UNITED STATES AIR FORCE AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

QF-4E, T/N 74-1629

DETACHMENT 1, 82D AERIAL TARGETS SQUADRON
53RD WING
HOLLOMAN AIR FORCE BASE, NEW MEXICO

LOCATION: WHITE SANDS NATIONAL MONUMENT

DATE OF ACCIDENT: 7 FEBRUARY 2014

BOARD PRESIDENT: MAJOR ROBERT G. MATHIS

Abbreviated Accident Investigation, conducted pursuant to Chapter 11 of Air Force Instruction 51-503

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR COMBAT COMMAND
JOINT BASE LANGLEY-EUSTIS VA

OFFICE OF THE VICE COMMANDER
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JUL 14 2014

ACTION OF THE CONVENING AUTHORITY

The Report of the Abbreviated Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 7 February 2014, mishap near Holloman Air Force Base, New Mexico, involving QF-4E, T/N 74-1629, assigned to Detachment 1, 82d Aerial Targets Squadron, Holloman Air Force Base, New Mexico, complies with applicable regulatory and statutory guidance; on that basis it is approved.

LORI J. ROBINSON
Lieutenant General, USAF
Vice Commander

Agile Combat Power

EXECUTIVE SUMMARY

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
QF-4E, T/N 74-1629, HOLLOMAN AIR FORCE BASE, NEW MEXICO
7 FEBRUARY 2014

On 7 February 2014, at 16:07:22 Zulu (Z) time, a QF-4E Phantom II aircraft, tail number (T/N) 74-1629, on approach for landing, impacted the ground in the White Sands National Monument approximately 5 miles southwest of runway 04 at Holloman Air Force Base (AFB), New Mexico (NM). The mishap aircraft (MA) was assigned to Detachment 1, 82d Aerial Targets Squadron (82 ATRS) and based at Holloman AFB, NM. Detachment 1, 82 ATRS reports to the 53rd Weapons Evaluation Group (53 WEG), 53rd Wing (53 WG), Tyndall AFB, Florida (FL). The MA was destroyed on impact. The total damage to Department of Defense (DoD) property was assessed to be $4,890,429. Damage to non-DoD but other government property included two road signs/posts and a small (3'x 1') impact crater on a road; DoD paid for new signs and repaired the road.

At 16:02:01Z, and approximately 15 miles from recovery, the Mishap Controller (MC) commanded automatic landing of the MA via the White Sands Integrated Target Control System (WITS) Operating Console. At 16:06:48Z, the Chase Pilot (CP) notified the MC "we're rocking a little bit." However, when the MC crosschecked the flight instruments on the WITS Operating Console right screen the wings appeared level. At 16:07:03Z, the MA made an aggressive left roll to approximately 70 degrees angle of bank, which caused the MA to lose altitude, turn left and then roll out wings level. At 16:07:17Z, the MC switched the MA into manual control. The MC checked the attitude indicator on the WITS Operating Console right screen and noted the MA's pitch attitude moving downwards. The MC determined the MA was in an unusual attitude and began performing the "Unusual Attitude Recovery" emergency procedure (EP) checklist by selecting All Attitude Recovery (AAR). The MA continued to oscillate up and down after the MC selected AAR; therefore, the MC selected Automatic Takeoff (ATO). The MA did not respond so the MC completed the "Unusual Attitude Recovery" EP checklist by selecting Backup Automatic Flight Control System (BUAFCS) on the WITS Operating Console control stick followed by AAR. At 16:07:22Z, the CP observed the MA impact the ground. There were no aural tones over the controller radio frequencies during the mishap sequence indicating a loss of transmission between the MA and the WITS.

The Abbreviated Accident Investigation Board (AAIB) President found by clear and convincing evidence that the cause of this mishap was a brief failure of the pitch and roll attitude gyro, the instrument used to inform the MC of the MA's orientation relative to Earth's horizon, which sent erroneous inputs to the MA's Automatic Flight Control Computer (AFCC). The MA subsequently responded by driving the stabilator, the aircraft component that moves the aircraft up and down, into a stall prevention mode as quickly as possible resulting in a continuous cycle of overcorrection of the MA's pitch and an increase in pitch oscillations. This cycle continued despite the MC's efforts to recover the MA until the MA impacted the ground.

SUMMARY OF FACTS AND STATEMENT OF OPINION

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
QF-4E, T/N 74-1629, HOLLOMAN AIR FORCE BASE, NEW MEXICO
7 FEBRUARY 2014

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COMMONLY USED ACRONYMS AND ABBREVIATIONS

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53 WEG	53rd Weapons Evaluation Group
53 WG	53rd Wing
82 ATRS	82nd Aerial Target Squadron
83 FWS	83rd Fighter Weapons Squadron
A1C	Airman First Class
AAR	All-Attitude Recovery
AAIB	Abbreviated Aircraft Investigation Board
AB	Afterburner
A/B	Alpha and Bravo
ACC	Air Combat Command
ADAS	Auxiliary Data Annotation Set
ADI	Attitude Director Indicator
ADO	Assistant Duty Officer
ADDS	Aviation Digital Data Service
AF	Air Force
AFB	Air Force Base
AFCC	Automatic Flight Control Computer
AFCS	Automatic Flight Control System
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFIP	Air Force Institute of Pathology
AFMAN	Air Force Manual
AFMC	Air Force Material Command
AFPET	Air Force Petroleum Laboratory
AFSEC	Air Force Secretary
AFSAS	Air Force Safety Automated System
AFTTP	Air Force Technical Training Manual
AFTO	Air Force Technical Order
AGE	Aerospace Ground Equipment
AGL	Above Ground Level
AH	Altitude Hold
AHRS	Attitude Heading Reference System
AI	Attitude Indicator
AIB	Accident Investigation Board
AFLCMC	Air Force Life Cycle Management Center
AMARG	Aerospace Maintenance and Regeneration Group
AMIC	Aircraft Mishap Investigation Course
AMRAAM	Advance Medium Air to Air Missile
AMXS	Aircraft Maintenance Squadron
AOA	Angle of Attack
APP	Approach
ARR	Arrive
ASW	Auxiliary Switch
ATC	Air Traffic Controller
ATD	Aircrew Training Devices
ATO	Automatic Takeoff
ATRS	Aerial Targets Squadron
AWACS	Airborne Warning and Control System
AWBS	Automated Weight and Balance System
BAE	British Aerospace
BUAFCC	Backup Automatic Flight Control Computer
BUAFCS	Backup Automatic Flight Control System
Capt	Captain
CC	Commander
CD	Deputy Commander
CEMP	Comprehensive Emergency Management Plan
CG	Center of Gravity
CIV	Civilian
CMD/TEL	Command Control/Telemetry
COM	Communication
COMACC	Commander of Air Combat Command
CP	Chase Pilot
CT	Coordinator
CTS	Command Telemetry System
DALR	Digital Audio Legal Recorder
D1C	Drone One Controller
DC	Deputy Commander
Det	Detachment
DFCS	Drone Formation Control System
DFS	Drone Formation System
DMC	Drone Mission Commander
DO	Director of Operations
DoD	Department of Defense
DOT	Department of Transportation
DPE	Drone Peculiar Equipment
DS2	Defense System Services
DSN	Defense Switching Network
DRU	Down Range Unit
EA	Electronic Attack
EH	Electro-Hydraulic
ECM	Electronic Countermeasures
EM	Electro-Mechanical
EOC	Emergency Operations Center
EP	Emergency Procedure
EPE	Estimated Position Error
EPIP	Electronic Improvement Protection Program
ER	Exceptional Release
FAE	Functional Area Expert
FCF	Functional Check Flight
FCS	Fixed Control Station

FD	Flight Data
FE	Flight Engineer
FL	Florida
FLT	Flight
FOA	Field Operating Agency
FOIA	Freedom of Information Act
FS	Flight Simulator
FSAT	Full Scale Aerial Target
FSAT AFCS	Full Scale Aerial Target Automatic Flight Control System
FW	Fighter Wing
FWS	Fighter Weapons Squadron
G	Gravitational Force
GAB	Ground Abort
GC	Ground Control
GMCS	WITS Mobile Control Station
WITS	Gulf Range Drone Control Station
GRDS	Gulf Range Control System
GS	Government Service
HFACS	Human Factor Analysis and Clarification System
HQ	Headquarters
HHI	Heading Hold Inhibit
HMN	Holloman Control Tower
IAC	Information Analysis Center
IAS	Intelligence Analysis System
IAW	In Accordance With
IC	Incident Commander
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Integrated Logistics Support
IMDS	Integrated Maintenance Documentation System
INIT	Initialization
INSTM	Instrumentation
IO	Investigating Officer
IPI	Infrastructure Protection
ISB	Interim Safety Board
JA	Judge Advocate
JMIC	Joint Military Intelligence College
JOAP	Joint Oil Analysis Program
JP-8	Jet Propellant
KHMN	Holloman AFB ICAO Identifier
Kt	Knot
KIAS	Knots Indicated Airspeed
L	Local Time
LA	Legal Advisor
LC	Local Control
LCDO	Launch Control Destruct Officer
LEU	Leading Edge Up
LED	Leading Edge Down
LET	Lead Electronic Technician
LOLA	Live on Loaded Aircraft
LTO	Landing/Takeoff
Lt Col	Lieutenant Colonel

MA	Mishap Aircraft
Mach	Speed of Sound
Maj	Major
MAJCOM	Major Command
MATLAB	Matrix Laboratory
MC	Mishap Controller
MCS	Maneuver Control System
MAX	Maximum Throttle Including Full AB
MDCO	Mobile Drone Console Operator
MED	Medical Member
MFR	Memorandum For Record
MHz	Megahertz
MM	Maintenance Member
MIKE	NULLO Mission Commander
MIL	Maximum Throttle Command Prior to AB
MM	Maintenance Member
MMC	Mishap Mission Coordinator
MOA	Minute of Angle
MT	Maintenance Technician
NAD	No Air Data
nm	Nautical Mile
NM	New Mexico
NOTAMS	Notice to Airmen
NS	Network Simulator
NULLO	Not Under Live Local Operator
NV	Nevada
OI	Operating Instruction
OPLAN	Operations Plan
ORM	Operational Risk Management
OSC	On Scene Commander
OSS	Operations Support Squadron
OWS	Operations Weather Squadron
PA	Public Affairs
PAC	Pitch Attitude Control
PAFCC	Primary Automatic Flight Control Computer
PAFCS	Primary Automatic Flight Control System
PAR	Precision Approach Radar
PC	Power Control (System)
PID	Proportional-Integral-Derivative
PM	Pilot Member
P/N	Part Number
POC	Point of Contact
POR	Power on Reset
PRT	Proportional Telemetry Channel
PCTO	Pitch Loop Command to Stabilator
QA	Quality Assurance
QAE	Quality Assurance Evaluator
QT	Quality Team
QUAL	Qualification
RC	Recorder
RCF	Range Control Facility
RDO	Range Destruct Officer
RHAWS	Radar Homing and Warning System

