SUMMARY OF FACTS AND STATEMENT OF OPINION
F-16C, T/N 92-003886
22 JULY 2012

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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.

COMMONLY USED ACRONYMS AND ABBREVIATIONS

5 AF	5th Air Force
AAR	Air-to-Air Refueling
ACMI	Advanced Combat Maneuvering Instrumentation Pod
AD	Active Duty
ADG	Accessory Drive Gearbox
AF	Air Force
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFPAM	Air Force Pamphlet
AFTO	Air Force Technical Order
AIB	Aerospace Accident Investigation Board
AK	Alaska
AMU	Aircraft Maintenance Unit
AOS	Air Operations Squadron
ATP	Advanced Targeting Pod
BPO/PRE	Basic Post Flight/Pre-Flight
Capt	Captain
CAF	Combat Air Forces
CMR	Combat Mission Ready
Col	Colonel
CSMU	Crash Survivable Memory Unit
DCO	Delivery Control Officer
DoD	Department of Defense
EEC	Engine Electric Control
FFT	Fuel Flow Transmitter
FL	Flight Lead
FLCS	Flight Control System
FOD	Foreign Objects and Debris
FRC	Fault Reporting Codes
FS	Fighter Squadron
FW	Fighter Wing
g	Gravitational Force
GCMS	Gas Chromatograph/Mass Spectrometry
GPS	Global Positioning System
HUD	Heads up Display
IAT	Individual Aircraft Tracking
IAW	In Accordance With
IMDS	Integrated Maintenance Data System
IP	Instructor Pilot
IVSC	Integrated Vehicle Subsystem Controller
JBER	Joint Base Elmendorf-Richardson
JPC	Joint Pathology Center
K	Thousand
KCAS	Knots Calibrated Airspeed
KTAS	Knots True Airspeed
kts	Knots
L	Local Time
LM-Aero	Lockheed Martin Aeronautics Company
Lt Col	Lieutenant Colonel
M	Mach
MA	Mishap Aircraft
Maj	Major
MAJCOM	Major Command
MDEC	Modified Digital Engine Control
MP	Mishap Pilot
MS	Mishap Sortie
MSL	Mean Sea Level
NM	Nautical Miles
NOTAMs	Notices to Airmen
OAP	Oil Analysis Program
OBOGS	On-board Oxygen Generating System
OCS	On-Scene Commander
OG	Operations Group
ONE	Operation Nobel Eagle
Ops Tempo	Operations Tempo
ORM	Operational Risk Management
OSS	Operation Support Squadron
OTI	One Time Inspection
PA	Public Affairs
PACAF	Pacific Air Forces
PF	Pre-Flight
PHA	Physical Health Assessment
QC	Quality Check
RTB	Return-To-Base
SAR	Search and Rescue
SEFE	Standardization and Evaluation Flight Examiner
SII	Special Interest Item
SM	Statute Mile
SOF	Supervisor of Flying
TCTO	Time Compliance Technical Order
T/N	Tail Number
TOD	Tech Order Data
VDC	Volts Direct Current
VMC	Visual Meteorological Conditions

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

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SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 17 August 2012, General Herbert J. Carlisle, Commander PACAF appointed Colonel Terry Scott to conduct an aircraft accident investigation of the 22 July 2012 mishap of an F-16C Fighting Falcon aircraft, tail number (T/N) 92-003886, at Misawa Air Base (AB), Japan (Tab Y1). The F-16C aircraft accident investigation was conducted in accordance with Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, Chapter 11, at Misawa Air Base, Japan, from 8 October 2012 through 20 October 2012. The following board members were also appointed: Medical Member (MDM), Legal Advisor (LA), Pilot Member (PM), Maintenance Member (MXM), and Recorder (REC) (Tabs Y2, Y3).

b. Purpose

This is a legal investigation convened to inquire into the facts surrounding the aircraft or aerospace 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. In addition to setting forth facts concerning the accident, the board president is also required to state his opinion as to the cause of the accident or the existence of factors, if any, that substantially contributed to the accident. This investigation is separate and apart from the safety investigation, which is conducted pursuant to AFI 91-204 for the purpose of mishap prevention. The report is available for public dissemination under the Freedom of Information Act (5 United States Code (U.S.C.) § 552) and AFI 37-131.

2. ACCIDENT SUMMARY

On 22 July 2012 at approximately 1109 hours local time (L), the MA, an F-16C T/N 92-003886, assigned to the 14th Fighter Squadron, 35th Fighter Wing, Misawa Air Base, Japan, crashed during a transoceanic mission and impacted the ocean at N 4633.3, E 15631.4 (Tab N1.1). Jest 73, the MP, ejected safely into the Pacific Ocean. The aircraft disintegrated upon impact with the loss valued at $32,610,492.34 (Tab P3). At the time of the mishap, there were several small news items related to the crash but there has been no continuing media interest since then (Tab DD1, DD2).

3. BACKGROUND

The MA belonged to the 14th Fighter Squadron, 35th Fighter Wing, 5th Air Force, Pacific Command, stationed at Misawa Air Base, Japan (Tab CC1 through CC5).

a. MAJCOM: Pacific Air Forces (PACAF)

PACAF's primary mission is to provide U.S. Pacific Command integrated expeditionary Air Force capabilities to defend the homeland, promote stability, dissuade/deter aggression, and swiftly defeat enemies.

