UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

B-1B, Tail Number 85-0091

34TH BOMB SQUADRON
28TH BOMB WING
ELLSWORTH AIR FORCE BASE

LOCATION: BROADUS, MONTANA

DATE OF ACCIDENT: 19 AUGUST 2013

BOARD PRESIDENT: COLONEL BRIAN A. HUMPHREY

CONDUCTED IN ACCORDANCE WITH AIR FORCE INSTRUCTION 51-503

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

19 DEC 2013

OFFICE OF THE VICE COMMANDER
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ACTION OF THE CONVENING AUTHORITY

The Report of the Accident Investigation Board, conducted under the provisions of AFI 51-503, that investigated the 19 August 2013, mishap near Broadus, Montana, involving a B-1B, T/N 85-0091, assigned to the 34th Bomb Squadron, 28th Bomb Wing, Ellsworth AFB, SD, complies with applicable regulatory and statutory guidance; on that basis it is approved.

LORI J. ROBINSON
Lieutenant General, USAF
Vice Commander

EXECUTIVE SUMMARY
AIRCRAFT ACCIDENT INVESTIGATION

B-1B, Tail Number 85-0091
BROADUS, MONTANA
19 AUGUST 2013

On 19 August 2013, at approximately 0916 hours local time (L), the mishap aircraft (MA), a B-1B, Tail Number 85-0091, assigned to the 34th Bomb Squadron, 28th Bomb Wing, Ellsworth Air Force Base (AFB), South Dakota, impacted grass-covered pastureland near Broadus, Montana. The four crewmembers ejected safely and sustained non-life-threatening injuries. There were no injuries to civilians. The MA was destroyed, with the government loss valued at $317,722,980.67. Damage to private property consisted of burnt pastureland.

The MA departed Ellsworth AFB at approximately 0857L on 19 August 2013. Following takeoff, Mishap Pilot 2 (MP2) leveled the MA off at an altitude of approximately 20,000 feet. At that time, the mishap crewmembers (MC) completed an aircraft systems check. MP2 then reduced engine thrust to idle, initiated a descent to 10,000 feet, and swept the wings from the forward to the aft position. During the sweep, the MA developed an undetectable fuel leak in the 4.5-inch main fuel line located in the left overwing fairing. The fairing is a structure that provides a smooth surface for air to flow over portions of the aircraft (e.g., wing) thereby reducing drag. Approximately 7,000 pounds of fuel leaked from the 4.5-inch main fuel line into the left overwing fairing while the MC continued their training mission. Eventually, the fuel contacted exposed portions of the hot precooler duct, ignited, and caused an explosion that separated the left overwing fairing from the MA. Ignited fuel streamed from the exposed left overwing fairing cavity, heated one of the MA's fuel tanks, and ignited the fuel vapors inside the tank. This detonation propagated through the fuel venting system that connects the fuel tanks in the MA, resulted in a cascade of catastrophic explosions and caused a complete and permanent loss of power to the crew compartment.

The efforts of the MC to extinguish the fires were unsuccessful. Mishap Pilot 1 appropriately ordered the MC to eject. Following ejection, the fuselage of the MA split in two and impacted the ground.

The Accident Investigation Board President found by clear and convincing evidence that a displaced fold down baffle in the left overwing fairing caused the mishap. The fold down baffle fills in gaps when the wings are in the forward position to form a fairing under the wing. The fold down baffle became detached for an unknown reason sometime prior to the initiation of the aft wing sweep. During the sweep, the wing pushed the detached fold down baffle into the 4.5-inch main fuel line, resulting in a v-shaped cut to the top half of the fuel line and the subsequent fuel leak. The leaking fuel ignited, caused multiple catastrophic detonations throughout the MA, and ultimately led to the breakup of the MA prior to ground impact.

SUMMARY OF FACTS AND STATEMENT OF OPINION
B-1B, Tail Number 85-0091
19 AUGUST 2013

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

12 AF	Twelfth Air Force
28 BW	28th Bomb Wing
34 BS	34th Bomb Squadron
A1C	Airman First Class
ACC	Air Combat Command
AF	Air Force
AFTO	Air Force Technical Order
AFB	Air Force Base
AFE	Air Flight Equipment
AFI	Air Force Instruction
AFIP	Air Force Institute of Pathology
AFS	Avionics Flight Software
AGL	Above Ground Level
AIB	Accident Investigation Board
AMU	Aircraft Maintenance Unit
APG	Airplane General Mechanic
APU	Auxiliary Power Unit
CAMS	Core Automated Maintenance System
CITS	Central Integrated Test System
CRG	Contingency Response Group
CW	Civilian Witness
DIFM	Due in for Maintenance
DO	Director of Operations
DSO	Defensive Systems Operator
ECS	Environmental Control System
ENG	Engine
EMUX	Electrical Multiplexing
ETAR	Engineering Technical Assistance Report
FDP	Flight Duty Period
FOD	Foreign Object Debris
GX	Gravitational Force Awareness Exercise
IAW	In Accordance With
ICS	Intercom Crew System
I&E	Intake and Exhaust
IDARS	Integrated Data Acquisition Recorder System
IMDS	Integrated Maintenance Data System
IP	Instructor Pilot
JDAM	Joint Direct Attack Munitions
KVA	Kilovolt Amperage
L	Local Time
Lt Col	Lieutenant Colonel
MBW	Multipurpose Ballistics Weapon
MC	Mishap Crew
MICAP	Mission Capable
MIZ	Maintenance Information System
MM	Maintenance Member
MOA	Military Operating Area
MP	Mishap Pilot
MSgt	Master Sergeant
MSA	Minimum Safe Altitude
MSL	Mean Sea Level
MXS	Maintenance Squadron
NOTAMs	Notices to Airmen
OH	Ohio
Ops	Operations
ORM	Operational Risk Management
PCA	Permanent Change of Assignment
PLF	Parachute Landing Fall
SD	South Dakota
SIM	Suppression/Insulation/Migration
TCTO	Time Compliance Technical Order
Tech	Technical
TF	Terrain Following
T/N	Tail Number
T.O.	Technical Order
USAF	United States Air Force
U.S.C.	United States Code
VSD	Vertical Situation Display
VMC	Visual Meteorological Condition
WSO	Weapons System Officer
Z	Zulu

The above list was compiled from the Summary of Facts, the Statement of Opinion, the Index of Tabs, and Witness Testimony (Tab V).