RSO	Range Safety Officer
RTB	Rear Transition Board
SA	Situational Awareness
SAFE	Software Acceptance Flight Evaluation
SE	Safety
SEFE	Secondary Electron Field Emission
SFO	Security Forces Office
SHOP	Speed Hold On Pitch
SHOT	Speed Hold on Throttle
SIB	Safety Investigation Board
SIM	Simulation
S/N	Serial Number
SNCO	Senior Non-Commissioned Officer
SP	Safety Pilot
SQ	Squadron
SrA	Senior Airman
SSAT	Small Scale Aerial Target
SSgt	Staff Sergeant
SSE	System Security Engineering
STBY	Standby
STINFO	Science and Technical Information
TACAN	Tactical Air Navigation System
TAF	Terminal Area Forecast
TAFB	Tyndall Air Force Base
TANGO	NULLO Mobile Drone Console Operator
TCTO	Time Compliance Technical Order
TDY	Temporary Duty
TENCAP	Tactical Exploitation of National Capabilities
TO	Technical Order
T/N	Tail Number
TRG	Training Group
UAV	Unmanned Aerial Vehicle
UHF	Ultra-High Frequency
U.S.	United States
USAF	United States Air Force
USAFWC	United States Air Force Warfare Center
U.S.C.	United States Code
UT	Utah
VFR	Visual Flight Rules
W&B	Weight and Balance
WEG	Weapons Evaluation Group
WG	Wing
WHISKEY	Master Console Operator
WITS	White Sands Integrated Target Control System
WL	Wings Level
WLDP	Warning Light and Display Panel
WOG	Weight on Gear
WPAFB	Wright Patterson Air Force Base
WPS	Weapons Squadron
WSEP	Weapons System Evaluation Program
WSFR	White Sands Radar Facility
WSMR	White Sands Missile Range
WSSH	White Sands Space Harbor
WTC	Washington Technology Center
X-RAY	NULLO Mission Controller
YANKEE	NULLO Mission Coordinator
Z	Zulu or Greenwhich Meant Time

SUMMARY OF FACTS

ABBREVIATED AIRCRAFT ACCIDENT INVESTIGATION
QF-4E, T/N 74-1629, HOLLOMAN AIR FORCE BASE, NEW MEXICO
7 FEBRUARY 2014

1. AUTHORITY AND PURPOSE

a. Authority

On 24 April 2014, Lieutenant General Lori J. Robinson, Vice Commander, Air Combat Command (ACC), United States Air Force (USAF), appointed Major Robert G. Mathis to conduct an aircraft accident investigation of a mishap that occurred on 7 February 2014 involving a QF-4E Phantom II unmanned aircraft, tail number (T/N) 74-1629, at White Sands Missile Range (WSMR) near Holloman Air Force Base (AFB), New Mexico (NM). The abbreviated aircraft accident investigation was conducted in accordance with Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations,* 26 May 2010, Chapter 11, at Holloman AFB, NM, from 1 May 2014 through 21 May 2014. Board members were Major Robert G. Mathis, the Board President; a Legal Advisor; a Recorder; and a Functional Area Expert on the White Sands Integrated Target Control System (WITS) (Tab Y-1.1 through Tab Y-3.2).

b. Purpose

In accordance with AFI 51-503, Paragraph 8.7.8.1.2, this is a legal investigation convened to inquire into the facts surrounding the aircraft accident, to prepare a publicly releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes.

2. ACCIDENT SUMMARY

On 7 February 2014, at 16:07:22 Zulu (Z) time, a QF-4E Phantom II aircraft, tail number (T/N) 74-1629, on approach for landing, impacted the ground in the White Sands National Monument approximately five miles southwest of Runway 04 at Holloman Air Force Base (AFB), New Mexico (NM) (Tab N-7; Tab S-9). The mishap aircraft (MA) was assigned to Detachment 1, 82d Aerial Targets Squadron (82 ATRS), Holloman AFB, NM (Tab CC-4.2). Detachment 1, 82 ATRS reports to the 53rd Weapons Evaluation Group (53 WEG), 53rd Wing (53 WG), Tyndall AFB, Florida (FL) (Tab CC-1.1 through Tab CC-4.2). The MA was destroyed on impact (Tab P-4; Tab S-2 through Tab S-6). The total damage to Department of Defense (DoD) property was assessed to be $4,890,429.00 (Tab P-4). Damage to non-DoD but other government property included two road signs/posts and a small (3'x1') impact crater on a road; DoD paid for new signs and repaired the road (Tab P-2 through Tab P-3).

3. BACKGROUND

The Mishap Aircraft (MA) was an asset of Detachment 1, 82d Aerial Targets Squadron (82 ATRS), 53rd Weapons Evaluation Group (53 WEG), 53rd Wing (53 WG), United States Air Force Warfare Center (USAFWC), Air Combat Command (ACC), Holloman Air Force Base (AFB), New Mexico (NM) (Tab CC-1.1 through Tab CC-4.2).

a. Air Combat Command

ACC, with headquarters at Joint Base Langley-Eustis, Virginia, is a major command created 1 June 1992, by combining its predecessors Strategic Air Command and Tactical Air Command (Tab CC-1.1). ACC is the primary provider of air combat forces to America's warfighting commanders (Tab CC-1.1). To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle-management and electronic-combat aircraft (Tab CC-1.1). It also provides command, control, communications and intelligence systems, and conducts global information operations (Tab CC-1.1). As a force provider, ACC organizes, trains, equips and maintains combat-ready forces for rapid deployment and employment while ensuring strategic air defense forces are ready to meet the challenges of peacetime air sovereignty and wartime air defense (Tab CC-1.1). ACC numbered air forces provide the air component to U.S. Central, Southern and Northern Commands, with Headquarters ACC serving as the air component to Joint Forces Commands (Tab CC-1.1). ACC also augments forces to U.S. European, Pacific and Strategic Commands (Tab CC-1.1).

b. United States Air Force Warfare Center

The USAFWC, located at Nellis AFB, Nevada (NV), reports directly to ACC (Tab CC-2.1). The USAFWC exists to ensure deployed forces are well trained and well equipped to conduct integrated combat operations (Tab CC-2.1). From the testing and tactics development programs to the training schools and venues, USAFWC provides Airmen with proven and tested technology, the most current tactics, superb academic training and a unique opportunity to practice integrated force employment (Tab CC-2.1). The USAFWC vision, mission and priorities are central to supporting ACC's mission to fly, fight, and win – integrating capabilities across air, space, and cyberspace to deliver precise coercive effects in defense of the U.S. and its global interests (Tab CC-2.1).

c. 53rd Wing

The 53 WG, located at Eglin AFB, Florida (FL), serves as the focal point for the Combat Air Forces in electronic warfare, armament and avionics, chemical defense, reconnaissance and aircrew training devices (Tab CC-3.1). The wing is responsible for operational testing and evaluation of new equipment and systems proposed for use by these forces (Tab CC-3.1). The 53 WG, comprised of four groups, numbers more than 2,200 military and civilians at 22 various locations throughout the U.S. (Tab CC-3.1). The wing reports to the USAFWC at Nellis AFB, NV, a direct reporting unit to ACC (Tab CC-3.1).

d. 53rd Weapons Evaluation Group

The 53 WEG is an ACC tenant organization that reports to the 53 WG, Eglin AFB, FL (Tab CC-4.1). The 53 WEG is comprised of five squadrons and two detachments: the 53d Test Support Squadron; the 81st Range Control Squadron; the 82 ATRS and 83rd Fighter Weapons Squadron (83 FWS), located at Tyndall AFB, FL; the 86th Fighter Weapons Squadron, located at Eglin AFB, FL; Detachment (Det) 1, 82 ATRS, located at Holloman AFB, New Mexico (NM); and Det 1, 86 FWS, located at Hill AFB, Utah (UT) (Tab CC-4.1). The group conducts the Air Force's air-to-air Weapons System Evaluation Program (WSEP), known as Combat Archer, and the Air Force's air-to-ground WSEP, known as Combat Hammer (Tab CC-4.1). It also supports Weapons Instructor Course air-to air formal training syllabi (Tab CC-4.1). Unit personnel provide all Air Force aerial target support for Department of Defense (DoD) users in the Gulf Ranges and full-scale targets for Title 10 testing at White Sands Missile Range, Holloman AFB, NM (Tab CC-4.1).

e. 82d Aerial Targets Squadron

The 82 ATRS at Tyndall AFB, FL and Holloman AFB, NM operates the DoD's only full-scale aerial target program, maintaining an inventory of 50 modified QF-4 Phantom II aircraft for this purpose (Tab CC-4.2). It also provides BQM-167 subscale aerial targets to Gulf Range customers at Tyndall AFB, FL (Tab CC-4.2). Full and subscale aerial targets are provided to Air Force, Navy, and Army customers for development and operational tests (Tab CC-4.2). The squadron maintains three 120-foot drone recovery vessels and two smaller patrol vessels to recover aerial targets and support range safety and salvage operations (Tab CC-4.2). Squadron members also operate the Air Force's only two DeHavilland E-9A "Widget" airborne surveillance/telemetry relay aircraft (Tab CC-4.2). These aircraft provide ocean surface surveillance and relay missile and target telemetry for over-the-horizon coverage of the Gulf Range and also support over-land telemetry missions for WSEP at Holloman AFB, NM, and the Utah Test and Training Range near Hill AFB, UT (Tab CC-4.2). The squadron is a mix of highly experienced contract personnel and active-duty Air Force personnel (Tab CC-4.2). Detachment 1, 82 ATRS, Holloman AFB, NM operates and maintains a portion of the QF-4 full-scale aerial target fleet for use on the White Sands Missile Range (Tab CC-4.2). In addition to Air Force programs such as the F-22, AMRAAM, AIM-9X and F-35, Detachment 1, 82 ATRS supports Army surface-to-air programs and foreign military customers as well (Tab CC-4.2).

f. QF-4 Full Scale Aerial Target System

The supersonic QF-4 is a reusable full-scale target aircraft modified from the F-4 Phantom II (Tab CC-6.1). The QF-4 program attained initial operational capability in 1997 (Tab CC-6.1). The Air Force adopted the Navy's F-4C, under the initial designation of "F-110A Spectre," and retained the Navy Phantom name when it went into service in 1963 (Tab CC-6.1). Although the Air Force had some resistance to acquiring a Navy fighter aircraft, after adopting the Phantom the Air Force quickly became enthusiastic about this type of aircraft (Tab CC-7.2). Phantom aircraft later converted into high-performance target drones are collectively referred to as "QF-4s" regardless of the distinct aircraft variant (Tab CC-7.6).

The QF-4 provides a realistic full-scale target for air-to-air weapons system evaluation, development and testing at Tyndall AFB, FL, and Holloman AFB, NM (Tab CC-6.1). The QF-4 is a remotely controlled target, which simulates enemy aircraft maneuvers (Tab CC-6.1). The drone can be flown by remote control or with a safety pilot to monitor its performance (Tab CC-6.1). The aircraft is flown unmanned when missiles are fired at it, or only in specific overwater airspace authorized for unmanned flight (Tab CC-6.1). When flown unmanned, an explosive device is placed in the QF-4 to destroy the aircraft if necessary (Tab CC-6.1).

The QF-4 is equipped to carry electronic and infrared countermeasures to fully evaluate fighters and weapons flown and fired against it (Tab CC-6.1). Full-scale unmanned aircraft are flown by computer using the White Sands Integrated Targets System (WITS) (Tab CC-6.1). As a safety precaution, a chase plane trails the unmanned aircraft during critical periods of flight (Tab CC-6.1).

This mishap was a Full Scale Aerial Target (FSAT) Not Under Live Local Operator (NULLO) mission. During this mishap, the individuals involved and their responsibilities were as follows:

(1) The White Sands Integrated Target Control System (WITS) Drone Controller (MC):

The Mishap Controller (MC), call sign X-RAY 2, was the primary NULLO controller for the MA (there were two QF-4s on this mission). (Tab V1.2; Tab BB-5.2). The MC was responsible for controlling the QF-4 through all phases of flight including the execution of emergency checklist procedures in the event of a malfunction or emergency (Tab V1.1 through V1.9; Tab BB-5.2). The MC coordinated mission duties with the MMC, handled ultrahigh frequency (UHF) communications with controlling agencies and provided alternate destruct capability (Tab V1.1 through V1.9; Tab BB-5.2).

(2) Assistant WITS Drone Controller (MMC):

The MC worked with a secondary NULLO Controller, who was the Mishap Mission Coordinator (MMC) (Tab V-2.1). The MMC, call sign YANKEE, was responsible for backing up the MC and the other QF-4 controller, whose call sign was X-RAY 1. (Tab V-2.3; Tab BB-5.3).