The command's vision is to bring the full power of America's Air Force and the skill of its Airmen to promote peace and stability in the Asia-Pacific region.

PACAF's area of responsibility extends from the west coast of the United States to the east coast of Africa and from the Arctic to the Antarctic, covering more than 100 million square miles. The area is home to 50 percent of the world's population in 36 nations and over one-third of the global economic output. The unique location of the Strategic Triangle (Hawaii-Guam-Alaska) gives our nation persistent presence and options to project U.S. airpower from sovereign territory (Tab CC1).

b. NAF: Fifth Air Force (5 AF)

Defend Japan, enhance interoperability, maximize reception, staging, onward movement & integration capabilities, and conduct humanitarian assistance/disaster relief operations.

Our coalition operations with the Japan Air Self-Defense Force send a clear message every day that U.S. forward presence is robust, ready and prepared to meet current and future challenges in the region. This strong partnership stems from over 50 years of bilateral operations and long-term relationships. Enduring presence in Japan has been key to the development of this association.

The key to Fifth Air Force's presence is the frontline air bases spanning Japan from north to south (Tab CC2).

c. Wing: 35th Fighter Wing (35 FW)

The wing's mission is to protect U.S. interests in the Pacific and assist in the defense of Japan with sustained forward presence, worldwide deployable forces, and focused mission support.

The 35 FW employs two squadrons of the Block 50 model F-16CJ Fighting Falcon. The wing conducts daily F-16 flight training to maintain its combat readiness edge. Its pilots fly air-to-air weapons delivery exercises over water and sharpen their air-to-ground skills using the Draughon Range located 12 miles north of Misawa.

In addition to its flight training schedule, the wing holds quarterly local operational readiness exercises, which allow its people to concentrate training on war fighting skills essential for readiness. The 35 FW also maintains its readiness by participating in Pacific Air Forces-sponsored exercises, including RED FLAG-Alaska, COPE TAUFAN in Malaysia, and COMMANDO SLING in Singapore. The wing also participates in other joint and bilateral exercises, such as NORTHERN EDGE in Alaska and KEEN SWORD in Japan.

Additionally, the wing has continually supported the War on Terror, including two deployments of F-16s and personnel in support of ENDURING and IRAQI FREEDOM in 2007 (Tab CC3).

d. Squadron: 14th Fighter Squadron (14 FS)

Provides operational support to the 35th Operations Group (Tab CC4).

e. Aircraft: F-16C – Fighting Falcon

Mission
The F-16 Fighting Falcon is a compact, multi-role fighter aircraft. It is highly maneuverable and has proven itself in air-to-air combat and air-to-surface attack. It provides a relatively low-cost, high-performance weapon system for the United States and allied nations.

Features
In an air combat role, the F-16's maneuverability and combat radius (distance it can fly to enter air combat, stay, fight and return) exceed that of all potential threat fighter aircraft. It can locate targets in all weather conditions and detect low flying aircraft in radar ground clutter. In an air-to-surface role, the F-16 can fly more than 500 miles (860 kilometers), deliver its weapons with superior accuracy, defend itself against enemy aircraft, and return to its starting point. An all-weather capability allows it to accurately deliver ordnance during non-visual bombing conditions.

In designing the F-16, advanced aerospace science and proven reliable systems from other aircraft such as the F-15 and F-111 were selected. These were combined to simplify the airplane and reduce its size, purchase price, maintenance costs and weight. The light weight of the fuselage is achieved without reducing its strength. With a full load of internal fuel, the F-16 can withstand up to nine G's -- nine times the force of gravity -- which exceeds the capability of other current fighter aircraft.

The cockpit and its bubble canopy give the pilot unobstructed forward and upward vision, and greatly improved vision over the side and to the rear. The seat-back angle was expanded from the usual 13 degrees to 30 degrees, increasing pilot comfort and gravity force tolerance. The pilot has excellent flight control of the F-16 through its "fly-by-wire" system. Electrical wires relay commands, replacing the usual cables and linkage controls. For easy and accurate control of the aircraft during high G-force combat maneuvers, a side stick controller is used instead of the conventional center-mounted stick. Hand pressure on the side stick controller sends electrical signals to actuators of flight control surfaces such as ailerons and rudder.

Avionics systems include a highly accurate enhanced global positioning and inertial navigation systems, or EGI, in which computers provide steering information to the pilot. The plane has UHF and VHF radios plus an instrument landing system. It also has a warning system and modular countermeasure pods to be used against airborne or surface electronic threats. The fuselage has space for additional avionics systems.

Background

The F-16A, a single-seat model, first flew in December 1976. The first operational F-16A was delivered in January 1979 to the 388th Tactical Fighter Wing at Hill Air Force Base, Utah.

The F-16B, a two-seat model, has tandem cockpits that are about the same size as the one in the A model. Its bubble canopy extends to cover the second cockpit. To make room for the second cockpit, the forward fuselage fuel tank and avionics growth space were reduced. During training, the forward cockpit is used by a student pilot with an instructor pilot in the rear cockpit.