DEFINITIONS

Above ground level	Altitude measurement based on distance from underlying ground surface
Afterburner or augmented thrust	Enhancement of engine power by adding additional oxygen or fuel to the exhaust
Fairing	Structure to provide smooth surface for air to flow over portions of the aircraft (e.g., wing), thereby reducing drag
Flight level	Altitude measurement based on barometric pressure used to normalize measurement of altitude among aircraft
Fuselage	Main body section of aircraft
Fold down baffle	Fills gaps when wings are in forward position to form a fairing under wing
G	A force acting on a body as a result of acceleration
G-Awareness Exercise	A flight maneuver performed prior to high G conditions to ensure crewmembers are capable of coping with increased G
Integrated Data Acquisition System	Compact, solid-state recording system used to collect, process, and store flight data (e.g., accelerometer measurements)
Isochronal inspection	Periodic inspection scheduled according to flying hour utilization rates in specific calendar periods
Mandrel spring assembly	Provides pressure necessary to push fold down baffle into place when wings are in forward position
Mean Sea Level	Altitude measurement based on an aircraft's distance from average height of ocean
Military Power/ intermediate power	Maximum thrust setting of aircraft without afterburner
Military Operating Area	Airspace designated to segregate non-hazardous military activities from non-military air traffic
Nacelle	Structure that contain engines, auxiliary power units, precooler, and other aircraft systems

Overpressure condition	Rapid expansion of combustible materials in a confined area
Overwing fairing cavity	Space below fairing located at wing roots containing 4.5-inch main engine fuel line, 2-inch fuel cooling loop line, and other systems
Preflight	Inspection of aircraft prior to takeoff
Precooler bay	Compartment used to cool engine air for use in aircraft systems
Reconstitution	Post-deployment plan to ensure squadron members be current on training
Sortie	Deployment of aircraft for a particular mission
Technical order	Publication that explains procedures for aircraft operations and maintenance
Wing root	Connection point between the wing and aircraft fuselage
Wing sweep	Movement of the wings forward (15 degrees) or aft (67.5 degrees), allowing increased performance at different airspeeds

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 25 October 2013, Lieutenant General Lori J. Robinson, Vice Commander, Air Combat Command (ACC), appointed Colonel Brian A. Humphrey as Board President (BP) to conduct an aircraft accident investigation of a mishap that occurred on 19 August 2013 involving a B-1B aircraft near Broadus, Montana (MT) (Tab Y-5 to Y-6). The BP conducted the aircraft accident investigation in accordance with Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, at Ellsworth Air Force Base (AFB), South Dakota (SD), from 28 October 2013 through 22 November 2013 (AFI 51-503, *Aerospace Accident Investigations*, 26 May 2010, Incorporating Change 1, 21 June 2010). Board members included a Medical Member, a Pilot Member, a Legal Advisor, a Maintenance Member, and a Recorder (Tab Y-5).

b. Purpose

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 (AFI 51-503, paragraph 1.2).

2. ACCIDENT SUMMARY

On 19 August 2013, at approximately 0916 hours local time (L), the mishap aircraft (MA), a B-1B, Tail Number 85-0091, assigned to the 34th Bomb Squadron (34 BS), 28th Bomb Wing (28 BW), Ellsworth AFB, impacted the ground on civilian owned pastureland near Broadus, Montana. The MA and its crew were conducting a training mission simulating surface attack for post-deployment reconstitution in a Military Operating Area (MOA) (Tabs J-67, J-71, K-7, K-13, CC-11, DD-3, EE-3, EE-25, and FF-7). The purpose of post-deployment reconstitution is to ensure all squadron members become current on training items that expired during deployment (Tab EE-3). All crewmembers ejected safely (Tabs H-2, H-12 to H-13, V-1.9 to V-1.11, V-2.12 to V-2.14, V-3.14 to V-3.15, and V-4.13 to V-4.16). Mishap Pilot 1 (MP1), Mishap Crewmember 1 (MC1), and Mishap Crewmember 2 (MC2) suffered minor injuries (Tabs H-13, V-1.9, V-2.10, V-2.13, V-3.15 to V-3.16, V-4.14 to V-4.16, and X-3 to X-4). Mishap Pilot 2 (MP2) sustained more significant, but not life-threatening, injuries (Tabs H-13, V-4.14 to V-4.16 and X-3 to X-4). There were no injuries to civilians (Tab DD-3 and DD-5 to DD-6). The 28th Bomb Wing Commander responded to media interest following the mishap (Tab DD-3 and DD-5 to DD-6). The MA was destroyed, with the government loss valued at $317,722,980.67 (Tab P-5). There was also damage to private property consisting of burnt pastureland.

3. BACKGROUND

The MA belonged to 28 BW, Twelfth Air Force (12 AF), ACC (Tabs K-7, K-13, CC-5, and CC-7).

a. Air Combat Command

ACC is the primary force provider of combat airpower to America's warfighting commands (Tab CC-3). To support global implementation of national security strategy, ACC operates fighter, bomber, reconnaissance, battle management, and electronic-combat aircraft (Tab CC-3). It also organizes, trains, equips and maintains combat-ready forces for rapid deployment and employment, while ensuring strategic air defense forces are ready to meet emerging challenges (Tab CC-3).

b. Twelfth Air Force

Twelfth Air Force is responsible for the combat readiness of 10 active duty wings and one direct reporting unit (Tab CC-7). It is one of four Numbered Air Forces in ACC (Tab CC-3 and CC-5). Twelfth Air Force includes commands that, in total, operate more than 818 aircraft with more than 65,000 uniformed and civilian personnel (Tab CC-7). It enables combat-ready forces for rapid global deployment to receive, command and control, and employ joint air component assets to meet U.S. strategic objectives across a full spectrum of operations (Tab CC-7).