(3) The Drone Mission Commander (DMC):

The Drone Mission Commander (DMC), call sign MIKE, was responsible for oversight of the drone control team, the safe conduct of drone operations, and the integration of drone operations into the live-fire mission (Tab V-3.1; Tab BB-2.6). The DMC was the overall mishap mission commander (Tab V-3.1). The DMC had the authority to destruct the drone during NULLO missions if necessary (Tab V-3.3).

(4) Mobile Drone Console Operator (MDCO):

The Mobile Drone Console Operator (MDCO), call sign TANGO, was the pilot controller who performed preflight inspections of the MA (Tab V-10.1 through V-10.3; Tab BB-5.3). The MDCO also provided alternate destruct capability (Tab BB-5.3).

(5) Chase Pilot (CP)

The Chase Pilot (CP) was a QF-4 pilot who flew in an additional manned QF-4 behind the MA (Tab V-4.1; Tab BB-2.13). The CP had the responsibility to observe the MA during critical stages of flight in order to provide real-time feedback to the MC (Tab V-4.1; Tab BB-2.13). A CP was required for this NULLO launch (Tab BB-2.13).

(6) Lead Electronics Technician (LET)

The Lead Electronics Technician (LET) was responsible for the Avionics Remote Auto Pilot System on the QF-4s, including the MA (Tab V-5.1).

4. SEQUENCE OF EVENTS

a. Mission

The mission was scheduled as a two-drone formation Full Scale Aerial Target (FSAT) Not Under Live Local Operator (NULLO) mission (Tab V-1.1; Tab V-3.1; Tab V-4.1). The mission was authorized by Air Combat Command (ACC) (Tab V-3.1; Tab V-4.1).

b. Planning

The mission briefings were conducted in two segments, and both were in accordance with standard procedures outlined in Air Force Instruction (AFI) 11-2QF-4, Volume 3, *QF-4 Operations and Procedures*, 1 July 2000, Chapter 2; 82d Aerial Targets Squadron (82 ATRS) Operating Instruction (OI) 11-5; *Flying Operations*, 9 January 2006; and *82 ATRS Standards*, September 2012, Paragraph 4 (Tab V-1.1; Tab V-3.1; Tab V-4.2).

The first brief, also known as the NULLO mission brief, was conducted on 6 February 2014 at 20:00Z. X-RAY 1 and Navy Test personnel briefed the mission, which consisted of a review of the mission profiles, communications, weather, Notice to Airman (NOTAMs), launch and recovery procedures, chase procedures, and safety requirements (Tab V-1.1 through V-1.2; Tab V-3.1; Tab V-4.2). The briefing was attended by the Mishap Controller (MC) the Mishap Mission Coordinator (MMC), the Mobile Drone Console Operator (MDCO), the MA mission commander (DMC), the other QF-4 controller (X-RAY 1), the Chase Pilot (CP), the White Sands Integrated Target Control System (WITS) engineers, maintenance members, and Navy personnel from the AMRAAM program (Tab V-1.1 through V-1.2; Tab V-3.1; Tab V-4.2).

X-RAY 1 conducted the second briefing on 7 February 2014 at approximately 13:00Z in the White Sands Missile Range (WSMR) control building and covered specific duties and responsibilities of the various participants as well as any changes to the NOTAMs and weather (Tabs V-1.1 through V-1.2; Tab V-3.1). The briefing was attended by the MC, DMC, X-RAY 1, Navy AMRAAM program personnel and White Sands Missile Range (WSMR) personnel (Tab V-3.1 through Tab 3.2).

c. Preflight

A two-part Pre-Mission Test (PMT) was conducted in accordance with Technical Order (TO) 1F-4(Q)C-2-96GS-00-1, *Pre-Mission Test Procedures: USAF Series QF-4E, QF-4G, and QRF-4C Aircraft*, 6 March 2009, on the mishap aircraft (MA) (Tab U-1.1; Tab V-5.1 through Tab V-5.2). During the first part of the PMT on 8 January 2014, otherwise known as the static test, the MA was attached to an external power source to evaluate the remote commands of the MA, and all gyros, accelerometers, attitude indicators, airspeed indicators and payloads in both the Primary Automatic Flight Control System (PAFCS) and Backup Automatic Flight Control System (BUAFCS) (Tab U-1.1; Tab V-5.1 through Tab V-5.2). During the second part of the PMT, otherwise known as the dynamic test, the MA was evaluated with the engines on utilizing internal aircraft power to determine that the primary and backup autopilots, control inputs to the aircraft, and the destruct system were functional (Tab U-1.1; Tab V-5.1). Additionally, the dynamic test was a full-functional check of all aircraft systems (Tab V-5.1). Further, the Ground Mobile Control Station (GMCS) was utilized for the dynamic test to check control input and output functions of the data link system (Tab U-1.1; Tab V-5.1; Tab V-10.2). The PMT did not demonstrate a failure, malfunction, or degradation in an MA component (Tab U-1.1).

On 7 February 2014, the pre-flight checks of the MA were conducted in accordance with *Detachment 1, 82 ATRS Local Checklist 101: QF-4 Target Program*, 1 March 2012, and did not demonstrate a failure, malfunction, or degradation in a MA component (Tab V-1.2; Tab V-10.2; Tab AA-2.4 through Tab AA-2.15). The MA was tested preflight manually by Defense Support Services (DS2) personnel and remotely by the Mishap Controller (MC) and Mobile Drone Console Operator (MDCO) (Tab V-1.2; Tab V-10.2). However, the DS2 personnel and MC were limited in testing the actual flight performance capabilities of the attitude gyros, the instrument used to inform the MC of the MA's orientation relative to Earth's horizon, since the aircraft is on the ground (Tab V-1.2; Tab V-10.2). Specifically, the only PMT DS2 could conduct to determine if the attitude gyro was working was to manually shake the aircraft and observe a movement in the gyros, which are the mechanisms that sense if the aircraft is pointed up/down or turning left/right, and from that movement opine that the MA's gyros were performing correctly (Tab V-1.2; Tab V-10.2). DS2 conducted this movement test on the gyros on 7 February 2014, and the MA did not show any degradation in the gyro's performance (Tab V-1.2; Tab V-10.2).

d. Summary of Accident

On 7 February 2014, the MA took off from Holloman Air Force Base (AFB), New Mexico (NM), at approximately 15:05Z as the second of a two-ship formation, and proceeded to the WSMR to serve as a Full Scale Aerial Target (FSAT) (Tab D-16; Tab S-9; Tab V-1.1; Tab V-3.1; Tab V-4.2). All missions segments, including pre-flight, departure and WSMR portions of the flight, were normal and conducted in accordance with existing regulations until recovery of the MA (Tab S-9; Tab V-1.2; Tab V-2.1; Tab V-4.1).

At 16:02:01Z, and approximately 15 miles from landing, the MC commanded automatic landing of the MA via the White Sands Integrated Target Control System (WITS) Operating Console (Figure 1; Tab V-1.5; Tab AA-1.8 through Tab AA-1.12; Tab AA-3.1). Once the MC commanded automatic landing, the MC was responsible for controlling the MA's airspeed and ensuring the MA remained on the heading approach line by monitoring the heading on the left WITS Operating Console screen (Figure 1-2; Tab V-1.4 through Tab V-1.5; Tab V-2.1; Tab AA-1.14). Initial approach of the MA was uneventful until 16:05:22Z when the MC performed a normal landing checklist procedure that resulted in a failed "rudder kick" (Tab S-9; Tab V-1.3; Tab V-2.1 through V-2.2; Tab V-4.3; Tab AA-3.2).

When the rudder kick failed, the MC pushed a button on the control panel that sent a signal to the MA to evaluate whether the Primary and Backup Yaw Rate Gyros and the calculated yaw rate were functioning properly (Tab V-2.2, Tab V-3.2; Tab V-4.3; Tab V-5.2; Tab V-9.2; Tab EE-1.3). The MC performed this task to ensure successful directional steering of the MA on the ground if the MA had successfully landed (Tab V-2.2, Tab V-3.2; Tab V-4.3; Tab V-5.2; Tab V-9.2; Tab EE-1.3). The rudder kick failure was attributed to a malfunctioning Auxiliary Yaw Rate Gyro, a backup system to the Primary Yaw Rate Gyro (Tab V-2.2; Tab V-4.2; Tab V-5.2; Tab V-9.3; Tab EE-1.3). The rudder kick failure was mitigated by the MC commanding "On-Rate Gyro," which is a backup steering capability once the aircraft has landed on the runway (Tab V-2.2; Tab V-4.2; Tab V-5.2; Tab V-9.3; Tab EE-1.3). After the failed rudder kick and the MC's successful mitigation actions, the MC did not receive additional warnings via the WITS Operating Console that any additional equipment failed (Tab V-1.3; Tab V-9.2; Tab AA-1.8 through Tab AA-1.12). The rudder kick failure and the MC's mitigation actions had all occurred by the time the MA was about 14 miles from Holloman AFB (Tab V-1.5).

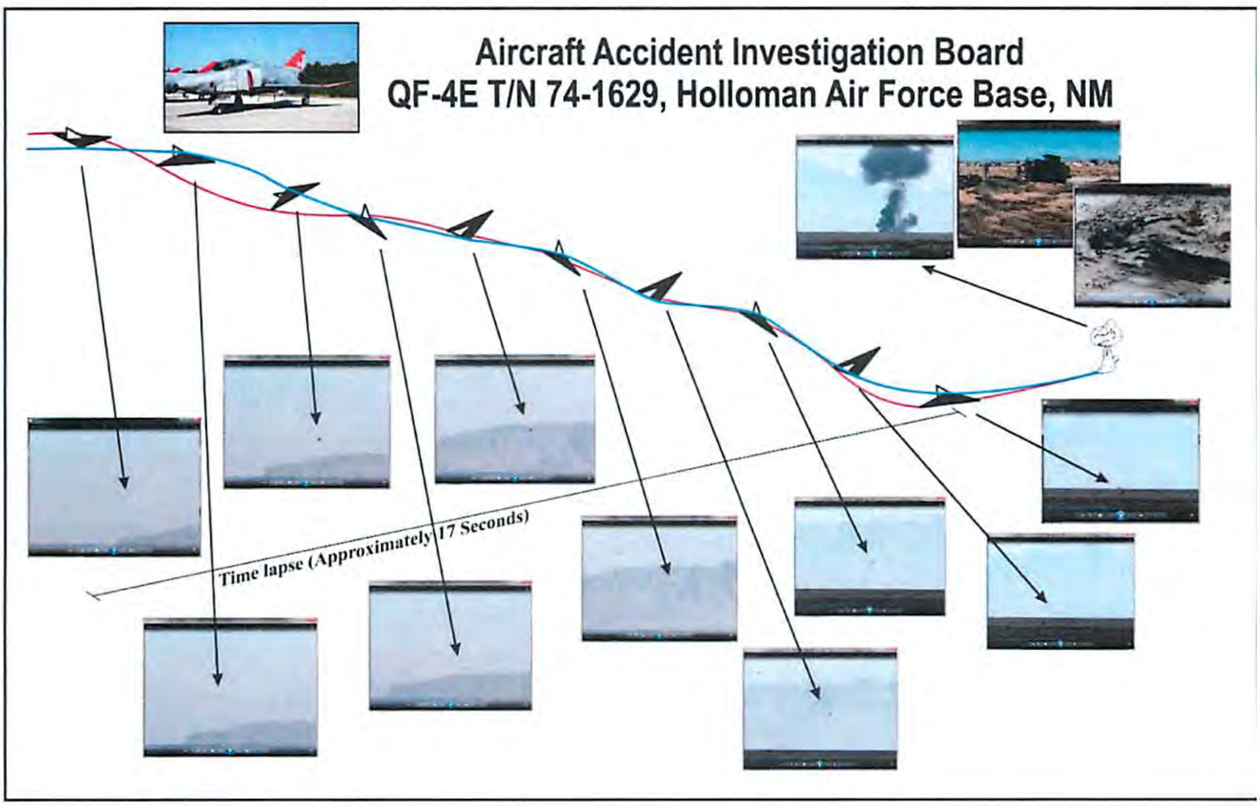

Figure 1: Graphic Illustration of Mishap Sequence (Tab Z-2.1)

At 16:06:48Z, and about seven miles from Holloman AFB, the Chase Pilot (CP) notified the MC that "we're rocking a little bit," which was not uncommon on an automatic recovery flown by the MA's autopilot (Figure 1; Tab N-7; Tab S-9; Tab V-1.3 through V-1.5; Tab V-2.1 through V-2.2). However, when the MC crosschecked the flight instruments on the WITS Operating Console right screen the wings appeared level (Figure 2; Tab N-7; Tab V-1.3 through V-1.5; Tab V-2.1 through V-2.2). At 16:07:03Z, the MA made an aggressive left roll to approximately 70 degrees angle of bank, which caused the MA to lose altitude, turn left and then roll out wings level (Figure 1; Tab N-7; Tab S-9; Tab V-2.2; Tab V-4.2; Tab V-9.3; Tab EE-1.2 through Tab EE-1.13). The CP called "a big left turn," followed by "roll out" four seconds later, describing what he saw the MA doing (Tab N-7; Tab V-1.4). The MC responded "it's level" as a result of crosschecking the MC's attitude indicator on the WITS Operating Console right screen, which showed straight and level flight parameters (Tab N-7; Tab V-1.4; Tab AA-1.8; Tab AA-1.14). However, the MC did note the MA was left of the automatic approach heading, and determined that he needed to take manual control of the MA, turn the MA back towards the WSMR, and troubleshoot the missed landing approach (Tab V-1.4; Tab V-1.6). At 16:07:17Z the MC switched the MA into manual control mode (Figure 3; Tab V-1.4; Tab AA-1.15; Tab AA-3.2).