All F-16s delivered since November 1981 have built-in structural and wiring provisions and systems architecture that permit expansion of the multirole flexibility to perform precision strike, night attack and beyond-visual-range interception missions. This improvement program led to the F-16C and F-16D aircraft, which are the single- and two-place counterparts to the F-16A/B, and incorporate the latest cockpit control and display technology. All active units and many Air National Guard and Air Force Reserve units have converted to the F-16C/D.

The F-16 was built under an unusual agreement creating a consortium between the United States and four NATO countries: Belgium, Denmark, the Netherlands and Norway. These countries jointly produced with the United States an initial 348 F-16s for their air forces. Final airframe assembly lines were located in Belgium and the Netherlands. The consortium's F-16s are assembled from components manufactured in all five countries. Belgium also provides final assembly of the F100 engine used in the European F-16s. Recently, Portugal joined the consortium. The long-term benefits of this program will be technology transfer among the nations producing the F-16, and a common-use aircraft for NATO nations. This program increases the supply and availability of repair parts in Europe and improves the F-16's combat readiness.

USAF F-16 multirole fighters were deployed to the Persian Gulf in 1991 in support of Operation Desert Storm, where more sorties were flown than with any other aircraft. These fighters were used to attack airfields, military production facilities, Scud missiles sites and a variety of other targets.

During Operation Allied Force, USAF F-16 multirole fighters flew a variety of missions to include suppression of enemy air defense, offensive counter air, defensive counter air, close air support and forward air controller missions. Mission results were outstanding as these fighters destroyed radar sites, vehicles, tanks, MiGs and buildings.

Since Sept. 11, 2001, the F-16 has been a major component of the combat forces committed to the Global War on Terrorism flying thousands of sorties in support of operations Noble Eagle (Homeland Defense), Enduring Freedom in Afghanistan and Iraqi Freedom.

General Characteristics
Primary Function: Multirole fighter
Contractor: Lockheed Martin Corp.
Power Plant: F-16C/D: one Pratt and Whitney F100-PW-200/220/229 or General Electric F110-GE-100/129
Thrust: F-16C/D, 27,000 pounds
Wingspan: 32 feet, 8 inches (9.8 meters)
Length: 49 feet, 5 inches (14.8 meters)
Height: 16 feet (4.8 meters)
Weight: 19,700 pounds without fuel (8,936 kilograms)
Maximum Takeoff Weight: 37,500 pounds (16,875 kilograms)
Fuel Capacity: 7,000 pounds internal (3,175 kilograms); typical capacity, 12,000 pounds with two external tanks (5443 kilograms)
Payload: Two 2,000-pound bombs, two AIM-9, two AIM-120 and two 2400-pound external fuel tanks
Speed: 1,500 mph (Mach 2 at altitude)
Range: More than 2,002 miles ferry range (1,740 nautical miles)
Ceiling: Above 50,000 feet (15 kilometers)
Armament: One M-61A1 20mm multibarrel cannon with 500 rounds; external stations can carry up to six air-to-air missiles, conventional air-to-air and air-to-surface munitions and electronic countermeasure pods
Crew: F-16C, one; F-16D, one or two
Unit cost: F-16A/B , $14.6 million (fiscal 98 constant dollars); F-16C/D,$18.8 million (fiscal 98 constant dollars)
Initial operating capability: F-16A, January 1979; F-16C/D Block 25-32, 1981;
F-16C/D Block 40-42, 1989; and F-16C/D Block 50-52, 1994
Inventory: Total force, F-16C/D, 1018 (Tab CC5)

4. SEQUENCE OF EVENTS

a. Mission

The mishap sortie (MS) was scheduled as a 5-ship deployment sortie in the second cell of Coronet West 553 from Misawa AB, Japan (RJSM) to Eielson AFB, Alaska (PAEI) on 22 July 2012 (Tab K1.1). For maintenance reasons the mishap flight (MF) stepped as a 4-ship (Tab R2.2). The flight lead (FL) from the first cell ground aborted his aircraft and took the FL position, Jest 71, in the second cell, the MF (Tab V1). Jest 74 aborted his aircraft prior to takeoff, leaving the MF as a 3-ship with the Mishap Pilot (MP) as Jest 73. The MF became a 4-ship after takeoff when an aircraft, Jest 66, from the first cell rendezvoused while correcting a minor fuel malfunction (Tab V1). The Pacific Air Forces Commander (PACAF/CC) approved the MS.

b. Planning

Two days prior to mission execution the MF attended the Mission Brief given by the Delivery Control Officer (DCO) where they received mission products of altitude reservations, computer generated flight plans, charts, air refueling abort data, tanking plans, and other details required to safely execute the mission (Tab V1, V3). In addition, the 13 FS consolidated airfield divert information along the route onto a manageable sized map for the cockpit (Tab K1). After the Mission Brief, Jest 71 briefed all flight coordination in accordance with AFI 11-202v3, *General Flight Rules,* 22 October 2010 and AFI 11-2F-16v3, *F-16 Operations Procedures,* 18 February 2010, using the 35 FW In-Flight Guide general and cross-country briefing guides (Tab V5). The 35 OG/CD, 13 FS/CC, 13 FS/DO, squadron operations supervisor (Top 3), and supervisor of flying (SOF) attended the Mission Brief (Tab V5).