c. 28th Bomb Wing

The 28th Bomb Wing is located at Ellsworth AFB near Rapid City, SD (Tab CC-5, CC-7, and CC-9). It provides essential base operating support services for Ellsworth AFB and combat support services for an Air Expeditionary Wing (Tab CC-9). It consists of four groups: the 28th Operations Group, 28th Mission Support Group, 28th Maintenance Group, and 28th Medical Group (Tab CC- 9 and CC-11). Its vision is to serve as the backbone of global engagement for the 21st century (Tab CC-9).

d. 34th Bomb Squadron

Known as the Thunderbirds, the mission of 34 BS is to employ the B-1B to defeat America's enemies across the globe at a moment's notice (Tab CC-11). After the 11 September 2001 terrorist attacks on the United States, 34 BS was one of the first units to deploy overseas in support of OPERATION ENDURING FREEDOM (Tab CC-11). Since 2003, the Thunderbirds have completed numerous deployments in support of OPERATIONS ENDURING FREEDOM and IRAQI FREEDOM (Tab CC-11).

e. B-1B

The B-1B carries the largest payload of both guided and unguided weapons in the Air Force inventory (Tab CC-13). It can rapidly deliver massive quantities of precision and non-precision weapons against any adversary, anywhere in the world (Tab CC-13). The B-1B is an improved variation of the B-1A, which was developed in the 1970s as a replacement for the B-52 (Tab CC-13). The wings on the B-1B sweep from a forward position of 15 degrees to and aft position of 67.5 degrees (Tab J-33). The United States first utilized the B-1B in combat to support operations against Iraq during OPERATION DESERT FOX in December 1998 (Tab CC-14). The B-1B played a critical role in OPERATION ENDURING FREEDOM, dropping nearly 40 percent of the total tonnage delivered by coalition forces during the first six months of the operation (Tab CC-13).

4. SEQUENCE OF EVENTS

a. Mission

The mission during the 19 August 2013 mishap was a post-deployment training flight in which the mishap crew (MC) would simulate a low-threat surface attack (Tabs V-1.4, V-2.3 to 2.4, V-3.4, V-4.3, EE-3, and EE-16). The MC's objective was to simulate ordnance employment, allowing them to become current on combat-mission readiness training items that could not be accomplished during their recent deployment (Tabs V-1.4, V-2.3, V-3.4, EE-3, and EE-16). The Director of Operations for 34 BS properly authorized the mission on 19 August 2013 (Tab K-13). The mission required the MC to fly in the Powder River MOA (Tabs K-7, and EE-17). It included defensive maneuvers in response to simulated threats, low and medium altitude Modifiable Ballistics Weapon bomb runs, and multiple Joint Direct Attack Munition bomb runs (Tab V-1.4, V-2.3, V-3.4, and V-4.3). The MA and an additional B-1B were the only military aircraft from Ellsworth AFB scheduled to be in the MOA at the time of the mishap (Tabs K-6 to K-7 and EE-25).

b. Planning

The mission planning and briefing were accomplished in accordance with (IAW) 34 BS, 28 BW, and Air Force directives and standards (Tab EE-11 to EE-12). The MC attended 34 BS reconstitution briefings on 16 August 2013, which included the mission briefing for the 19 August 2013 mishap flight (Tab V-1.3 to V-1.4, V-2.3 to V-2.4, V-3.4, and V-4.3). MP1 and MC1 developed the mission plan prior to 16 August 13 (Tab V-2.3 and V-3.3). MC1 briefed 34 BS personnel, including the MC, on the mission scenario, mission execution, emergency procedures, obstructions and high terrain, special interest items, flight administration, training rules, airspace, and forecast weather, IAW the *28th BW In-flight Guide* (Tabs V-1.3 to V-1.4, V-2.3, V-4.4, EE-10 to EE-12, and EE-15 to EE-19). The Commander and Director of Operations for 34 BS attended the mission brief (Tab V-1.4 to V-1.5, V-2.4, V-3.4 to V-3.5, and V-4.3). The MC understood the mission (Tab V-1.5, V-2.4, V-3.5, and V-4.4). Following the mission brief, MP1 briefed the MC, IAW 28 BW guidance (Tabs V-2.4, V-3.3 to V-3.4, V-4.3, and EE-11). The weather flight from the 28th Operational Support Squadron, Ellsworth AFB, developed the weather planning documents for the mission, which included forecasts and observations for

Ellsworth AFB, Powder River MOA, and surrounding airspace, as well as satellite and radar images showing, weather, winds, and other relevant data (Tab F-2 to F-13).

c. Preflight

Prior to departing 34 BS for the MA on 19 August 2013, the MC gathered and inspected their Aircrew Flight Equipment (AFE) gear and received a brief from the operations supervisor (Tab V-1.3, V-1.5 to V-1.6, V-2.4, V-3.5 and V-4.4). This brief concerned aircraft parking locations, maintenance issues, and configurations, and also included a review of the Notices to Airmen (NOTAMS), bird watch conditions, updated information on airfield and weather conditions, and reconstitution guidance from the Commander of 34 BS (Tab EE-12 and EE-21 to EE-29). The flight plan (Department of Defense Form 175) was electronically filed with the Federal Aviation Administration (Tab K-3). The MC departed 34 BS and arrived at the MA at approximately 0730L (Tab V-3.5 and V-4.5). At the MA, the MC conducted a review of the aircraft forms, completed a walk-around inspection, and initiated the engine start sequence and preflight checks (Tab V-1.6, V-2.5, V-3.5 to V-3.6, and V-4.5). Aside from an issue with one of two available radar channels, neither the MC nor maintenance personnel noted anything abnormal during preflight or ground operations prior to takeoff (Tabs R-15, R-19, V-1.6, V-2.5, V-3.6, V-4.5, V-9.3, and V-10.4). The radar issue was resolved prior to takeoff (Tabs R-15, R-19, V-1.6 to V-1.7, V-4.5, V-9.3, and V-10.4).

d. Summary of Accident

The MA departed Ellsworth AFB at approximately 0857L under the call sign THUNDER 21 (Tabs J-66, K-7, K-13, and FF-4). The preflight, engine start, taxi, and takeoff performed by MP2 were uneventful (Tab V-3.6 and V-4.5). The MA proceeded to the training airspace, climbing to 20,000 feet (Flight Level 200) (Tab V-2.6, V-3.6, and 3.11). The MC conducted aircraft system checks, which indicated all systems were operating within normal parameters (Tab V-1.7, V-1.12, V-2.6, V-3.6, V-3.11, and V-4.6).