Personnel in the control room watching a live video feed of the MA began verbally reacting to the MA's pitch oscillations (Figure 1; Tab S-9; Tab V-1.4; Tab V-3.2; Tab EE-1.6 through Tab EE-1.11). The MC did not watch the video feed of the MA because it provided a delayed feed of the actual performance of the MA (Tab V-1.4). However, the Mishap Mission Coordinator (MMC) who was responsible for monitoring both the WITS Operating Console and the video feed, identified the MA's pitch oscillations and directed the MC to select Automatic Takeoff (ATO) (Tab S-9; Tab V-1.4; Tab V-2.2). Selecting ATO would have raised the MA's flaps and landing gear, turned on the afterburners (AB) and raised the nose of the drone to a pitch of 12 degrees for a climb in an effort to recover the MA (Tab V-1.4 through V-1.5; Tab V-2.2; Tab AA-1.16).

The MC checked the attitude indicator on the WITS Operating Console right screen and noted the MA's pitch attitude moving downwards towards the ground (Figures 1-2; Tab S-9; Tab V-1.4 through Tab V-1.5; Tab AA-1.8; Tab AA-1.13). The MC determined the MA was in an unusual attitude and, instead of selecting ATO, began performing the "Unusual Attitude Recovery" emergency procedure (EP) checklist by selecting All Attitude Recovery (AAR) (Tab V-1.4 through V-1.5; Tab V-2.2; Tab V-3.3; Tab AA-1.4; Tab AA-1.11; Tab BB-8.20). Selecting AAR was equivalent to selecting ATO in the landing approach pattern with the exception that AAR did not raise the landing gear and flaps (Tab V-1.5; Tab V-2.2). The MA continued to oscillate up and down after the MC selected AAR; therefore, per the MMC's direction the MC selected ATO in an attempt to establish a climb in altitude away from the ground (Figure 1; Tab S-9; Tab V-1.5; Tab V-2.2; Tab EE-1.6 through Tab EE-1.11). The MA did not respond so the MC completed the "Unusual Attitude Recovery" EP checklist by selecting Backup Automatic Flight Control System (BUAFCS) on the WITS Operating Console control stick followed by another AAR command (Figure 1; Tab S-9; Tab V-1.5; Tab V-2.2 through V-2.3; Tab AA-1.4; Tab AA-1.10; Tab AA-1.15; Tab AA-3.2 through Tab AA-3.3; Tab EE-1.6 through Tab EE-1.11). At 16:07:22Z, the CP observed the MA impact the ground and relayed that information to the MC (Figure 1; Tab S-9; Tab N-7; Tab V-1.5; Tab V-2.3; Tab V-4.2; Tab EE-1.6 through Tab EE-1.11). There were no aural tones over the controller radio frequencies during the mishap sequence indicating a loss of transmission between the MA and the WITS (Tab V-1.6; Tab V-3.3; Tab V-4.4; Tab AA-1.4; Tab AA-1.8 through Tab AA-1.9).

e. Impact

The MA impacted the ground at 16:07:22Z, skidded across the Desert Dunes Road, exploded and was destroyed (Tab N-7; Tabs S-2 through Tab S-6; Tab S-9; Tab V-2.3; Tab V-4.2).

f. Egress and Aircrew Flight Equipment (AFE)

Not applicable.

g. Search and Rescue (SAR)

Not applicable.

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

At the time of the mishap, the Mishap Aircraft (MA) had accumulated 3,492.5 flight hours (Tab D-2). The mishap sortie was the MA's second Full Scale Aerial Target (FSAT) Not Under Live Local Operator (NULLO) flight (Tab U-3.1).

a. Forms Documentation

Air Force Technical Order (AFTO) 781 series forms, Intermediate Maintenance Data System (IMDS), and Time Compliance Technical Orders (TCTO) document aircraft maintenance and provide a record of inspections, servicing, configuring, status and flight records related to a specific aircraft (Tab U-1.1 through Tab U-1.3). There were documentation errors for the removal and replacement of the Command Telemetry System (CTS) #1 in the AFTO form 781A and documentation errors related to the replacement of the Lower Chin Antenna and Backup Yaw Rate Gyro in both the IMDS and the AFTO Form 781A (Tab U-1.1 through Tab U-1.3; Tab U-3.1 through Tab U-3.2.). However, there is no evidence that the forms documentation discrepancies or errors were a factor in this mishap.

b. Inspections

Scheduled maintenance inspections and time change items (TCI) are performed in accordance with Technical Order (TO) 1F-4(Q)C-6, *Aircraft Scheduled Inspection and Maintenance Requirements: USAF Series of QF-4E and QRF-4C Aircraft*, 10 September 2013 (Incorporating Change 1, 30 November 2013); and TO 1F-4C-6, *Aircraft Scheduled Inspection and Maintenance Requirements: USAF Series F-4C, F-4D, F-4E, and RF-4C Aircraft*, 15 October 1985 (Incorporating Change 57, 15 November 2013). All scheduled maintenance and TCIs were completed as prescribed (Tab U-1.1 through Tab U-1.3).

Additionally, TO 1F-4(Q)C-2-96GS-00-1, *Pre-Mission Test Procedures: USAF Series of QF-4E, QF-4G and QRF-4C Aircraft*, Revision Number 3, 6 March 2009, directed the Pre-Mission Test (PMT). A completed PMT with no failures constituted successful verification of QF-4 NULLO mission readiness. The MA static portion of the PMT was successfully completed on 8 January 2014, and the dynamic portion was completed on 21 January 2014; therefore, the PMT was valid for the MA NULLO flight (Tab U-1.1 through Tab U-1.3; Tab U-4.1 through Tab U-4.2).

c. Maintenance Procedures

A review of the MA's AFTO 781 series forms, IMDS, and TCTO records revealed all maintenance actions on the MA were accomplished with standard approved maintenance procedures and TOs (Tab U-1.1).

d. Maintenance Personnel and Supervision

Local maintenance activities for the MA at Holloman Air Force Base (AFB), New Mexico (NM), were performed by Defense System Services (DS2), a contracted maintenance services organization (Tab U-1.1; Tab V-5.1). After reviewing the training certificates, all DS2 personnel involved in the preflight, servicing, inspecting, and launch of the MA were qualified in their duties (Tab U-1.1 through Tab U-1.3). Additionally, a post-mishap medical evaluation of DS2 personnel determined they were medically qualified for their assigned duties (Tab FF-3.1 through Tab FF-3.5).

e. Fuel, Hydraulic, and Oil Inspection Analyses

Collection of fuel and oil samples were tested for contaminates at the Air Force Petroleum Laboratory (AFPL) at Wright Patterson AFB, Ohio (OH) (Tab J-2 through Tab J-5). Fuel and hydraulic samples contained small amounts of fine dirt particle contaminates (Tab J-2 through Tab J-5). However, the lubricating oil revealed no volatile contaminates (Tab J-2 through Tab J-5). Therefore, there is no evidence that fuel, hydraulic, or oil were factors in this mishap.

f. Unscheduled Maintenance

Local maintenance activities for the MA at Holloman AFB, NM, were performed by DS2, a contracted maintenance services organization (Tab U-1.1; Tab V-5.1). On 31 January 2014, the Mobile Drone Console Operator (MDCO) noted a discrepancy during the MA's previous NULLO flight; specifically, a Backup Yaw Rate Gyro failed a rudder kick during recovery of the MA (Tab U-1.1; Tab U-3.2). Therefore, the most recent unscheduled maintenance performed on the MA was on 5 February 14 when DS2 tested the Backup Yaw Rate Gyro utilizing the static and dynamic tests procedures to ensure it was working properly (Tab U-1.1; Tab U-3.2). No discrepancies were noted in the testing of the Backup Yaw Rate Gyro (Tab U-1.1; Tab U-3.2). This was the only significant maintenance action prior to the mishap.

On 30 January 2014, DS2 removed and replaced Command Telemetry System (CTS) #1, which would not calibrate, and a bad Lower Chin Antenna (Tab U-1.1; Tab U-3.1; Tab U-3.3). Both maintenance actions were conducted prior to the MA's last successful NULLO flight on 31 January 2014 (Tab U-1.1; Tab U-3.1; Tab U-3.3). There is no evidence that unscheduled maintenance procedures were relevant to the mishap.

6. AIRFRAME SYSTEMS

a. Structures and Systems

(1) White Sands Integrated Target Control System (WITS)

The White Sands Integrated Target Control System (WITS) is a ground-based, highly automated computer system operated and maintained by the White Sands Missile Range (WSMR), New Mexico (NM), used to track and control unmanned aerial targets (Tab V-9.1). The Mishap Controller (MC) gave commands to the MA in one of two ways: (1) manually, utilizing the WITS Operating Console, or (2) by directing the Full Scale Aerial Targets Automatic Flight Control System (FSAT AFCS) to automatically operate the MA by utilizing a series of pre-determined commands (Figure 2; Tab AA-1.2 through Tab AA-1.14; Tab Z-1.1 through Tab Z-1.3).

Figure 2: WITS Operating Console (Tab Z-1.1)

Manual commands were transmitted by the MC using a control stick and pushbuttons to fly the MA similar to a manned aircraft (Figures 3-4; Tab AA-1.13; Tab Z-1.2).

Figure 3: WITS Control Stick (Tab Z-1.2)

Figure 4: WITS Flight Instrument Display (Tab Z-1.2)

The MC was responsible for controlling the MA through all phases of flight including the execution of the emergency procedures (EP) checklist in the event of a malfunction or emergency during FSAT missions; however, the MC does not manually control the MA during landing (Tab V-1.5). Manual landings of drone aircraft require two operators and are considered more dangerous than automatic landings (Tab V-1.5). Instead, the WITS provided automatic control of the MA through the Drone Formation System (DFCS), which provides navigation, guidance and control messages addressed to the MA (Tab V-1.5; Tab AA-1.1 through AA-1.15; Tab BB-8.9; Tab BB-8.11). Remote control of the MA was possible because of drone-peculiar aircraft systems that processed the messages for execution through the FSAT AFCS. (Tab BB-8.9). Messages from the FSAT continuously informed the ground station on the status of the MA (Tab BB-8.9, Tab EE-1.6 through Tab EE-1.11).