c. Preflight

The MF assembled at the flying squadron at 0615L where they received the Final Briefing from the DCO that covered the weather and Notices to Airmen (NOTAMs) (Tab R2.2, V1). The MF received their Flight Authorizations (Tab K1.7) and a copy of the flight plan filed by the DCO (Tab AA1). At 0745L the MF completed dressing to fly and stepped to their aircraft (Tab V1).

d. Summary of Accident

The MP taxied at 0835L. The MP departed Misawa AB at 0900L in trail of his two flight members and climbed through a few thin layers of clouds before arriving in visual meteorological conditions (VMC) at his cruising altitude of FL250. The MF followed the tanker aircraft northeast towards Alaska while air to air refueling (AAR) four times. After the MP completed his fourth AAR, he started the Trapped External Fuel Checklist for trapped fuel in the Centerline External Fuel Tank (Tab V1). During this checklist the MP reported that MA engine lost thrust, displaying only 70% RPM, and would not respond to throttle inputs (Tab V1). The MP made a radio call to his flight that he had "...loss of thrust, RPM's rolling back" at 11:09:47L (Tab N1.1). Without sufficient thrust to maintain level flight the MA lost altitude and airspeed (Tab V1, V2). In response, the MP jettisoned aircraft stores and attempted to recover thrust via Abnormal or No Engine Response and Airstart checklists (Tab V1, V2, N1.1). Whilst the MP attempted to recover usable thrust, the MA experienced an un-commanded engine shutdown after approximately three minutes at 70% RPM (Tab V1, FF1.1). Unable to recover the unresponsive engine after four attempts, the MP ejected at his minimum ejection altitude (Tab V1, V2).

TO 1-F-16CM-1 Page 1-92 states that:

> [F]uel flows through an electric main fuel shutoff valve which has a full travel time of 2-4 seconds and is controlled by the FUEL MASTER switch (FMS).

TO 1-F-16CM-1 page 1-118 states that:

> The EPU [Emergency Power Unit] automatically activates when both main and standby generators fail or when both hydraulic system pressures fall below 1000 psi.

TO 1-F-16CM-1 Page 1-123 states that:

> After receiving any start command, the EPU requires approximately 2 seconds to come up to speed. EPU startup may not be audible. Once operating, however, the EPU may be heard but does not sound the same as during the EPU ground check.

TO 1-F-16CM-1 Page 3-144 states that:

> If engine does not respond, shut down the engine with the FUEL MASTER switch. At MIL, the engine flames out in approximately 6 seconds. At IDLE, the engine flames out in approximately 45 seconds.

TO 1-F-16CM-1 page 3-147 states that:

> If the engine flames out, fuel starvation or mechanical failure has occurred. A flameout is indicated by a decrease in FTIT and engine rpm decaying below in-flight idle (approximately 70 percent RPM). Loss of thrust and lack of response to throttle movement confirm the flameout. The ENGINE warning light illuminates when engine rpm is below 60 percent. Additionally, the MAIN GEN and STBY GEN lights illuminate below 50 percent rpm and the EPU should start running.

In simulations, starting at FL250 and 310KCAS, the engine flamed out in 9 seconds after FMS - OFF. (TAB FF1). Engine flame out should normally be followed by EPU activation. (TO 1-F-16CM-1, page 3-147). The EPU activates when engine RPMs fall below 50% (TO 1-F-16CM-1, page 3-147). The EPU is only audible in MP radio transmissions after 11:13:24L. (Tab FF1, N1.1). This corroborates the MP statement that the engine maintained 70% RPMs for approximately three minutes after the initial loss of thrust without Engine Warning Light or EPU activation, followed by a complete engine shutdown with the EPU maintaining the reported RPM level at approximately 20%. (Tab FF1).

e. Impact

Aircraft T/N 92-003886 impacted the Pacific Ocean at approximately 1116L on 22 July 2012 near N 4633 E 15631 (Tab N1.1). Upon impact, the aircraft disintegrated and sank (Tab S2).

f. Egress and Aircrew Flight Equipment (AFE)

The MP successfully ejected from the aircraft at 1116L. The ejection was accomplished within the performance envelope of the system and the MP made a radio call that he had "a good chute" at 1117L (Tab N1.1). Upon post flight evaluation of the MP's AFE gear, no deficiencies or malfunctions were noted, except the failure of the AN/URT 44 Emergency Locator Beacon rendering it unusable to the MP (Tab I1, H4.3). All AFE gear inspections were current (Tab H4).

g. Search and Rescue (SAR)

Jest 72 flew in the chase position when the MP ejected and generated accurate coordinates of his position, which he passed to the on-scene commander (OCS) (Tab R2.2). Rummy 21, the tanker, assumed OSC at 1116L when Jest 73 ejected (Tab R1.1). Rummy 21 sent the MP location to Tokyo Center at 1145L (Tab R1.1). Rummy 32 became OSC at 1415L and continued to pass updated coordinates from the MP's Global Positioning System (GPS) unit to other vessels assisting the Search And Rescue (SAR) (Tab R1.1). US container ship, Manukai, diverted to the MP's location with an estimated time of arrival of 1730L (Tab N3.2). At 1452L a Japanese P-3C Orion arrived and began SAR (Tab R1.1). At 1625L, JA501A, and Japanese Gulfstream arrived on station to assist the SAR effort (Tab R1.1). The Hokkou Maru, a Japanese research boat, rescued the MP at 1744L then transferred him to the Manukai at 1758L (Tab R1.1). The captain of the Manukai reported that the MP "appears in good shape" (Tab N3.2). The US Coast Guard met the Manukai near Dutch Harbor, AK, received the MP, and then flew him to Joint Base Elmendorf-Richardson (JBER) for re-integration (Tab N3.2, S2).

h. Recovery of Remains

Not Applicable.

