and G-89). A review of his post-mishap medical examination record did not reveal any factors relevant to the mishap (Tab G-89). Toxicology testing was performed with negative results (Tab G-88). Review of the MMP's 7 day

and 72 hour histories did not reveal any unusual lifestyle habits, behavior, or stress (Tab G-52 to G-57). Review of the MMP's 72 hour history confirms that he met both crew rest and flight duty period requirements (Tab G-52 to G-54).

d. Mishap Mission Control Element Sensor Operator (MMSO)

The MMSO was medically qualified for flight duties (Tab G-63 and G-89). A review of his post-mishap medical examination record did not reveal any factors relevant to the mishap (Tab G-89). Toxicology testing was performed with negative results (Tab G-88). Review of the MMSO's 7 day and 72 hour histories did not reveal any unusual lifestyle habits, behavior, or stress (Tab G-70 to G-73). Review of the MMSO's 72 hour history confirms that he met both crew rest and flight duty period requirements (Tab G-70 to G-71).

10. OPERATIONS AND SUPERVISION

a. Operations

The 348 RS personnel executed an operations tempo supporting an average of two flights per day (Tab K-4 to K-17). There was a general healthy desire within the operations group that motivated individuals towards accomplishing the mission (Tab V-12.2). This may have created some perceived pressure to gain control of the MA before landing and continue the mission in the Tiger MOA (Tab R-30 to R-34).

b. Supervision

Operations supervision was provided by an on-duty operation supervisor, the MOS (Tab K-13). The MOS was certified in accordance with AFI 11-418 319 OG supplement (Tab G-77). Additionally, per this guidance, the 348 RS commander certified the MOS on 18 June 2021 (Tab G-74 to G-76). Operations supervisor training covered procedures, duties, and responsibilities of the operations supervisor role, to include: flight authorizations, Go/No-Go, handling mission changes, and general expectations and conduct of 348 RS operations supervision (Tab V-5.28, V- 9.5 and V-9.6). For operations supervisor duties, personnel must be afforded 8 hours of uninterrupted crew rest, and the maximum crew duty day is 14 hours (Tab BB-84). On the day of the mishap, the mishap operations supervisor met both crew rest and crew duty day requirements (Tab G-78 to G-80).

11. HUMAN FACTORS ANALYSIS

a. Introduction

The Department of Defense Human Factors Analysis and Classification System 7.0 lists potential human factors that can play a role in aircraft mishaps and identifies potential areas of assessment during an accident investigation (Tab BB-86 to BB-89). Four human factors were identified as relevant to the mishap: (1) procedure not followed correctly, (2) rushed or delayed a necessary action, (3) wrong choice of action during an operation, and (4) pressing (Tab BB-86 to BB-89).

b. Procedure Not Followed Correctly

A procedure not followed correctly is a factor when a procedure is performed incorrectly or accomplished in the wrong sequence (Tab BB-86).

c. Rushed or Delayed a Necessary Action

This is a factor when an individual takes the necessary action as dictated by the situation, but performs these actions too quickly or too slow (Tab BB-86).

d. **Wrong Choice of Action During an Operation**

A wrong choice of action during an operation is a factor when the individual, through faulty logic or erroneous expectations, selects the wrong course of action (Tab BB-87).

e. **Pressing**

Pressing is a factor when the individual knowingly commits to a course of action that excessively presses the individual and/or their equipment beyond reasonable limits (e.g., pushing self or equipment too hard) (Tab BB-88).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

AFI 51-307, *Aerospace and Ground Accident Investigations,* 18 March 2019
AFI 11-418, *Operations Supervision,* 31 March 2020
AFMAN 11-2ERQ-4 Volume 1, *RQ-4/EQ-4, Flying Operations-Crew Training,* 4 February 2020
AFMAN 11-2ERQ-4 Volume 3, *RQ-4/EQ-4, Flying Operations-Operations Procedures,* 28 May 2020
AFMAN 11-202 Volume 2, *Flying Operations,* 1 October 2019
AFMAN 11-202 Volume 3, *General Flight Rules,* 10 September 2020

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. *Change language as appropriate.*

b. Other Directives and Publications Relevant to the Mishap

TO 00-20-1, *Aerospace Equipment Maintenance Inspections, Documentation, Policies, and Procedure*, 6 September 2019
TO 00-20-2, *Maintenance Data Documentation*, 22 July 2021
AFTTP 3-3.RQ-4B, *Tactical Doctrine Combat Aircraft Fundamentals-RQ-4B,* 24 September 2021
AFI 11-418, *Operations Supervision,* 31 March 2020_319 OG Supplement
RQ-4B Electronic Flight Manual, 7 July 2021
RQ-4B Electronic Flight Manual, 5 October 2021
RQ-4B Systems Handbook, Version 4.5, 15 January 2021
RQ-4 RAP Tasking Memo, 1 October 2020

DOD Human Factors Analysis and Classification System – Version 7.0

c. Known or Suspected Deviations from Directives or Publications

Not Applicable.