The MA position, control and performance data were displayed on two controller screens (Figure 4; Tab Z-1.2 through Tab Z-1.3; Tab AA-1.6 through Tab AA-1.12). The left display showed an overhead view of the MA's position on a map; the right display showed an attitude director indicator, compass, and various control and performance parameters (Figure 4; Tab Z-1.3; Tab AA-1.12). The right display provided information to the MC that replicated what the MC would see if the MC was in the MA cockpit (Figure 4; Tab V-1.8; Tab Z-1.3).

Figure 5: WITS Operating Screens (Tab Z-1.1)

(2) Primary Automatic Flight Control Computer (PAFCC) and Backup Automatic Flight Control Computer (BUAFCC)

The MA had two Automatic Flight Control Computers (AFCC) on board (Tab BB-9.2). The AFCCs are used during remote control flight (Tab-BB 8.11). One is designated as the Primary Automatic Flight Control Computer (PAFCC) and the other is designated as the Backup Automatic Flight Control Computer (BUAFCC) (Tab BB-8.11). Through a highly automated computer system using pre-programmed flight commands, these computers commanded and controlled the MA (Tab V-9.1; Tab BB–8.11). The computers command the control surface servos and actuators of the basic AFCS as well as the drone flight control system modifications (Tab BB-8.11). The computers are the same with only minor differences; the BUAFCC is capable of performing all of the functions of the PAFCC and can provide safe FSAT recovery to base in the event of PAFCC malfunction (Tab BB-8.11; Tab BB-8.15). The BUAFCC does not operate unless the PAFCC malfunctions (Tab BB–8.11). The PAFCC was in control of the MA during the automatic landing of the aircraft receiving inputs from the attitude gyros and sending them to the Automatic Flight Control Systems (AFCS) to direct the actions of the MA (Tab V-1.5; Tab V-2.2; Tab EE-1.6).

(3) Primary Automatic Flight Control System (PAFCS) and Backup Automatic Flight Control System (BUAFCS)

The MA had a primary and back up Automatic Flight Control System (AFCS) on board (Tab BB-8.12). The Primary Automatic Flight Control System (PAFCS) consists of the PAFCC and the active transponder with associated basic aircraft and drone-peculiar sensors and actuators to perform control functions as commanded (Tab BB-8.15). The PAFCS will normally control the FSAT unless a malfunction occurs which necessitates using the backup system, or if the controller commands a switchover to BUAFCS (Tab BB-8.15). The PAFCS is the only system that communicates with the drone-peculiar Tri-Axis Rate Gyro, the Directional Displacement Gyro and Pitch/Roll Displacement Gyro (Tab BB-8.15). In the event of a PAFCS failure sensed by the PAFCC Built-In-Test (BIT), the PAFCC will downlink a failure code to the ground station for display (Tab BB-8.15). The BUAFCS may then be commanded on by the MC (Tab BB-8.15). The MC's decision will be based on downlinked messages that identify the type of failure, and on aircraft controllability (Tab BB-8.15).

b. Evaluation and Analysis

The following aircraft systems, data logs and recovered hardware were evaluated in order to determine the cause of the mishap. An analysis determined the following:

(1) Analysis of WITS

A detailed review of the WITS data was conducted for the MA (Tab EE-1.1 through Tab EE-1.13). An analysis of the WITS data demonstrated that there were no failures detected in the communication between WITS and the MA (Tab EE-1.1 through Tab EE-1.13). The MA was in an automatic landing mode in which the Automated Flight Control Computer (AFCC) controlled the pitch attitude, roll attitude and the heading (Tab EE-1). At approximately 1,000 feet above ground level (AGL), 180 knots indicated air speed (KIAS), and 15 units angle of attack (AOA), the aircraft suddenly rolled left, then appeared to somewhat recover the roll axis, but was then followed quickly by an unstable pitch axis (Tab EE-1.3). The MC correctly commanded AAR in an attempt to stabilize the aircraft (Tab EE-1.3). The roll axis appeared to stabilize itself but the pitch axis went through a series of limit cycle instabilities, which were induced by the stall feedback and rate limits associated with the AFCC pitch attitude control loop (Figure 6; Tab EE-1.3).

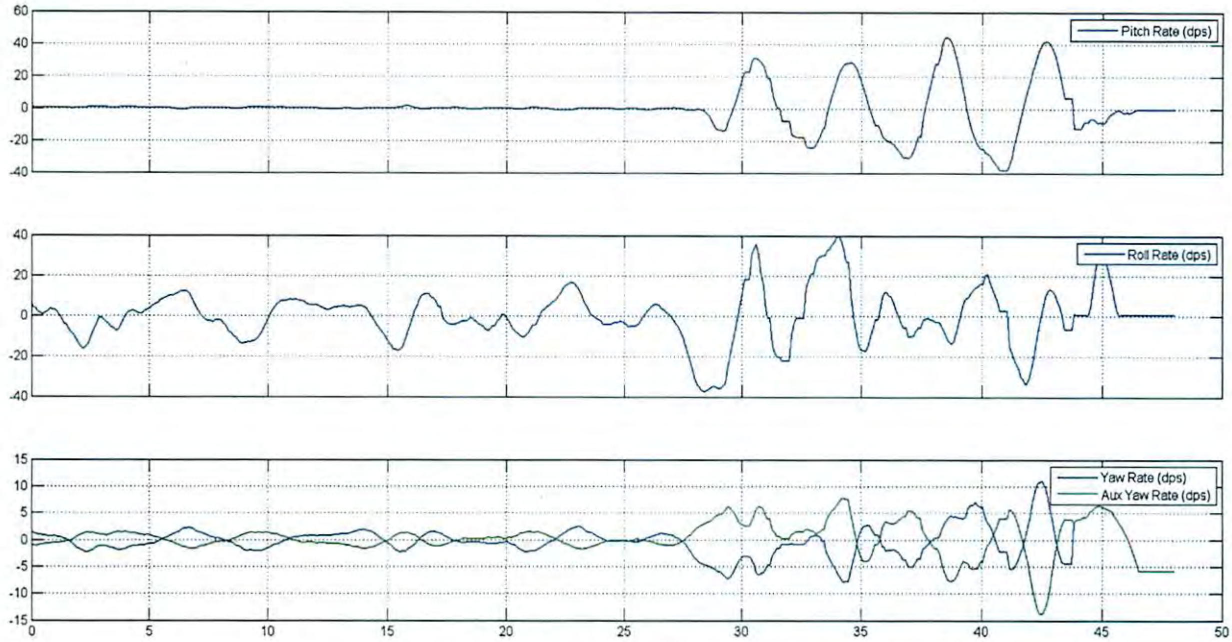

Figure 6: WITS Downlink Rate Gyro Data (Tab EE-1.7)

The MA engines were in afterburner (AB), as demonstrated by the increase in the temperature of the engines and the increase in the KIAS; however, the pitch gyrations caused the MA to continue its descent faster than before causing the MA to impact the ground approximately 17 seconds after the instability started (Figures 6-7; Tab EE-1.3 through Tab EE-1.4).

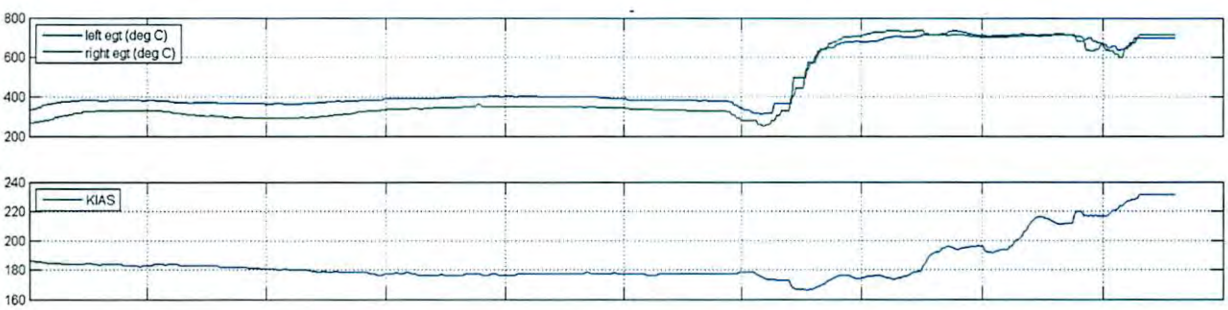

Figure 7: WITS Downlink Flight Data (Tab EE-1.6)

The rate gyro downlink data demonstrated that at or about 26 seconds on the rate gyro roll data plot the aircraft started a left roll, as demonstrated by a trough of approximately -38 degrees per second (Figure 8; Tab EE-1.4; Tab EE-1.9). Additionally, at about 28 seconds on the rate gyro pitch plot the MA started pitching down as demonstrated by a trough of approximately -10 degrees per second (Figure 9; Tab EE-1.4; Tab EE-1.9).

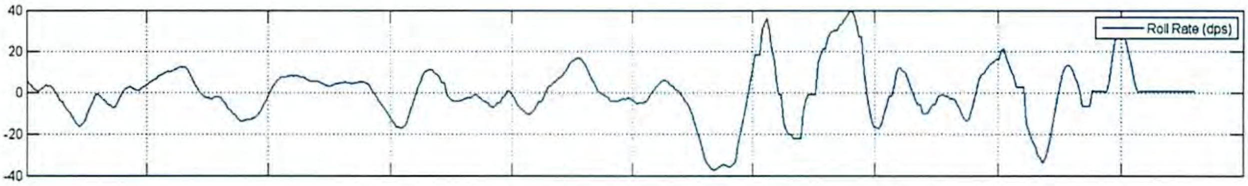

Figure 8: MA Rate Gyro Roll Data (Tab EE-1.7)

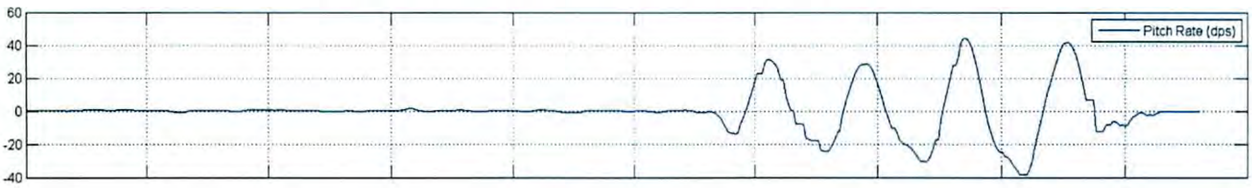

Figure 9: MA Rate Pitch Data (Tab EE-1.7)

However, the attitude gyro downlink data showed a large right roll demonstrated by a peak of approximately 10 degrees on the attitude gyro pitch plot, and a large pitch up demonstrated by a peak of approximately 50 degrees on the attitude gyro roll plot, at 26 seconds and 28 seconds respectively (Figures 10; Tab EE-1.4; Tab EE-1.10). Therefore, the rate gyro roll and rate gyro pitch of the MA and the attitude gyro roll and attitude gyro pitch conflicted (Figures 6-11; Tab EE-1.4; Tab EE-1.9 through Tab EE-1.10).