5. MAINTENANCE

a. Forms Documentation

Due to the loss of the active forms in the mishap, the only written forms available are from the aircraft jacket file. The aircraft jacket file contains pulled forms from 20 Apr 2012 to 17 Jul 2012. Analysis of aircraft forms documentation after 17 Jul 2012 can only be done on reports from Integrated Maintenance Data System (IMDS) (Tab U4). There is no maintenance documentation relevant to the accident in any of the forms from the aircraft jacket file. Relevant maintenance documentation exists in Lockheed Martin Field Team Operations F-16 C Model Modification Workbook – OBOGS, BLOS and EGI Modifications, Document No. F001, External Power Operational Checks and Tests. Page 2 of 4, item 22 documents the performance of "operational check of engine fuel shut-off valve actuator assembly" ref. JG28-22-05 on 05 Jun 2012 by stamp FLD TM 058 MECH. Further, Lockheed Martin Field Team Operations F-16 C Model Modification Workbook – OBOGS, BLOS and EGI Modifications, Document No. F001, External Power Operational Checks and Tests page 4 of 4, item 45, "verify area is free of foreign objects and all tools are accounted for," was completed on 07 Jun 2012 by stamp FLD TM 145 MECH and Quality Check (QC) was completed by stamp FLD TM 142 QC (Tab U1).

b. Inspections

Review of AFTO IMT 95, Significant Historical Data, reveals that one 370 gallon external fuel tank, S/N 30358, and one 300 gallon centerline fuel tank, S/N 4439, installed on the MA were overdue required annual inspection. According to AFTO IMT 95 for tank S/N 30358 the last annual 370 gallon tank/pylon inspection was completed on 20 Sept 2010. According to AFTO IMT 95 for tank S/N 4439 the last annual 300 gallon tank inspection was completed on 28 Apr 2010 (Tab U2). Furthermore, an IMDS print out of the AFTO Form 781K from the pulled forms dated 13 July 2012 - 17 July 2012, block C annotates two separate 12 month 370 gallon tank pylon inspection/clean/lube (Tab U3). One inspection was scheduled for 23 Sept 2012 and the other is scheduled for 19 Nov 2012. Neither inspection lists the serial number of the tank that is due inspection. A printed IMDS report documents 300 gallon tank S/N 4439's annual inspection as completed on 23 Aug 2011, which would make it current on its annual inspection (Tab U6). This inspection could not be verified by the 35th Maintenance Operations Squadron, Plans and Scheduling Section due to the fact that all three external tanks from the MA were deleted from IMDS at some point after the mishap and before this investigation.

IMDS report "ACR" lists a 400 hour Aircraft Structural Integrity Program (ASIP) Control Point B5303LA inspection is next due at 4,388.0 airframe hours (Tab U6). The MA recorded 6,379.7 airframe hours before takeoff, a difference of 1991.7 hours. When questioned about the overdue scheduled inspection, 35th Maintenance Operations Squadron, Plans and Scheduling Section provided a report F-16 Individual Aircraft Tracking (IAT) Inspections Aircraft Structural Integrity Program for the MA (Tab U7). The report does not list Control Point B5303LA inspection as completed or as a current inspection required.

A maintenance repair history report from IMDS for the period of 17 Jul 2012 to 27 July 2012 documents the completion of the last Basic Post-Flight(BPO)/Pre-flight inspection on 17 Jul 2012 (Tab U4). This inspection is only valid for 72 hours, in this case until 20 July. Since the aircraft flew on 22 July and there is no record of a more current BPO/Pre-flight this aircraft was overdue its pre-flight inspection by at least 24 hours. Due to the loss of the active forms there is no way to validate that the pre-flight inspection was completed more recently and not documented in IMDS.

Of significant relevance, the last three 100 hour inspections of the engine fuel shutoff valve actuator were completed within the required timeframe. The last 100 hour inspection of the engine fuel shutoff valve actuator was completed on 08 Apr 2012 and was not due for another 91.6 flight hours (Tab U3). Additionally, IMDS reports document the completion of TCTO 1F-16-2522 Main Fuel Shut-Off Valve Configuration, 35FW L98-01 Inspection Main Fuel SOV Control Panel for Corrosion, one time inspection (OTI) of F-16 Main Fuel Shutoff Valve and TCTO 1F-16-1911 Inspection of Main Fuel Shutoff Valve Actuator.

c. Maintenance Procedures

A Service Life Extension Program (SLEP) modification was completed on MA engine F110-129B SN GE0E538441 on 11 Jan 2012 at Tinker Air Force Base. Engine 538441 was installed on the MA 24 April 2012.