After arriving in the Powder River MOA at approximately 0905L, MP2 decreased thrust to initiate a descent to 10,000 feet Mean Sea Level (MSL) for a G-Awareness Exercise (Tabs J-66, L-4, V-2.5, V-3.6, and V-4.6). MP2 initiated a sweep of the wings from 25 degrees (the takeoff and climb setting) aft to 67.5 degrees, leveled off at 10,000 feet MSL, and conducted the G-Awareness Exercise (Tabs J-67, V-2.5, V-3.6, and V-4.6).

Soon after the descent to 10,000 feet began, the MA developed an undetectable (see discussion in paragraph 6.a.(4)) fuel leak in the 4.5-inch main fuel line of the left overwing fairing (Tabs J-66, J-78, J-108 to J-110, and FF-4). The leak occurred at a rate of approximately 820 pounds per minute (approximately 120 gallons per minute) for 8.5 minutes totaling approximately 7,000 pounds of fuel (1,000 gallons) (Tab J-78). There were no cockpit indications of a leak (Tab V-1.12, V-2.14, V-3.11 to V-3.12, and V-4.6 to V-4.7). The fuel level indicator located inside the fuel tank was unable to detect a downstream leak (see discussion in paragraph 6.a.(4)).

Unaware of the fuel leak, and following the two G-Awareness Exercise turns, MP2 initiated a descent from 10,000 feet MSL to 1,000 feet Above Ground Level (AGL) (Tabs J-67, V-1.7, V-2.6, V-3.6, V-2.11, V-4.6 to V-4.7, and FF-4). MP2 leveled the MA at 1,000 feet AGL and

began the low altitude unguided bomb run at approximately 0913L (Tabs J-67, V-2.6, V-3.6, V-4.7, and FF-5). After the MC completed the level-off checks, MP2 initiated a defensive left turn maneuver in response to a simulated threat from the northeast announced by MC1 (Tab V-1.7, V-2.6 to V-2.7, and V-3.6). MP2 turned the MA to an approximate heading of 220 degrees and moved the throttles to the maximum augmented thrust (Tabs J-68, V-2.6 to V-2.7, and V-3.6).

At approximately 0914L, the MC heard a loud noise (described as a "bang," "pop," "violent," and "loud explosion"), which some of the MC perceived to be from the left side of the MA (Tabs V-1.7, V-2.9, V-3.6 to V-3.7, V-3.13, V-4.7, and FF-5). The noise was accompanied by an uncommanded left yaw and bank (Tabs J-67 to J-68 and V-3.7). Subsequently, the left overwing fairing fire light illuminated in the cockpit and an alarm sounded, signaling overheat or fire in the left overwing fairing (Tab V-2.8, V-3.7 to V-3.8, V-3.13, and V-4.10). At 0914:30L, MP2 moved the throttles to an intermediate power setting (Tabs J-67, V-2.7 to V-2.8, V-2.11, V-3.7 to V-3.8, V-4.10, and FF-5). At the same time, MP1 informed the MC of the overwing fairing fire indication and began to perform the applicable procedures to extinguish the fire, to include activating the main fire suppression system in the left overwing fairing (Tabs J-67, V-2.7 to V-2.8, V-2.11, V-3.7 to V-3.8, V-4.10, and FF-5).

At 0914:33L, the Engine 2 fire light illuminated in the cockpit, and one second later, the Engine 1 fire light illuminated (Tabs J-67, V-1.7 to V-1.8, V-1.12, V-3.8 to V-3.9, V-4.10 to V-4.11, and FF-5). MP2 then began a climb from the low altitude environment by selecting maximum augmented thrust on all four engines (Tabs J-67, V-1.7 to V-1.8, V-2.7, V-3.8, and V-4.9). Then, in response to the Engine 1 and 2 fire warning lights, MP1 initiated procedures to shut down Engine 1 and Engine 2, IAW technical order (T.O.) procedures (Tabs V-3.8, V-3.12, V-3.18, and T.O. 1B-1B-1). MP2 announced the MA had passed the minimum safe altitude for the airspace, and MP2 continued to climb in anticipation of returning to Ellsworth AFB (Tab V-3.8 and V-4.9). Approximately 30 seconds after the first attempt to extinguish the fire in the left overwing fairing, MP1 activated the reserve fire suppression system (Tab V-3.14). MP1 then called for a turn toward Ellsworth AFB (Tab V-1.8 and V-2.7). MC2 put Ellsworth AFB in the navigation system, and MP2 began a left turn (Tabs J-67, V-1.8, V-2.7, and V-3.8 to V-3.9). The Engine 1 fire light turned off, but the left overwing fairing fire light and the Engine 2 fire light remained illuminated (Tab V-3.8 to V-3.9 and V-4.11).