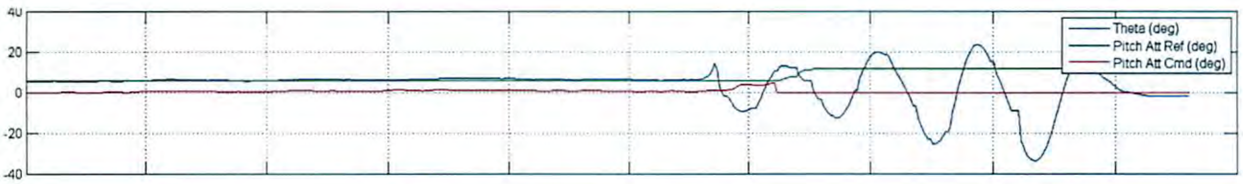

Figure 10: MA Attitude Gyro Pitch Data (Tab EE-1.7)

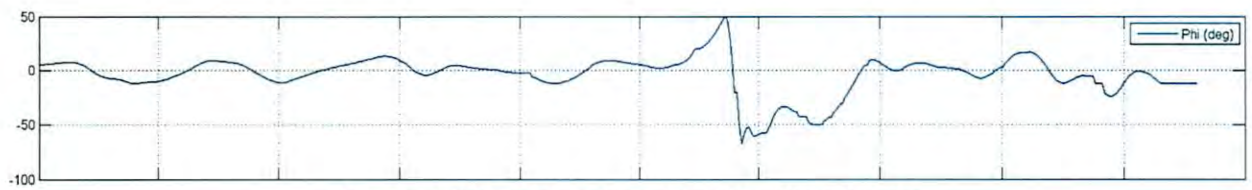

Figure 11: MA Attitude Gyro Roll Data (Tab EE-1.7)

Conflicting data was only plausible in four situations: (1) the attitude pitch and roll gyros were wired or installed backwards; (2) the rate pitch and roll gyros were wired or installed backwards; (3) the attitude pitch and roll gyros failed; or (4) the rate pitch and roll gyros failed (Tab EE-1.4). In situations (1) and (2) the MA would have failed moments after brake release during takeoff (Tab EE-1.5). Instead, the MA successfully flew a near complete mission and was in the process of landing (Tab EE-1.5). Therefore, either the attitude gyro or rate gyro experienced a failure (Tab EE-1.5). Video evidence and witness testimony demonstrated the MA initially rolled left and pitched down consistent with the rate gyro downlink data (Figures 7-8; Tab S-2; Tab V-4.2 through V-4.4; Tab EE-1.5).

An analysis comparing the calculated pitch and roll of the MA compared to the attitude gyro downlink data identify a 2-3 second "glitch" at approximately 26 seconds where the attitude gyro pitch and roll downlinks conflicted with the actual flight performance of the MA (Figure 12; Tab EE-1.5; Tab EE-1.4). After the 2-3 second glitch, the attitude gyro downlink data closely mirrored what the MA actually did (Figure 11; Tab EE-1.5; Tab EE-1.4). Additionally, after the 2-3 second glitch in the attitude gyro downlink data, the roll axis appeared to stabilize, but the attitude gyro pitch axis began to go unstable (Figures 12-13; Tab EE-1.5; Tab EE-1.4).

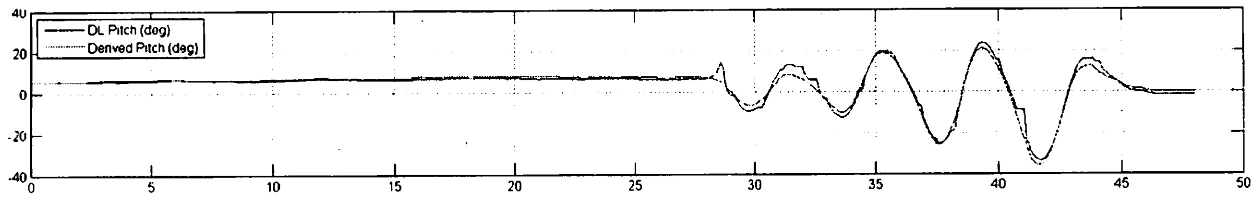

Figure 12: Calculated MA Pitch Performance vs. Attitude Gyro Pitch Downlinked Data (Tab EE-1.10)

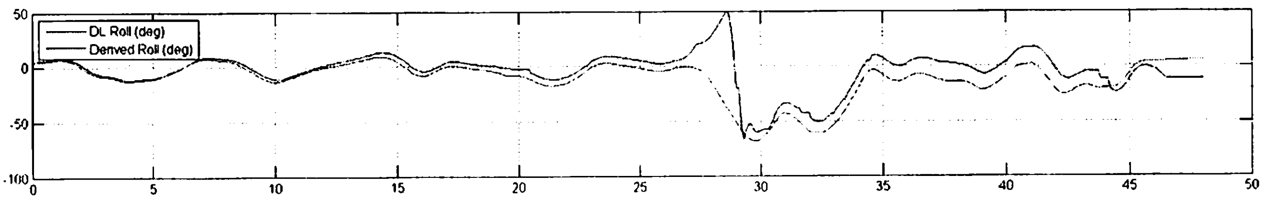

Figure 13: Calculated MA Roll Performance vs. Attitude Gyro Roll Downlinked Data (Tab EE-1.10)

An analysis of the attitude gyro pitch demonstrated the pitch instability was caused by large initial erroneous attitude errors at low speeds while the aircraft was in an automatic landing sequence. (Figures 12-13; Tab EE-1.4). The source of the error could not be determined. (Tab DD-3.1). The MA subsequently responded by driving the stabilator, the aircraft component that moves the aircraft up and down, into a stall prevention mode as quickly as possible resulting in a continuous cycle of overcorrection of the MA's pitch and an increase in pitch oscillations (Figure 14; Tab EE-1.4 through Tab EE-1.5).

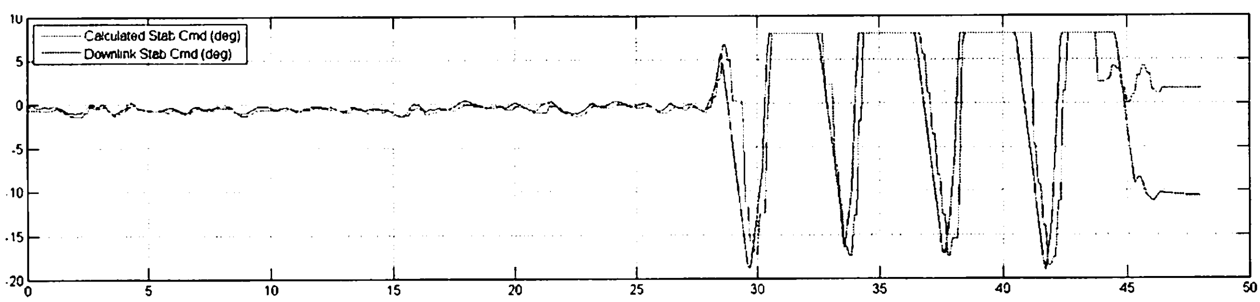

Figure 14: Calculated Stabilator Command vs. Actual Stabilator Command (Tab EE-1.10)

The instability, once started, would have only been corrected by either switching the MA to BUAFCS or enabling manual flight control with the addition of a very small pitch rate inputs (Tab EE-1.6). These pitch stick out (PSO) inputs would have put the MA into a pitch rate mode, thus eliminating the large oscillations that were a result of the MA attempting to maintain a particular attitude (Tab EE-1.6). In accordance with the emergency procedures (EP) checklist and the lack of any other caution lights on the control panel, the MC commanded AAR followed by an Automatic Takeoff (ATO), switched to BUAFCS and commanded AAR again prior to the MA impacting the ground (Tab V-1.5; Tab V-1.7; Tab EE-1.3). By the time the MC switched to the BUAFCS, however, the MA was too close to the ground to recover (Tab N-7; Tab AA-3.3).

(2) Analysis of the PAFCS and BUAFCS

The AAIB reviewed the PAFCC and BUAFCC data that was downlinked to the WITS (Tab EE-1.1 through Tab EE-1.13). The PAFCC served as the brain of the MA during all stages of flight until a few seconds before impact, controlling the actions of the MA through a series of commands after receiving and processing information received from multiple components (Tab EE-1.1 through Tab EE-1.13). Shortly prior to impact, the MC commanded "BUAFCS On" in accordance with the EP checklist (Tab V-1.5; Tab V-1.7). The PAFCC and BUAFCC WITS data was examined cycle by cycle for the period of interest (Tab EE-1.1 through Tab EE-1.13). No failures were detected (Tab EE-1.4).

7. WEATHER

a. Forecast Weather

The weather forecast for Holloman Air Force Base (AFB), New Mexico (NM) was winds 230 degrees at 8 knots, 7 statute miles visibility with a broken cloud layer at 7,000 feet and 12,000 feet, no significant weather predicted, temperature 1 degree Celsius and altimeter setting 30.05 (Tab F-2). A hazard of light and/or rime icing existed from 11,000 to 14,000 feet and 16,000 to 18,000 feet from 12:00 to 17:00Z (Tab F-2). The forecasted weather for the White Sands Missile Range (WSMR) was winds 200 degrees at 6 knots, 7 statute miles visibility with a broken cloud layer from 11,000 to 13,000 feet and few clouds from 16,000 to 19,000 feet and no significant weather predicted (Tab F-4).

b. Observed Weather

The observed weather for Holloman AFB, NM on 7 February 2014 was winds 140 degrees at 4 knots, temperature 2 degrees Celsius, altimeter setting 30.09, no icing, turbulence, or wind shear, and 10 statute miles visibility with sky clear (Tab F-7). Post-mishap weather was winds 160 degrees at 6 knots, temperature 3 degrees Celsius, altimeter setting 30.09, no icing turbulence or wind shear, and 10 statute miles visibility with few clouds at 6,500 feet mean sea level (MSL) (Tab F-7).

c. Operations

Operational systems were conducted within their prescribed operational weather limitation (Tab V-1.2; Tab V-4.2). There is no evidence to suggest weather was a factor in this mishap.

8. CREW QUALIFICATIONS

a. Mishap Controller (MC)

(1) Training

The Mishap Controller (MC) has been qualified as a pilot controller in the QF-4 since 17 April 2008 (Tab G-36). The MC's certificate of aircrew qualification, individual training summary, and 30/60/90 flying report were reviewed with three discrepancies noted (Tab G-6; Tab G-37 through Tab G-59; Tab T-1.1 through Tab T-1.3). The individual training summary generated on 7 February 2014 was inaccurate due to several factors (Tab V-8.1). First, the Aviation Resource Manager responsible for updating applicable databases was attending classes for transition out of the military for the previous several weeks and was behind on logging paperwork (Tab V-8.1). Secondly, access to training accomplishment tracking software and databases were intermittent due to Holloman Air Force Base's (AFB) network upgrade, which did not allow individual aircrew to log training accomplished (Tab V-8.1). However, the squadron kept a manual record of sorties and training accomplished to help circumvent those inadequacies, which proved that the MC was current on the three discrepancies (Tab T-1.4; Tab V-8.1; Tab V-8.3).

(2) Experience

At the time of the mishap, the MC was current and qualified and had a total flight time of 829.1 hours as a QF-4 pilot (Tab G-37; Tab T-1.4; Tab V-8.1; Tab V-8.3). The MC's flight time for the 30/60/90 days prior to the mishap were as follows (Tab G-6):

	Hours	Sorties
Last 30 Days	12.2	8
Last 60 Days	19.1	13
Last 90 Days	30.1	21

b. Mishap Mission Coordinator (MMC)

(1) Training

The Mishap Mission Commander (MMC) has been qualified in the QF-4 as a pilot since 25 March 2011 (Tab G-66). The MMC's training record was reviewed and there were no discrepancies noted. Additionally, a review of the certificate of aircrew qualification and 30/60/90 flying report were completed with no discrepancies noted (Tab G-26; Tab G-59 through Tab-67). The MMC's individual training report was not catalogued on the day of the mishap; however, the MMC stated his currencies were up to date and checked by both the Detachment 1, 82d Aerial Targets Squadron (82 ATRS) and the parent squadron, 82 ATRS personnel prior to the mishap (Tab V-2.3).

(2) Experience

At the time of the mishap, the MMC was current and qualified and had a total of 40.7 hours as a

QF-4 pilot (Tab G-26; Tab V-2.3). The MMC's flight time for the 30/60/90 days prior to the mishap were as follows (Tab G-26):

	Hours	Sorties
Last 30 Days	4.0	3
Last 60 Days	4.0	3
Last 90 Days	4.0	3

c. Mobile Drone Console Operator (MDCO)

(1) Training

The Mobile Drone Console Operator (MDCO) has been qualified in the QF-4 as a pilot since 31 January 2008 (Tab T-3.1). The MDCO's training record was reviewed and there were no discrepancies noted (Tab T-3.3 through Tab T-3.4). Additionally, a review of the certificate of aircrew qualification, individual training summary, and 30/60/90 flying report were completed with no discrepancies noted (Tab T-3.5).