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30 March 2022

GEOFFREY S. FUKUMOTO, Colonel, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

RQ-4B BLOCK 40, T/N 08-2035
6.8 MILES NORTH OF GRAND FORKS AIR FORCE BASE, NORTH DAKOTA
6 August 2021

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 by the United States or by any person referred to in those conclusions or statements.

1. OPINION SUMMARY

On 6 August 2021, at 0727 local (L) time, an RQ-4B Block 40 Global Hawk, tail number (T/N) 08-2035, impacted farmland approximately 6.8 miles north of Grand Forks Air Force Base (GFAFB), North Dakota (ND). Approximately fourteen hours into the mission, the mishap remotely piloted aircraft (MA) returned to base after a mission control element workstation lockup, executed a missed approach, and performed another approach to landing. The mishap crew (MC) established control of the MA on the second approach, failed to send the MA a new navigational route, and the MA overshot the runway crashing into a field north of GFAFB, ND. The MA was flown by the 348th Reconnaissance Squadron, 319th Reconnaissance Wing, GFAFB, ND.

I find, by a preponderance of the evidence, the cause of the mishap was the mishap pilot's (MP) incorrect selection of aircraft flight commands resulting in the MA's controlled flight into terrain. Further, I find, by a preponderance of the evidence, the cause of the mishap was the mishap instructor pilot's (MIP) failure to provide sufficient inputs to the MP to prevent the MA's controlled flight into terrain. Furthermore, I find, by a preponderance of the evidence, the mishap mission control element pilot (MMP) failed to follow established procedures, resulting in the MA's delayed descent and preprogrammed selection of a go-around/missed approach route, significantly contributing to the mishap. I developed my opinion and determined the mishap sequence of events by analyzing factual data from the mishap. This data included mission control element data logs, launch and recovery data logs, radar information, maintenance records, witness interviews, information provided by technical experts, and Air Force directives and guidance.

2. CAUSES

I find, by a preponderance of the evidence, the cause of the mishap was the MP's incorrect selection of aircraft flight commands resulting in the MA's controlled flight into terrain. As the MA autonomously returned to GFAFB for a landing, the MP did not configure his workstation properly in a timely manner, which delayed positive control of the MA. This compressed the amount of time he had to fly the MA before it commenced its final approach to landing. After properly configuring his workstation, the MP sent altitude override commands to the MA on its approach routing. This arrested the MA's descent and resulted in a climb and altitude deviation from the MA's preprogrammed approach to GFAFB. The MP failed to notice the MA's climb

from 5,400 to 7,000 feet. Upon reaching the final approach fix (FAF), the MA was approximately 4,000 feet too high. The MP did not recognize the MA's altitude deviation or the approach routing's associated preprogrammed logic. Because the MP did not command another route, the MA continued on its preprogrammed approach routing and attempted to land on the GFAFB runway. By the manufacturer's design of the system, there were no other go-around/missed approach route options programmed in the MA's logic, therefore, with no further routes commanded, the MA was committed to its attempt to land. The MP had the requisite training for this scenario, but it was the MP's inadequate application of knowledge that contributed to his error in flight selection. The MP could have simply sent the MA another route to fly, and the MA would have come off the go-around/missed approach route without making an attempt to land. Consequently, without another route commanded, the 4,000-foot altitude deviation caused the MA to overshoot the runway and crash into a field 6.8 miles north of GFAFB. I find that although the amount of time the MP had to send the MA commands to be of a short duration, his awareness of the MA's altitude, altitude deviation, knowledge of approach routing and preprogrammed logic, did not meet the standards of a qualified RQ-4 pilot. The MP's selected actions, deficiency of knowledge, and lack of awareness caused the mishap.

Further, I find, by a preponderance of the evidence, the cause of the mishap was the MIP's failure to provide sufficient inputs to the MP to prevent the MA's controlled flight into terrain. The MIP failed to notice the MA's climb from 5,400 to 7,000 feet, the 4,000-foot altitude deviation at the FAF, or the approach routing's associated preprogrammed logic. The MIP failed to instruct the MP to command another route to the MA, resulting in the runway overshoot and crash into a field 6.8 miles north of GFAFB. I find that the MIP failed to meet the standards of his qualification as an instructor, especially as one that was evaluated as "exceptionally qualified." The MIP's insufficient instruction and displayed deficiency of knowledge, as an RQ-4 instructor pilot, caused the mishap.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

First, I find, by a preponderance of the evidence, the mishap MMP failed to follow established procedures, resulting in the MA's delayed descent and preprogrammed selection of a go-around/missed approach route, significantly contributing to the mishap.

Approximately 14 hours into the mission, the mishap mission control element (MMCE) controlling the MA experienced a pilot workstation lockup, preventing the MMP from sending control inputs to the MA. Despite the workstation lockup, the MMCE's control link remained intact, but without further MMP control inputs, the MA continued to fly its last commanded mission. This mission, with an altitude override command at 54,000, was a route in the Tiger MOA followed by a descent and approach to GFAFB. Without further MMP control inputs, the MA could fly this route completely autonomously and return to GFAFB for landing.