At approximately 0916L a second explosion occurred and the cockpit of the MA lost all electrical power (Tabs V-1.8 to V-1.9, V-2.7, V-3.9, V-3.13, V-4.11, and FF-7). The nose of the MA pitched down, and the MA experienced an uncommanded left roll (Tab V-2.9, V-3.9, and V-4.12). MP1 called for ejection IAW T.O. guidance for the complete loss of electrical power (Tabs V-1.8 to V-1.9, V-2.7, V-3.15, V-4.14, and T.O. 1B-1B-1). MP1 and MP2 prepared for ejection by pulling the ejection handles on their seats, which initiated the ejection sequence for the MC (Tab V-3.9, V-3.15, and V-4.13). The MC ejected from the MA at approximately 10,700 feet MSL (7,377 feet AGL) and .74 Mach (400 Knots Equivalent Airspeed) (Tabs H-12 and FF-7). All four crewmembers ejected safely and sustained non-life threatening injuries (Tabs H-2, H-12 to H-13, V-1.9 to V-1.11, V-2.10, V-2.12 to V-2.14, V-3.14 to V-3.16, V-4.13 to V-4.16, and X-3 to X-4).

A timeline built from Integrated Data Acquisition Recorder System (IDARS) data, witness testimony, and post-mishap technical reports is included in Tab FF (Tab FF-4 to FF-7). Key points from the timeline are summarized in Table 1 below.

Local Time	Event
0856:50	MA departs Ellsworth AFB
0905:42	MP2 reduces engine thrust to idle
0905:44	MP2 initiates wing sweep
0906:14	MA develops undetectable fuel leak, left overwing fairing
0906:37	MP2 advances throttle to military power
0914:26	Leaking fuel ignites; MP2 moves to intermediate power setting
0914:30	MP1 activates main fire suppression system in left overwing fairing
0914:32	MP2 initiates climb to 10,000 feet MSL
0915:00	MP1 activates reserve fire suppression system in left overwing fairing
0915:59	Detonation of fuel vapors in Tank 1D, Tank 2A, Tank 2B and Tank 4
0916:00	Last data recorded, all power lost in aircraft
0916:07	Crew ejection

Table 1. Summary of Mishap Timeline (Tab FF-4 to FF-7).

e. Impact

The MA impacted the ground at approximately 0916L (Tabs J-67 and FF-7). Debris from the MA spread over a 17-mile area of privately owned, grass-covered pastureland within the MOA, approximately 24 miles east of Broadus, MT (Tab J-53 and J-71). Distinct groups of MA parts were found along a path generally headed in a northwesterly direction, which eventually changed to a southeasterly direction (Tab J-71 to J-72). The debris spanned Site 1 to Site 7 in Figure 1 (Tab J-54). The forward portion of the MA separated and impacted approximately 1.5 miles from the main crash site (see Figure 1) (Tabs H-7, J-54, and J-72).

At the time the MC ejected, the MA was at approximately 10,700 feet MSL, making a left hand turn, and in a slight descent (Tabs H-12, J-68, and V-3.9). The exact configuration and flight parameters of the MA at the time of impact are unknown because data from IDARS concerning the moments immediately prior to impact could not be recovered (Tabs H-12, J-67, and L-2 to L-5). Electrical power to IDARS was lost prior to ejection (Tabs H-12, J-67, L-2 to L-5, V-1.8 to V-1.9, V-2.7, V-3.9, V-3.13, and V-4.11).

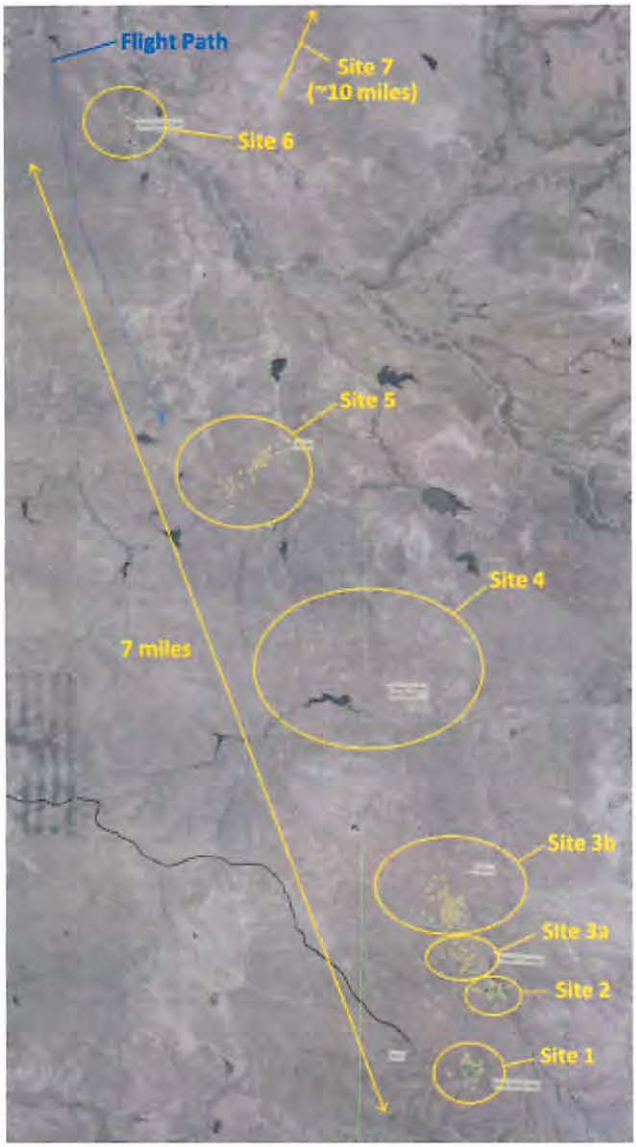

Figure 1. Crash Sites (Tab J-53 to J-64).