(2) Experience

At the time of the mishap, the MDCO was current and qualified and had a total of 716.4 hours as a QF-4 pilot (Tab T-3.1 through T-3.5). The MDCO's flight time for the 30/60/90 days prior to the mishap were as follows (Tab T-3.5):

	Hours	Sorties
Last 30 Days	10.3	8
Last 60 Days	18.1	14
Last 90 Days	27.7	21

9. MEDICAL

a. Qualifications

At the time of the mishap, the Mishap Controller (MC), Mishap Mission Coordinator (MMC) and Mobile Drone Console Operator (MDCO) were medically qualified for flight duty (Tab T-1.5; Tab T-2.1; Tab T-3.7).

b. Health

The MC and MDCO's medical records were reviewed by a qualified flight surgeon post-mishap (Tab V-6.1; Tab FF-1.1 through Tab FF-2.1). The MMC was not instructed by the 82d Aerial Targets Squadron (82 ATRS) or 49th Medical Group (49 MDG) to provide his medical records from Tyndall Air Force Base (AFB), Florida (FL), and was not given an examination by a flight surgeon post-mishap as he was on a temporary assignment from Tyndall AFB, FL (Tab V-2.3; Tab V-6.3). The MC's Federal Aviation Administration Medical Certifications were current (Tab T-1.5). The MMC and MDCO's Air Force (AF) Information Management Tool (IMT)

1042 Medical Recommendation for Flying were current (Tab T-2.1; Tab T-3.7). Further, the MC, MMC and MDCO denied health issues or concerns on the day of the mishap or 14 days prior to the mishap (Tab V-7.1; Tab V-2.3; Tab V-10.3; Tab FF-1.1 through Tab FF-2.1).

c. Pathology

Toxicology testing was ordered for the MC and MDCO immediately following the mishap (Tab FF-1.2; Tab FF-2.2). Urine samples were submitted to the Armed Forces Medical Examiner System for analysis (Tab FF-1.2; Tab FF-2.2). No prohibited substances were detected (Tab FF-1.2; Tab FF-2.2). The MMC was not instructed by the 82 ATRS or 49 MDG to provide a sample (Tab V-2.3).

d. Lifestyle

The mission pacing for the two weeks prior to mishap for the Full Scale Aerial Target (FSAT) Not Under Live Local Operator (NULLO) missions required an earlier than normal show time due to range scheduling constraints (Tab V-1.1; Tab V-2.3; Tab V-3.3). The 7 February 2014 mission was the last mission in the two weeks series of missions (Tab V-6.3; Tab V-7.1). The MC reported sleeping for 4 1/2 hours the night prior to the mishap during the post-mishap medical evaluation (Tab V-6.3; Tab V-7.1; Tab FF-1.1). The flight surgeon who evaluated the MC opined that 4 1/2 hours was "not a lot of sleep," and indicated that the MC could have voluntary disqualified himself from flying prior to the mission (Tab V-6.3). The MC stated the sleep schedule initially affected him in the early stages of the two-week mission series; however, he stated the lack of 8 hours of sleep prior to the mishap did not affect his alertness (Tab V-7.1). Further, the MMC did not observe the MC displaying any symptoms indicative of a lack of sleep or have concerns regarding the MC's alertness for the mission (Tab V-2.3).

e. Crew Rest and Crew Duty Time

All aircrew were required to have proper crew rest prior to performing flying duties as outlined in Air Force Instruction (AFI) 11-202, Volume 3, *Flying Operations*, 22 October 2010, paragraphs 9.4.5 and 9.8. Proper crew rest was defined as a minimum of a 12-hour non-duty period before the designated flight duty period begins. During this time, an aircrew member may participate in meals, transportation, or rest as long as he or she has had at least 10 hours of continuous restful activity with an opportunity for at least 8 hours of uninterrupted sleep. The MC, MMC and MDCO were provided the opportunity for the proper crew rest prior to performing flying duties (Tab V-2.3; Tab V-7.1; Tab V-10.3). There is no evidence that crew rest or duty times were factors in this mishap.

10. OPERATIONS AND SUPERVISION

a. Operations

The Mishap Controller (MC) flew two sorties in the previous week prior to the mishap to include sorties on 4 February 2014 for 1.0 hours and 6 February 2014 for 1.4 hours (Tab T-1.4; Tab V-8.3). There is no indication the MC's operational tempo was a factor in this mishap. The

Mishap Mission Coordinator (MMC) flew two sorties in the previous week prior to the mishap to include sorties on 4 February 2014 for 1.2 hours and 5 February 2014 for 0.9 hours (Tab G-33). There is no indication the MMC's operational tempo was a factor in the mishap.

b. Supervision

The briefing for the mission, conducted in two segments, was in accordance with Air Force Instruction (AFI) 11-2QF-4, Volume 3, *QF-4 Operations and Procedures*, 1 July 2000, Chapter 2; 82d Aerial Targets Squadron (82 ATRS) Operating Instruction (OI) 11-5; *Flying Operations*, 9 January 2006; and *82 ATRS Standards*, September 2012, Paragraph 4 (Tab V-1.1; Tab V-3.1; Tab V-4.2). The MA mission commander attended and properly supervised mission planning and execution prior to the mishap (Tab V-1.1 through Tab V-1.2; Tab V-3.1 through Tab V-3.6; Tab V-4.1 through Tab V-4.2). There is no indication that supervision was a factor in this mishap.

11. HUMAN FACTORS

AFI 91-204, *Safety Investigations and Reports*, 12 February 2014, Attachment 5 contains the Department of Defense Human Factors Analysis and Classification System, which lists potential human factors that can play a role in aircraft mishaps. A human factor is any environmental or individual physical or psychological factor a human being experiences that contributes to or influences their performance during a task.

The White Sands Integrated Target Control System (WITS) is a ground-based, highly automated computer system operated and maintained by the White Sands Missile Range (WSMR), New Mexico (NM), used to track and control unmanned aerial targets (Tab V-9.1). While the Mishap Controller (MC) was responsible for controlling the mishap aircraft (MA) through all phases of flight, the MC did not manually control the landing of the MA (Tab V-1.5). Manual landings require two operators to control the landing and are considered more dangerous than automatic landings (Tab V-1.5). However, the MC was responsible for the execution of emergency procedures (EP) checklist during the mishap sequence (Tab BB-5.2).

The MC visually scanned back and forth between the two WITS Operating Console screens during the mishap sequence (Figure 2; Tab V-1.3 through V-1.4; Tab AA-1.8; Tab AA-1.13 through Tab AA-1.14). The left screen was a "God's Eye" view of the aircraft overlaid onto a moving map which showed the location of the aircraft and the direction it was pointed (Figure 2, Figure 5; Tab V-1.2; Tab AA-1.14) The right display showed all aircraft flight instruments to include aircraft attitude, airspeed, angle of attack (AOA), throttle position, altitude, caution lights and several other indications (Figures 2-5; Tab V-1.2; Tab AA-1.8; Tab AA-1.13).

Using the left screen, the MC crosschecked the location and direction of the MA in relation to the heading approach line controlled by the Automatic Flight Control Computer (AFCC), which displayed the ground track the MA should have remained on during the automatic landing (Figures 2-5; Tab V-1.4 through Tab V-1.5; Tab AA-1.14). During this crosscheck, and based on feedback from the Chase Pilot (CP), the MC correctly identified the MA turning left of the approach line (Figure 1; Tab N-7; Tab S-9; Tab V-1.3 through Tab V-1.5; Tab V-2.1 through

Tab V-2.2). However, when the MC crosschecked the flight instruments on the WITS Operating Console right screen the wings appeared level (Figure 2; Tab N-7; Tab V-1.3 through Tab V-1.5; Tab V-2.1 through Tab V-2.2). Additionally, the Mishap Mission Coordinator (MMC) concluded the attitude indicator froze periodically for no more than 2/10 of a second during the mishap sequence (Tab V-2.3).

The MC correctly identified a discrepancy between the information received from the CP's radio calls, the moving map display and the aircraft instruments, and determined a problem existed (Tab N-7; Tab V-1.4; Tab AA-1.8; Tab AA-1.13 through Tab AA-1.14). Therefore, the MC determined that he needed to take manual control of the MA, turn the MA back towards the WSMR, and troubleshoot the missed landing approach (Tab V-1.4; Tab V-1.6). At 16:07:17Z the MC switched the MA into manual control (Figure 3; Tab V-1.4; Tab AA-1.15; Tab AA-3.2). Personnel in the control room watching a live video feed of the MA began verbally reacting to the MA's pitch oscillations (Figure 1; Tab S-9; Tab V-1.4; Tab V-3.2; Tab EE-1.6 through Tab EE-1.11). The MC did not watch the video feed of the MA because it provided a delayed feed of the actual performance of the MA (Tab V-1.4). However, the Mishap Mission Coordinator (MMC) who was responsible for monitoring both the WITS Operating Console and the video feed, identified the MA's pitch oscillations and directed the MC to select Automatic Takeoff (ATO) (Tab S-9; Tab V-1.4; Tab V-2.2).

The MC checked the attitude indicator on the WITS Operating Console right screen and noted the MA's pitch attitude moving downwards towards the ground (Figures 1-2; Tab S-9; Tab V-1.4 through Tab V-1.5; Tab AA-1.8; Tab AA-1.13). The MC determined the MA was in an unusual attitude and began performing the "Unusual Attitude Recovery" emergency procedure (EP) checklist by selecting All Attitude Recovery (AAR) (Tab V-1.4 through Tab V-1.5; Tab V-2.2; Tab V-3.3; Tab AA-1.4; Tab AA-1.11; Tab BB-8.20). Selecting AAR was equivalent to selecting ATO in the landing approach pattern with the exception that AAR did not raise the landing gear and flaps (Tab V-1.5; Tab V-2.2). The MA continued to oscillate up and down after the MC selected AAR; therefore, the MC selected ATO (Figure 1; Tab S-9; Tab V-1.5; Tab V-2.2; Tab EE-1.6 through Tab EE-1.11). The MA did not respond so the MC completed the "Unusual Attitude Recovery" EP checklist by selecting Backup Automatic Flight Control System (BUAFCS) on the WITS Operating Console control stick followed by AAR (Figure 1; Tab S-9; Tab V-1.5; Tab V-2.2 through Tab V-2.3; Tab AA-1.4; Tab AA-1.10; Tab AA-1.15; Tab AA-3.2 through Tab AA-3.3; Tab EE-1.6 through Tab EE-1.11). Shortly after completing the EP checklist, the MA impacted the ground (Tab V-1.8; Tab V-2.3).