Extensive aircraft maintenance was performed on the MA by Lockheed Martin (LM) Aero from 15 May 2012 – 7 Jun 2012. The nature of maintenance performed was installation and modification of or to On Board Oxygen Generating System (OBOGS), Beyond Line of Sight

(BLOS), Modular Mission Computer (MMC) components. This work requires the removal and reinstallation of several electrical system components including circuit breakers and batteries. Follow on maintenance upon completion of contracted modification directs operational check out of the MFSOV in accordance with (IAW) technical order (T.O.) 1F-16CJ-2-28JG-20-2. Lockheed Martin Field Team Operations F-16C Model Modification Workbook – OBOGS, BLOS and EGI Modifications, Document No. F001, External Power Operational Checks and Tests page 2 of 4, item 22 documents the performance of "operational check of engine fuel shut-off valve actuator assembly" ref. JG28-22-05 on 05 Jun 2012 by FLD TM 058 MECH. Furthermore, Lockheed Martin Field Team Operations F-16C Model Modification Workbook – OBOGS, BLOS and EGI Modifications, Document No. F001, External Power Operational Checks and Tests page 4 of 4, item 45, "verify area is free of foreign objects and all tools are accounted for," was completed on 07 Jun 2012 by mechanic stamp 145 and QC was completed by FLD TM 142 QC (Tab U1).

d. Maintenance Personnel and Supervision

After review of available maintenance documentation and AF Forms 623, Individual Training Records, all USAF maintenance personnel were qualified and or certified to complete their respective tasks. The last MFSOV operational checkout was performed by an LM Aero Field Team technician, identified in maintenance documentation by stamp FLD TM 058 MECH, on 05 June 2012. When LM Aero supervision on site at Misawa AB was asked to produce training documentation on maintenance personnel they explained that LM Aero individuals are hired as fully qualified per position requirements. They further explained that LM Aero does not formally maintain training records in the same fashion as USAF. LM Aero did provide USAF Individual Training Plan documentation which was used to determine the qualification of prospective maintenance personnel at the time of hire. The LM Aero Field Team technician that performed the last MFSOV operational checkout was interviewed on 11 October 2012. The objective of the interview was to determine his level of proficency on the task of MFSOV operational checkout. The technician demonstrated a lack of proficiency as indicated below:

1. When asked to sign out tools, T.O.s, and equipment required to perform the MFSOV operational checkout from the 35 MXS Maintenance Flight Support Section, the technician did not sign out Isopropyl Alcohol or Synthetic Water Displacing Lubricant. Reference T.O. 1F16CJ-2-28JG-20-2, SSSN 28-22-05, page v and vi, paragraph 4.

2. Technician correctly identified that aircraft effectivity symbol "2" includes J.C. Carter actuator part number 82359 or 82359-2 however, failed to identify that aircraft effectivity symbol "2" also includes Talley actuator part number 2472T100-1, the part installed on the MA.

3. Technician correctly articulated performance of T.O. 1F16CJ-2-28JG-20-2, SSSN 28-22-05, steps 1 through 22. However, the technician indicated that there were no other steps required to be performed after step 22.

4. Technician incorrectly indicated that T.O. 1F16CJ-2-28JG-20-2, SSSN 28-22-05, steps 24 through 37 are omitted as directed by the "NOTE" prior to step 24.

5. Technician incorrectly stated that Isopropyl Alcohol is applied only to electrical connector 2822P1 and Synthetic Water Displacing Lubricant is applied only to MFSOV actuator receptacle at T.O. 1F16CJ-2-28JG-20-2, SSSN 28-22-05, steps 24 and 28.

6. Technician incorrectly identified J.C. Carter and Talley actuators in two aircraft undergoing modification.

7. When prompted to check out the required chemicals the technician correctly checked out the Isopropyl alcohol, however incorrectly checked out Electron 22 Cleaning Compound, Solvent (NSN: 6850013718049) instead of 1006 CON-TAC (NSN:8030014384101) as required in the T.O.

It was discovered that the 35th Maintenance Squadron, Maintenance Flight or the 35th Aircraft Maintenance Squadron, 14th Aircraft Maintenance Unit (AMU) and 13 AMU, support sections did not have 1006 CON-TAC Corrosion Preventative Compound (CPC), prescribed by the T.O., in stock. Finally, supply reports indicate that 1006 CON-TAC CPC has not been ordered, or on stock, at Misawa AB for at least two years prior to this investigation. These findings are relevant when considering the history of MFSOV failure analysis, normal operation of the MFSOV actuator and the implementation of corrective actions designed to prevent uncommanded closure of the MFSOV. Reference Tab FF-44, Tab FF 35 Catastrophic Uncommanded Closures of Engine Feedline Fuel Valve From Corroded Electrical Connectors.

e. Fuel, Hydraulic and Oil Inspection Analyses

Fluid samples from MA post-accident were not available for the purpose of analysis due to the loss of the aircraft in the ocean. JP-8 fluid analysis reports from fuel trucks 97L-160 (issued to MA) 96L-188, 96L-208, 96L-173 (all issued to KC-135 58-0036), fuel tank N-1 and fill stand 13 all report a Gas Chromatography/Mass Spectrometry (GCMS) spectrum that was typical of JP-8 type fuel (TAB U10).