SITE 1: Wing carry-through box structure, wings, main landing gear, engine nacelles, engines, and aft fuselage (Tabs J-61 to J-64 and Z-3 to Z-13)

SITE 2: Forward equipment bay, cockpit, nose landing gear, and central equipment bay (Tabs J-61 and Z-13 to Z-14)

SITE 3A: Bottoms of Tanks 2A and 2B, nose radome, crew entry ladder, and pieces of intermediate weapons bay doors (Tabs J-60 and Z-15 to Z-17)

SITE 3B: Sections of intermediate weapons bay and Tank 2 side walls, approximately 15 feet of tunnel bay above intermediate weapons bay, and pieces of intermediate weapons bay doors (Tab J-59)

SITE 4: Ejection seats, escape hatches, refueling tube from Tank 2, and an access panel from the tunnel bay above Tank 3 (Tab J-58)

SITE 5: Tops of Tanks 2A and 2B, numerous frames from Tanks 2A and 2B, and pieces comprising a section from the top of Tank 1D (Tabs J-56 to J-57 and Z-17 to Z-18)

SITE 6: Aft half of panel from the left overwing fairing (Tab J-55 to J-56)

SITE 7: Overwing fairing bumper, bottom of left aft nacelle, and the left aft overwing fairing (Tab J-55)

f. Egress and Aircrew Flight Equipment

The MC successfully ejected within the performance parameters of the Advanced Concept Ejection Seat II (Tab H-2 and H-12 to H-13). The ejection occurred at approximately 10,700 feet MSL (7300 feet AGL) and .74 Mach (400 KEAS), which places the ejection sequence near the boundary between the Mode II to Mode III (see Chart 1) (Tab H-6 and H-12 to H-13). In Mode III, once the seat drogue chute deploys, the deployment of the personnel recovery parachute is delayed until the conditions (altitude and airspeed) of Mode II are satisfied (Tab H-7).

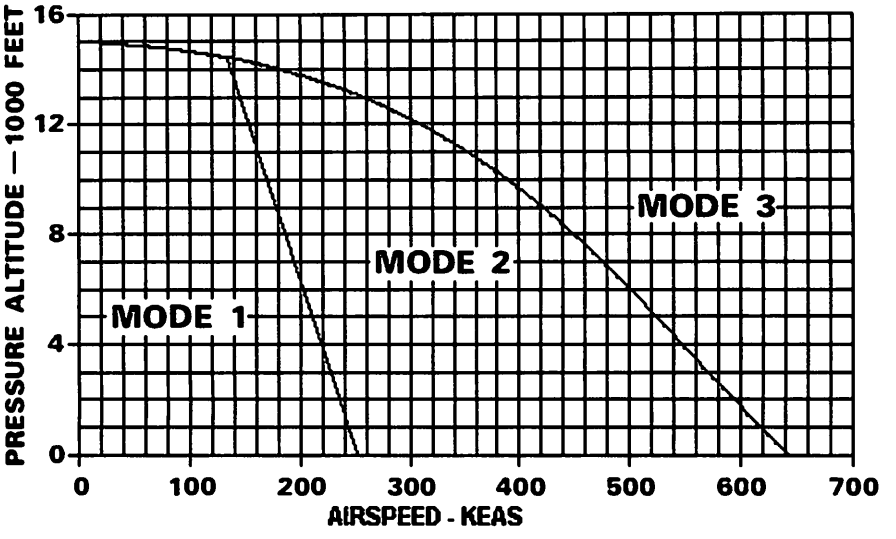

Chart 1. Digital Recover Sequencer Mode Selection Criteria (Tab H-6).

The MC landed within 2,000 feet of each other and approximately three miles north of the main impact site (Tab H-8). MP2 injured his left knee during ejection, possibly because the leg restraints failed to retract fully (Tab H-13). The left leg restraints on both forward ejections seats had not been properly installed during maintenance performed in August 2012 (Tab H-6, H-10, and H-13). In addition, the leg restraint shear rivets failed at loads lower than designed due to improper fabrication (Tab J-136).

The aircrew flight equipment inspections were all current (Tabs H-18 and FF-3). The MC had current training in aircrew flight equipment and wore their equipment properly (Tabs H-18, T-3 to T-5, V-1.9, V-2.10, V-4.13, and FF-3). The helmets of all four crewmembers came off during the ejection sequence (Tabs H-18 to H-19 and V-4.14). Although the helmets appeared to be properly configured, each helmet had multiple failures, likely caused by windblast during the ejection sequence (Tabs H-19, J-174, and J-198 to J-214).

Three of the MC's personal locator beacons transmitted as designed. One beacon did not transmit because the battery was dead (Tab H-21). The ejection survival kits appeared to be properly serviced and configured (Tabs H-21 to H-22). The MC used the following items from the kits: (1) water, (2) PRC-90 survival radios, (3) flares and pen gun flares, (4) life rafts (used for shade), (4) knife, (5) wool glove, and (6) signal mirror (Tabs R-4, R-6, R-10, H-21 and H-22, V-1.10, V-2.12 to V-2-13, and V-3.16).

g. Search and Rescue

Shortly after the MA impacted the ground (approximately 0916L), the Denver Air Route Traffic Control Facility contacted the second B-1B flying in the Powder River MOA to provide notification of an explosion in southeast Montana observed on satellite (Tabs J-67, N-3, and FF-7). MP1 and MC2 also contacted the airborne B-1B's crew and informed them that the MC had ejected (Tab V-1.10, V-2.12, and V-3.16). The remaining airborne B-1B crew became the initial

on-scene commander (Tab V-1.10 and V-3.16). MP2 and MC2, who were physically separated from each other, contacted the operations desk at 34 BS to inform the squadron of the situation and to initiate recovery efforts (Tab V-1.9, V-2.12, and V-3.16). The point of contact at 34 BS advised MC2 to call local emergency services (Tab V-1.10). Two local ranchers approached the MC to assist with medical needs (Tab V-1.10, V-2.13, V-3.16, and V-4.16). Both ranchers remained with the MC until two ambulances arrived approximately two hours after MP2's initial call to local emergency services (Tab V-1.11, V-2.13, V-3.17, and V-4.16). The two-hour delay resulted from the MC's remote location (Tab V-1.10). All crewmembers were transported by ambulance to nearby hospitals to be treated for their injuries (Tabs V-1.1, V-1.11, V-2.13, V-2.14, and X-3 to X-4).

h. Recovery of Remains

There were no fatalities during the mishap.