After a review of the MC's actions during the mishap sequence, the Abbreviated Accident Investigation Board (AAIB) found no evidence indicating human factors were a factor in this mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

(1) AFI 11-2QF-4, Volume 1, *QF-4 Aircrew Training*, 1 October 2003
(2) AFI 11-202, Volume 3, *Flying Operations*, 22 October 2010

(3) AFI 11-401, *Aviation Management*, 10 December 2010 (Certified Current, 9 January 2013)
(4) AFI 48-123, *Medical Examinations and Standards*, 5 November 2013
(5) AFI 51-503, *Aerospace Accident Investigations*, 26 May 2010
(6) AFI 91-204, *Safety Investigations and Reports*, 12 February 2014

NOTICE: All directives and publications listed above are available digitally on the Air Force Departmental Publishing Office website at: http://www.e-publishing.af.mil.

b. Other Directives and Publications Relevant to the Mishap

(1) TO 1F-4(Q) E-1, *USAF Series QF-4E and QRF-4C Aircraft*, June 2011 (Releasable portions are included in Tab BB of this report. The full TO is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(2) TO 1F-4(Q)C-2-96GS-00-1, *Pre-Mission Test Procedures: USAF Series QF-4E, QF-4G and QRF-4C Aircraft*, Change 1, 5 March 2010 (The TO is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(3) TO 1F-4(Q)C-6, *Aircraft Scheduled Inspection and Maintenance Requirements: USAF Series of QF-4E and QRF-4C Aircraft*, 10 September 2013 (Incorporating Change 1, 30 November 2013) (The TO is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(4) TO 1F-4C-6, *Aircraft Scheduled Inspection and Maintenance Requirements: USAF Series F-4C, F-4D, F-4E, and RF-4C Aircraft*, 15 October 1985 (Incorporating Change 57, 15 November 2013) (The TO is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(5) TO 1F-4(Q)C-6WC-2, *25 Hour Flightline Inspection: USAF Series QF-4E, QF-4G and QRF-4C Aircraft*, 1 August 2004 (The TO is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(6) TO 1F-4(Q)C-6WC-6, *Hourly Postflight Inspection: USAF Series QF-4E, QF-4G, and QRF-4C Aircraft*, Change 2, 27 October 2008 (The TO is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(7) Holloman AFB Instruction 11-250, *Flying Operations*, 10 August 2012 (Releasable portions are included in Tab BB of this report. The full publication is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(8) 53 WEG 11-250, *Operations*, 1 March 2013 (Releasable portions are included in Tab BB of this report. The full publication is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(9) 82 ATRS Operating Instruction 11-2, *Flying Operations*, 15 March 2013 (Releasable portions are included in Tab BB of this report. The full publication is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(10) *82 Aerial Targets Squadron Standards*, September 2012;
(11) Det 1 Operating Instruction 11-2, *Flying Operations*, 24 July 2013;
(12) *DFCS User's Guide: Holloman Project*, 2 October 2006 (Releasable portions are included in Tab AA of this report. The full guide is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778);
(13) *Det 1, 82 ATRS Standards*, no date;

(14) *82d ATRS Local Checklist 101*, 1 March 2012 (Releasable portions are included in Tab AA of this report. The full checklist is not releasable due to the Arms Export Control Act, 22 U.S.C. 2778).

c. Known or Suspected Deviations from Directives or Publications

No additional suspected deviations from directives or publications.

13. ADDITIONAL AREAS OF CONCERN

Detachment 1, 82d Aerial Targets Squadron (82 ATRS) is a tenant unit of the 49th Wing (49 WG), Holloman Air Force Base (AFB), New Mexico (NM) (Tab V-6.2). Detachment 1, 82 ATRS includes a mixture of active duty personnel, Government Service (GS) employees, and contractors employed by Defense Support Services (DS2) (Tab V-6.2). Approximately three years ago the pilot and controller positions converted from contractor positions to GS positions (Tab V-1.1). In accordance with Air Force Instruction (AFI) 48-123, *Medical Examinations and Standards*, 5 November 2013, paragraph 6.1.2., medical examinations are required when personnel, including civilian government employees, are directed to participate in frequent and regular aerial flight as defined by AFI 11-401, *Aviation Management*, 10 December 2010 (Certified Current, 9 January 2013). Therefore, the pilots and controllers of Detachment 1, 82 ATRS are required to complete either an Air Force Flying Class II examination or a Federal Aviation Administration (FAA) Class II examination (Tab V-6.2). However, AFI 48-123, paragraph 6.1.1., only requires Air Force or Air Reserve Component (ARC) applicants to process through an Air Force military treatment facility. Consequently, the active duty pilot and controllers complete the Air Force Flying Class II examination at a military treatment facility, where their medical records are appropriately maintained, while civilian pilot and controllers have discretion in providing their FAA Class II examination to the 49th Medical Group (49 MDG) (Tab V-6.2). This provides inconsistent oversight of the medical flying qualifications of Detachment 1, 82 ATRS civilian personnel and personnel sent to Holloman AFB, NM on temporary duty from the 82 ATRS, Tyndall AFB, Florida (FL), by the 49 MDG flight surgeons. Further, there is no Memorandum of Understanding (MOU) or Support Agreement articulating the roles and responsibilities of the 49 WG and Detachment 1, 82 ATRS to maintain, provide, and sequester medical records after an aviation accident has occurred (Tab V-6.2).

2 July 2014

ROBERT G. MATHIS, Maj, USAF
President, Abbreviated Accident Investigation Board

STATEMENT OF OPINION

AIRCRAFT ACCIDENT INVESTIGATION
QF-4E, T/N 74-1629, HOLLOMAN AIR FORCE BASE, NEW MEXICO
7 FEBRUARY 2014

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

1. OPINION SUMMARY

On 7 February 2014, at 16:07:22 Zulu (Z) time, a QF-4E Phantom II aircraft, tail number (T/N) 74-1629, on approach for landing, impacted the ground in the White Sands National Monument approximately 5 miles southwest of runway 04 at Holloman Air Force Base (AFB), New Mexico (NM). The mishap aircraft (MA) was assigned to Detachment 1, 82d Aerial Targets Squadron (82 ATRS), Holloman AFB, NM. Detachment 1, 82 ATRS reports to the 53rd Weapons Evaluation Group (53 WEG), 53rd Wing (53 WG), Tyndall AFB, Florida (FL). The MA was destroyed on impact. The total damage to Department of Defense (DoD) property was assessed to be $4,890,429. Damage to non-DoD but other government property included two road signs/posts and a small (3'x1') impact crater on a road; DoD paid for new signs and repaired the road.

At 16:02:01Z, and approximately 15 miles from recovery, the Mishap Controller (MC) commanded automatic landing of the MA via the White Sands Integrated Target Control System (WITS) Operating Console. At 16:06:48Z, the Chase Pilot (CP) notified the MC "we're rocking a little bit." However, when the MC crosschecked the flight instruments on the WITS Operating Console right screen the wings appeared level. At 16:07:03Z, the MA made an aggressive left roll to approximately 70 degrees angle of bank, which caused the MA to lose altitude, turn left and then roll out wings level. At 16:07:17Z the MC switched the MA into manual. The MC checked the attitude indicator on the WITS Operating Console right screen and noted the MA's pitch attitude moving downwards towards the ground. The MC determined the MA was in an unusual attitude and began performing the "Unusual Attitude Recovery" emergency procedure (EP) checklist by selecting All Attitude Recovery (AAR). The MA continued to oscillate up and down after the MC selected AAR; therefore, the MC selected Automatic Takeoff (ATO). The MA did not respond so the MC completed the "Unusual Attitude Recovery" EP checklist by selecting Backup Automatic Flight Control System (BUAFCS) on the WITS Operating Console control stick followed by AAR. At 16:07:22Z, the CP observed the MA impact the ground and relayed that information to the MC. There were no aural tones over the controller radio frequencies during the mishap sequence indicating a loss of transmission between the MA and the WITS.

I find by clear and convincing evidence, the cause of this mishap was a failure of the attitude pitch and roll gyro, the instrument used to inform the MC of the MA's orientation relative to

Earth's horizon, which briefly sent erroneous inputs to the Automatic Flight Control Computer (AFCC). The MA subsequently responded by driving the stabilator, the aircraft component that moves the aircraft up and down, into a stall prevention mode as quickly as possible resulting in a continuous cycle of overcorrection of the MA's pitch and an increase in pitch oscillations. This cycle continued despite the MC's efforts to recover the MA until the MA impacted the ground.

2. DISCUSSION OF OPINION

I developed my opinion by analyzing factual data from Technical Orders (TO), Air Force directives and guidance, engineering analysis of the WITS data, witness testimony, flight data, and information provided by technical experts. Specifically, a detailed review of the WITS data demonstrated that there were no failures detected in the communication between WITS and the MA. At approximately 1,000 feet above ground level (AGL), 180 knots indicated air speed (KIAS), and 15 units angle of attack (AOA), the aircraft suddenly rolled left then appeared to somewhat recover the roll axis, but the pitch axis quickly became unstable. The MC correctly commanded "ESCAPE" utilizing the All Attitude Recovery (AAR) command. The roll axis appeared to stabilize itself but the pitch axis went through a series of limit cycle instabilities, which were induced by the stall feedback and rate limits associated with the AFCC pitch attitude control loop. The MA engines were in afterburner (AB), as demonstrated by the increase in the temperature of the engines and increase in the KIAS; however, the pitch gyrations caused the MA to continue its descent faster than before causing the MA to impact the ground approximately 17 seconds after the instability started. The rate gyro downlink data demonstrated that at or about 26 seconds on the rate gyro roll data plot the aircraft started a left roll, as demonstrated by a trough of approximately -38 degrees per second. Additionally, at about 28 seconds on the rate gyro pitch plot the MA started pitching down as demonstrated by a trough of approximately -10 degrees per second.

However, the attitude gyro downlink data showed a large right roll demonstrated by a peak of approximately 10 degrees on the attitude gyro pitch plot, and a large pitch up demonstrated by a peak of approximately 50 degrees on the attitude gyro roll plot, at 26 seconds and 28 seconds respectively. Therefore, the rate roll and pitch gyro of the MA and the attitude roll and pitch gyro conflicted. Conflicting data was only plausible in four situations: (1) the attitude pitch and roll gyros were wired or installed backwards; (2) the rate pitch and roll gyros were wired or installed backwards; (3) the attitude pitch and roll gyros failed; or (4) the rate pitch and roll gyros failed. In situations (1) and (2) the MA would have failed moments after brake release during takeoff. Instead, the MA successfully flew a near complete mission and was in the process of landing. Therefore, I determined that either the attitude gyro or rate gyro experienced a failure. However, video evidence and witness testimony demonstrated the MA initially rolled left and pitched down consistent with the rate gyro downlink data.

An analysis comparing the calculated pitch and roll of the MA compared to the attitude gyro downlink data identified a 2-3 second "glitch" at approximately 26 seconds where the attitude gyro roll and pitch downlinks conflicted with the actual flight performance of the MA. After the 2-3 second glitch, the attitude gyro downlink data closely mirrored what the MA actually did. Additionally, after the 2-3 second glitch in the attitude gyro downlink data, the roll axis appeared to stabilize, but the attitude gyro pitch axis began to go unstable.

An analysis of the attitude gyro pitch demonstrated the pitch instability was caused by a large initial erroneous attitude input at a low speed. The source of the error could not be determined. The MA subsequently responded by driving the stabilator, the aircraft component that moves the aircraft up and down, into a stall prevention mode as quickly as possible resulting in a continuous cycle of overcorrection of the MA's pitch and an increase in pitch oscillations.

I further determined that the instability, once started, would only have been corrected by either switching the MA to BUAFCS or enabling manual flight control with the addition of a very small pitch rate inputs. These pitch stick out (PSO) inputs would have put the MA into a pitch rate mode, thus eliminating the large oscillations that were a result of the MA attempting to maintain a particular attitude. In accordance with the emergency procedures (EP) checklist and the lack of any other caution lights on the control panel, the MC correctly commanded an AAR followed by an Automatic Takeoff (ATO), switched to BUAFCS and commanded AAR again prior to the MA impacting the ground. Finally, I determined that although the BUAFCS was commanded, the MA was too close to the ground to recover.

3. CONCLUSION

Therefore, I find by clear and convincing evidence, the cause of the mishap was a failure of the pitch and roll attitude gyro, which briefly sent erroneous inputs to the Automatic Flight Control Computer (AFCC). The MA subsequently responded by driving the stabilator, the aircraft component that moves the aircraft up and down, into a stall prevention mode as quickly as possible resulting in a continuous cycle of overcorrection of the MA's pitch and an increase in pitch oscillations. This cycle continued despite the MC's efforts to recover the MA until the MA impacted the ground.

2 July 2014

ROBERT G. MATHIS, Maj, USAF
President, Abbreviated Accident Investigation Board

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