DD Form 2027 Oil Analysis Record for engine S/N 538441, dated 22 July 2012, shows no record of abnormal oil analysis program (OAP) findings in any of the previous five analysis performed before the mishap (TAB D48).

f. Unscheduled Maintenance

For the purpose of this report, the LM Aero modification completed on 7 June 2012 will serve as the last scheduled inspection. Unscheduled maintenance since then does not appear relevant.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS.

a. Structures and Systems

The entire aircraft was not recovered. United States Navy salvage teams were able to recover various structures and components and return them to Misawa AB, Japan. The following is a list of the recovered aircraft structures and/or components:

1. The MA engine, F110-129B SN GE0E538441, was recovered. The engine oil tank, augmenter fuel control, Modified Digital Engine Control (MDEC) and accessory drive gearbox (ADG) including the main fuel pump, main engine control, alternator stator, alternator rotor, fuel boost pump, augmenter fuel pump, hydraulic pump and lube and scavenge pump were not recovered (Tab Z1, Z2, Z12-28, S9).

2. The main body of the left wing minus portions of the leading edge flap and trailing edge flaps (Tab S10).

3. Portions of the aft right fuselage, to include the Main Fuel Shutoff Valve (MFSOV), Engine Electric Control (EEC) Fuel Cooling Valve, and the Fuel Flow Transmitter (FFT) (Tab Z5-11).

4. Portions of the left horizontal stabilizer and left speed brake to include the Crash Survivable Memory Unit (CSMU) (Tab Z4).

5. Various wiring harnesses and components from the main avionics bay directly aft of the cockpit (Tab Z30).

6. Sniper Advanced Targeting Pod (ATP) and Air Combat Maneuvering Instrumentation (ACMI) pods (Tab Z29).

All structures and components show signs of corrosion caused by salt-water exposure.

The recovered MFSOV, located under panel 4402, appeared intact and undisturbed from normal installation and configuration. The MFSOV was connected to the Fuel Flow Transmitter and bolted to the forward bulkhead providing an unobstructed view of the butterfly valve from the fuel tank side of the bulkhead (Tab Z11). The MFSOV actuator was manufactured by Talley 12/92, Part Number 2472T100-1, Serial Number 1624. The butterfly valve and the MFSOV actuator indicator were found in the full closed position. The Engine Electronic Control Fuel Cooling Shutoff Valve (EEC Fuel Cooling SOV), located under panel 4402 appeared undisturbed from normal installation. The EEC Fuel Cooling SOV did have a hole in the actuator body. The EEC Fuel Cooling SOV was manufactured by J.C. Carter, Part Number 609, and the actuator indicator was in the closed position (Tab Z5). The EEC Fuel Cooling SOV can only receive an electrical command to close via the MFSOV.

The MA engine, F110-129B SN GE0E538441, fan stator cases were almost entirely intact. Fan frame and fan duct showed signs of buckling consistent with impact. There was no damage found to the engine case consistent with blade liberation at any stage. Core variable stator vane actuators were in the extended position, indicating low airflow at the time of engine shutdown. First stage fan blades displayed massive foreign object damage. Several first stage blades were bowed and torn at the mid span. Large amounts of debris including rubber, believed to be pieces of the F1 fuel cell, metallic and composite aircraft structure and parts were found between the second stage stator and second stage fan blades. Second stage fan blades showed erratic Foreign

Object and Debris (FOD) damage, however all second stage fan blades were accounted for and attached to the second stage fan disk.

The CSMU was compromised by exposure to extreme pressure at the ocean floor. It was sent to the Air Force Safety Center, Kirtland AFB, NM.

b. Evaluation and Analysis

(1) Main Fuel Shutoff Valve

The MFSOV and associated wiring harness was removed from panel 4402 for analysis. The MFSOV actuator indicator moved freely from the closed to the open position and back with normal resistance. The butterfly valve moved from the closed to the open position and back normally. The harness was intact upon inspection of the MFSOV actuator receptacle and electrical connector 2822P1. There was significant moisture discovered inside the MFSOV actuator receptacle. Corrosion was identified on the receptacle, receptacle pins, electrical connector 2822P1 and connector pin sockets. All connectors and receptacles installed in panel 4402 exhibited varying degrees of moisture and corrosion. The MFSOV actuator bench check at the 35 MXG Air Force Repair Enhancement facility was unsuccessful as it did not move with power applied. The MFSOV and associated wiring harness underwent further engineering analysis for corrosion and other potential causes of failure by Metallurgical Analysis Section AFMC/76 MXSS/MXDTAC, Tinker AFB, OK (Tab EE-1). In summary, cannon plug sleeves and pins showed signs of wear and corrosion due to gold and tin interaction. Gold plating was completely worn away revealing underlying nickel plating in some areas. However, the condition of the actuator connector pins had not deteriorated to the state of those documented in previous case studies of other uncommanded MFSOV failures.

(2) F110-129B SN GE0E53488

The engine damage was consistent with the MP's testimony of the sequence of events. The FOD pattern was consistent with damage that occurred while the engine was not operating. The FOD pattern was consistent with an engine that was wind-milling on impact. The lack of fan or compressor rub-strip/blade interference and lack of heat distress or metal splatter in the hot section or augmenter/exhaust nozzle is consistent with FOD damage that occurred with the engine not operating. The lack of rub-strip/blade interference and evidence that the engine was wind-milling on impact discount an engine bearing failure as the cause of engine shutdown. Overall, the condition of the available engine parts is consistent with an engine that was operating normally when the shutdown occurred in-flight (Tab FF4).