5. MAINTENANCE

a. Forms Documentation

(1) General Definitions

Air Force maintenance and inspection histories are documented through Air Force Technical Order (AFTO) 781 series forms and the Integrated Maintenance Data System (IMDS). In addition to scheduling and documenting routine maintenance actions, these tools allow aircrew to report discrepancies and maintenance personnel to document actions taken to resolve any reported discrepancy (T.O. 00-20-1).

AFTO 781 series forms are divided into active forms and inactive forms. The active forms are those currently in use by maintenance personnel to record aircraft inspections, conditions, and repair actions. The inactive forms consist of historical forms, but all unresolved discrepancies are moved onto the active forms (T.O. 00-20-1).

Time Compliance Technical Orders (TCTOs) are used to process aircraft system changes (e.g., parts upgrades), which must be accomplished within a specific timeframe, depending on the severity of the issue as indicated by the TCTO. A TCTO may also direct inspections or adjustments to parts or equipment already installed on aircraft. Time change items are routine maintenance actions involving the removal and replacement of parts at a given interval (e.g., flight hours, engine operating hours, engine cycles, calendar days) (T.O. 00-5-1 and T.O. 00-5-15).

(2) Documentation Review

A review of the MA's IMDS information, maintenance logbooks, and active and inactive AFTO 781 series forms did not reveal any issues that contributed to the mishap. There were no significant recurring maintenance issues.

(a) Active Forms

The physical AFTO 781 forms binder was on the MA at the time of the mishap, was not recovered, and is presumed lost. Thus, the most recent forms could not be reviewed. The physical AFTO 781 series forms that remained at Ellsworth AFB had a few documentation errors, none of which contributed to the mishap (Tabs D-3 to D-22 and GG-6).

On 19 August 2013, there were seven open discrepancies in the active AFTO 781 series forms (Tab D-3 to D-22). None of the open discrepancies contributed to the mishap. The ejection seat for MC1 had a waiver for an overdue inspection (Tab D-4). All other inspection items were current, and there were no TCTOs or time change items pending that were relevant to the mishap (Tabs D-3 to D-22 and GG-5 to GG-6).

Maintenance personnel completed the preflight inspection prior to 0600L on 19 August 2013, documenting the inspection on the physical AFTO 781 and placing it on the MA (Tab V-5.6, V-6.5, V-7.4, and V-8.2). The preflight inspection remained valid for 72 hours (T.O. 1B-1B-6). The Exceptional Release was completed at 0600L, indicating the MA had a valid preflight inspection and had been released for takeoff (Tabs R-15, R-21, V-9.4 to V-9.5, and V-11.3 to V-11.4; T.O. 00-20-1).

(b) Inactive Forms

The MA's inactive AFTO 781 series forms had several documentation errors; however, none of the errors contributed to the mishap (Tab GG-5 to GG-6). The MA's 12-month historical files, including TCTOs, AFTO Form 95's (*Significant Historical Data Form*), major inspection packages, and archived IMDS data, revealed nothing relevant to the cause of the mishap (Tab GG-5 to GG-6).

b. Inspections

Maintenance personnel conducted inspections on the MA according to schedule and documented the inspections IAW applicable T.O.s. All inspections were completed satisfactorily (Tab GG-5 to GG-6). At the time of the mishap, there were no past-due inspections (Tab GG-5 to GG-6).

(1) Aircraft Inspections

Isochronal (ISO) inspections are scheduled based on flying hour utilization rates in specific calendar periods. The B-1B has a 900-hour ISO inspection cycle (T.O. 1B-1B-6). The MA underwent a routine 1,800-hour major ISO inspection on 19 March 2013 when the MA reached 8,300 flying hours (Tab GG-5). The overwing fairing cavity was inspected as part of the major ISO inspection, and deficiencies were corrected, to include sheet metal repairs, replacement of minor parts (e.g., cotter pins, chafe wrap), and fire bottle line repairs (Tabs V-12.3 to V-12.5, V-16.2 to V-16.4, V-17.2 to V-17.4, and GG-5). At the time of the mishap, the MA was scheduled to begin a 60-month Programmed Depot Maintenance on 9 September 2013 (Tab GG-5).

Prior to 0600L on 19 August 2013, maintenance personnel concluded the last minor inspection on the MA—a preflight inspection that lasted approximately five hours (Tabs V-5.5 to V-5.6 and

GG-5 to G-6). The preflight inspection includes fluid servicing, inlet and exhaust inspection, and a complete walk around inspection of the aircraft for panel and fastener security (T.O. 1B-1B-6). The overwing fairings were checked as part of the preflight inspection (Tabs R-12, V-8.2 to V-8.4, and V-8.6 to V-8.7). The preflight inspection does not require a specific check of the fold down baffles to ensure proper attachment or function (T.O. 1B-1B-6). The preflight inspection was valid at the time the MA departed Ellsworth AFB (Tabs J-66 and FF-4; T.O. 1B-1B-6).

The IMDS data confirmed that, with the exception of the inspection for MC1's ejection seat check (which had a waiver), all inspections were accomplished IAW applicable maintenance directives (Tab GG-5).

(2) Engine Inspections

Maintenance personnel visibly inspect the B-1B engine inlets and exhausts before and after every flight (Tab GG-6; T.O. 1B-1B-6). In addition, the engines are inspected before and after every engine maintenance run. Each engine also requires an inspection every 100, 200, and 300 flight hours (Tab GG-6; T.O. 00-20-1). All engine inspections were current for the MA at the time of the mishap (Tab GG-5 to GG-6).