As the MMP worked the MMCE workstation lockup issue, he had a responsibility to ensure the MA remained in controlled airspace, and if not, execute checklist steps to ensure the MA returned to base (RTB) in accordance with established procedures. The established RTB procedures were to follow the routing and altitude restrictions already programmed into the MA's route as it departed the Tiger MOA and returned to GFAFB. This route was designed to recover the MA via

a descent and approach to hit an IAF at 9,000 feet and the FAF at 2,962 feet. However, due to the MMCE workstation lockup, as the MA reached the last portion of its route within the Tiger MOA and commenced its route home, the MA did not descend in accordance with established altitude procedures. This is due to the altitude override command to remain at 54,000 feet.

The RQ-4 "Pilot Workstation Lockup or Log Out" checklist states that if the pilot is unable to maintain airspace requirements, the pilot must complete the common ground station (CGS) "Forced Contingency 1 – Lost Communication" checklist. This checklist clearly states that if another link, workstation, or CGS is unavailable, to turn off the ground communications interface (GCI) using the toggle switch to sever all links between the CGS and aircraft. At the time the MA began to depart the Tiger MOA and could not maintain airspace requirements, no other link, workstation, or CGS was available. Therefore, the MP should have immediately turned off the GCI by toggling the switch to sever all links between the MMCE and MA, and forced the MA to execute a descent and approach to GFAFB. However, since the MMP did not toggle the GCI switch at the appropriate time, the MA did not descend and remained at a much higher altitude along its programmed route home. Since the MMCE's workstations were still inoperable, turning off the GCI was the only option available to ensure the MA met the route's preprogrammed altitudes for the descent and approach into GFAFB.

The MMP had approximately 13 additional minutes from departing the MA's assigned airspace to toggle the GCI switch and force the MA to go C1, avoiding the selection of a go-around/missed approach route. As the MA flew its RTB routing at 54,000 feet, the MA reached the IAF 45,000 feet too high. The MA's programming then canceled the 54,000 foot altitude override command and commenced a descent. However, the MMP did not turn off the GCI until after the MA reached the FAF. At the FAF, the MA was still extremely high and the MA's flight path logic commenced a go-around/missed approach route. This route is programmed to take the aircraft west of the airfield, descend, and attempt another approach to land. While on this go-around/missed approach route, unless the MA was given another route to fly, it would continue the approach and commit through landing. It was on this go-around/missed approach route that the MP gained control of the MA, with no further go-around/missed approach route options.

It is my assessment that the MMP's delayed action to turn off the GCI caused the MA to RTB too high, leading to its selection of the go-around/missed approach route. If the MMP had followed procedures, the MA would have descended in accordance with published procedures and been on a normal approach and route to landing. In my opinion, the MMP's failure to adhere to published procedures was a substantially contributing factor to this mishap.

Finally, I find, by a preponderance of the evidence, the pilot workstation lockup, including the lack of documented procedures regarding requesting numerous detailed status requests within a short timeframe, resulted in the MMP's inability to positively control the aircraft resulting in the MA's execution of preprogrammed logic and return to base, significantly contributing to the mishap.

Approximately 14 hours into the mission, the MMP attempted to retrieve detailed status reports from the pilot workstation. This is a normal action performed by crews in order to obtain data on aircraft system status. During this period, the MMP requested seven detailed status reports over

the course of one minute. Evidence of the detailed status requests and resultant lockup is found in the workstation data logs. However, workstation technicians were unable to determine why or if the multiple detailed status requests in one minute caused the workstation lockup. The data logs show a Central Processing Unit (CPU) fatal warning fault, resulting in a workstation lockup, occurred one minute after the seven detailed status requests were commanded. Technicians gathered all available logs, but do not have the ability to troubleshoot further. Based on the available evidence, I find, by a preponderance of the evidence, the workstation lockup was the result of multiple detailed status requests sent over a relatively short time-frame of one minute, causing a CPU fatal warning.

It is my assessment that the susceptibility of workstation lockups from the request of detailed status commands is a workstation deficiency. The workstation lockup played an important role that significantly contributed to the mishap. Furthermore, there are no documented warnings or indications for operators that identifies this possible anomaly in order to prevent this action from occurring.

4. CONCLUSION

I find, by a preponderance of the evidence, the cause of the mishap was the MP's incorrect selection of aircraft flight commands resulting in the MA's controlled flight into terrain. Further, I find, by a preponderance of the evidence, the cause of the mishap was the MIP's failure to provide sufficient inputs to the MP to prevent the MA's controlled flight into terrain. Additionally, I find, by a preponderance of the evidence, the MMP failed to follow established procedures, resulting in the MA's delayed descent and preprogrammed selection of a go-around/missed approach route, significantly contributing to the mishap. Finally, I find, by a preponderance of the evidence, the pilot workstation lockup, including the lack of documented procedures regarding requesting numerous detailed status requests within a short timeframe, resulted in the MMP's inability to positively control the aircraft resulting in the MA's execution of preprogrammed logic and return to base, significantly contributing to the mishap.

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30 March 2022

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President, Accident Investigation Board

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