Engine components and modules have limited lifetimes that are tracked by engine operating time and cycles (Tabs J-2; T.O. 00-20-1). IMDS did not show any modules or components due for time change at the time of the mishap (Tab GG-5).

c. Maintenance Procedures

AFTO 781 series forms and IMDS reflect all maintenance actions conducted on an aircraft's systems and subsystems (T.O. 00-20-1). Aside from a few minor documentation discrepancies, which were not causal to the mishap, all maintenance procedures on the MA were performed IAW applicable T.O.s and AFIs (Tab GG-5 to GG-6).

d. Maintenance Personnel and Supervision

Maintenance procedures are specific to Air Force Specialty Code and consistent with the member's Career Field Education and Training Plan, require personnel to be trained and qualified on: theory of operations, system schematics, isolation of malfunctions, performance of operational checks, and parts removal and installation, (AFI 36-2232, *Maintenance Training*, 22 February 2006, Incorporating Change 1, 21 June 2010, Attachment 1). Training and qualifications for maintenance personnel are tracked and monitored electronically in the Training Business Area system (AFI 36-2232, Chapter 4).

All personnel assigned to the 28th Maintenance Group, Ellsworth AFB, who maintained the MA were qualified (Tab GG-6). The training records (i.e., AF Forms 623, *Individual Training Record Folder,* and AF Forms 797, *Job Qualification Standard Continuation/Command JQS*), and special certification rosters (i.e., staff progress records and staff certification records) for all personnel performing maintenance on the MA reflected proper training and full qualifications on all tasks accomplished (Tab GG-6). The operations supervision engaged with maintenance

leadership on a daily basis and saw no issues with maintenance practices and procedures (AFI 21-101, *Aircraft and Equipment Maintenance Management*, 26 July 2010, incorporating Change 1, 16 August 2011, including Air Force Guidance Memorandum 4, 19 April 2013, paragraph 3.2.1; Tab K-6 to K-8).

There was no evidence that the actions or omission of actions of maintenance personnel or supervision substantially contributed to the mishap.

e. Fuel, Hydraulic, and Oil Inspection Analyses

Following the mishap, fuel samples were taken from the fuel tank that supplied fuel to the MA (Tab U-4 to U-7). These samples were tested at Wright Patterson AFB, Ohio (OH) (Tab U-4 to U-7). The fuel analysis report shows the fuel used on the MA met specification requirements (Tabs U-4 to U-7 and GG-6).

Hydraulic fluid and oil samples taken post-mishap were sent to Mid-Continent Testing Laboratories for analysis (Tab U-8 to U-21). The hydraulic fluid and oil analyses reported high on water content but were within the acceptable operating standards (Tab U-8 to U-21 and GG-6).

No fluid samples were taken from the MA post-accident.

There was no evidence that abnormalities in the fuel, hydraulic fluid, or oil contributed to the mishap.

f. Unscheduled Maintenance

Review of the 90-day history in IMDS and historical AFTO 781 series forms reflected numerous unscheduled maintenance actions, including structural repairs and part replacement. Maintenance members completed the corrective actions for all of the unscheduled maintenance items (Tab GG-5 to GG-6).

There was no evidence that unscheduled maintenance contributed to the mishap.

6. AIRFRAME SYSTEMS

a. Structures and Systems

Figure 1 details the location of debris from the MA. Upon impact at Site 1, the main portion of the MA disintegrated, resulting in the immediate release of the remaining fuel and other combustibles (Tabs J-61 to J-64, J-72, and Z-3 to Z-13). Burning at the north end of Site 1, where the wings and main carry-through box impacted, was more intense than at the south end (Tab J-72). The fires self-extinguished because of the remote location of the crash site (Tab J-72).

The maintenance history of the components reflect nothing different from post-mishap analyses (Tabs J-2, J-81, J-107 and GG-5 to GG-6).

(1) Overwing Fairing

The overwing fairings are located at the left and right wing roots—the connection point between the body of the aircraft and the wing (T.O. 1B-1B-2-27GS-00-1). The purpose of the overwing fairings is to reduce turbulent airflow between the wing and fuselage surfaces (T.O. 1B-1B-2-27GS-00-1). The fairings accommodate contour changes from the varying wing sweep angles and deflections from aerodynamic loads (T.O. 1B-1B-2-27GS-00-1). The cavities formed by the overwing fairings contain the main engine fuel feed lines, fuel cooling loop lines, fuel cooling blower, fire detection loops, multiple aircraft wire harnesses and hydraulic lines (T.O. 1B-1B-2-27GS-00-1).

The overwing fairings are positioned up during ground operations, providing airflow for the fuel cooling blowers and auxiliary power units (1B-1B-2-27GS-00-1). The fairings shift from ground mode to airborne mode when airspeeds exceed 60 knots (1B-1B-2-27GS-00-1). When the wings are swept between 15 degrees and 61 degrees in flight, the overwing fairings are held in the down position (1B-1B-2-27GS-00-1). At wing sweep positions greater than 61 degrees, the fairings move automatically in response to wing flex (1B-1B-2-27GS-00-1). The fairings automatically open when the airspeed is less than 60 knots (1B-1B-2-27GS-00-1).

The outer edges of the overwing fairings have forward and aft inflatable seals, ensuring that gaps between the wings and the overwing fairings are minimized to reduce aerodynamic drag (1B-1B-2-27GS-00-1). The gap between the bottom of the wing and the nacelle also has an inflatable seal (T.O. 1B-1B-2-53GS-00-1).

The lower seal is attached to left and right nacelle, which contain the engines, auxiliary power units, hydraulic pumps, accessory drive gearboxes, and other aircraft systems (T.O. 1B-1B-2-53GS-00-1). It seals the bottom surface of the wing when the wings are swept back (T.O. 1B-1B-2-53GS-00-1). When the wings are swept forward, the seal and the underwing fold down baffle form the underwing fairing, working together to seal the cavity above the nacelle (T.O. 1B-1B-2-53GS-00-1 and T.O. 1B-1B-2-54GS-00-1). The fold down baffle, which is manufactured by the Boeing Company, is broad at the front and tapers to an acute, v-shaped angle at the aft end (see Figure 2) (Tab U-24 to U-25). Two mandrel spring assemblies, also manufactured by the Boeing Company, provide positive pressure against the fold down baffle to keep the seal in place (Tab U-23 and U-25; T.O. 1B-1B-2-54GS-00-1).

See Figure 2 for a depiction of the overwing fairing.