7. WEATHER

a. Forecast Weather

The forecast weather for takeoff was winds from 130° at 10kts, three Statute Mile (SM) visibility, mist, and clouds scattered at 500ft and broken at 800ft with a temporary forecast for 1 and 7/8 SM visibility with light drizzle (Tab F1.2). The en route weather forecast was hazard free with scattered clouds well below cruising flight level (Tab F1.2). There are no reporting stations near the mishap area, thus the forecast was approximate based on satellite and forecast model data. In addition, no radar data was available. The forecast weather at the mishap area was winds from 150° at 15kts, 1 SM visibility, light rain, mist, broken clouds at 300ft and overcast clouds at 1000ft (Tab F2.2). Air temperature was forecast to be 56°F and waves 4-5ft with a sea temperature of 46°F (Tab F2.2).

b. Observed Weather

The observed wind at takeoff was from 120° at 9kts. There were few clouds at 500ft, scattered clouds at 800ft, and broken clouds at 2000ft (Tab F1.1). En route the weather was clear with low scattered clouds and low winds (Tab V1). At the impact location and time there were scattered clouds 5-6000' MSL with reduced visibility and overcast 1000' MSL to surface (Tab R2.2).

c. Space Environment

Not applicable.

d. Operations

Based on the forecast and prevailing conditions, the weather was within limits for the MS. Operations were conducted in accordance with AFI 11-202v3, *General Flight Rules*, 22 October 2010 and AFI 11-207, *Combat Aircraft Delivery*, 1 December 2010.

8. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was a current Instructor Pilot (IP) and Standardization and Evaluation Flight Examiner (SEFE) with at total time of 1,612.6 hours in the F-16 prior to the mishap (Tab G1.1.1, G1.1.2). The MP had previously flown in approximately 10 other Air Operations Squadron (AOS) movements (Tab V1). Prior to the MS, the MP was Combat Mission Ready (CMR), met all currency and training requirements, and was qualified for the mission as briefed and flown (Tab G1.1.4).

Recent flight time is as follows (Tab G1.1.3):

	Hours	Sorties
Last 30 Days	4.0	3
Last 60 Days	13.2	11
Last 90 Days	23.6	20

MP qualifications were not contributory to this mishap.

9. MEDICAL

a. Qualifications

At the time of the mishap, the MP was medically qualified for flight duty without medical restrictions or waivers. The MP's most recent flight physical on 26 April 2012 determined he was medically qualified for flight duties and qualified for worldwide military duty. The MP displayed no physical or medical limitations prior to the mishap.

Additionally, the MF and AF ground maintenance crew members were medically qualified for duty at the time of the mishap. The AIB was unable to determine the current medical qualification of contract maintenance technicians involved. Physical and medical qualifications that were reviewed did not appear to be factors in the mishap.

b. Health

The AIB's medical advisor reviewed the medical and dental records of the MP and MF, as well as their 72 hour/14 day histories. Records revealed all individuals were in good health and had no recent performance limiting illnesses prior to the mishap.

After interviewing the MP, MF, and all AF maintenance crew members and thoroughly reviewing their medical records, there was no evidence that any medical conditions existed prior to the mishap. The AIB's medical advisor reviewed the MP's post-accident medical examination records. The MP sustained minor injuries from the ejection and made minimal medical complaints related to this mishap. An emergency room physician (Navy) and a qualified AF flight surgeon conducted post-accident physical exams on the MP and noted only minor injuries.

c. Toxicology

Toxicology testing was deferred on the MF, and the MP due to medical logistics following ejection and time until access to medical care.

Immediately following the mishap, commanders directed toxicology testing for all AF maintenance personnel involved in the launch of the MA. Blood and urine samples were submitted to the Joint Pathology Center (JPC) for toxicological analysis. This testing included carbon monoxide and ethanol levels in the blood and drug testing of the urine.
Carboxyhemoglobin saturations of zero to three percent are expected for non-smokers and three to ten percent for smokers. Saturations above ten percent are considered elevated and are confirmed by gas chromatography.

Furthermore, JPC screened the maintenance crew members' urine for amphetamine, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates and phencyclidine by immunoassay or chromatography. JPC detected none of these drugs in the associated maintenance crew members.

d. Lifestyle

There is no evidence that unusual habits, behavior or stress on the part of the MP, MF or maintenance crew members contributed to this accident. Witness testimonies, as well as review of 72 hour histories of the MP and MF revealed no lifestyle factors, including unusual habits, behavior or stress which were causal or substantially contributory to the mishap.

e. Crew Rest and Crew Duty Time

Air Force Instructions require pilots have proper "crew rest," as defined in AFI 11-202v3, prior to performing in-flight duties. Crew Rest is defined as a minimum 12 hour non-duty period before the designated flight duty period (FDP) begins. During this time, an aircrew member may participate in meals, transportation or rest as long as he or she has the opportunity for at least eight hours of uninterrupted sleep.

A review of the duty cycles of the MP and MF leading up to the mishap indicated that all had adequate crew rest. The MP stated he was well rested and had no complaints or illnesses. The MP complied with the crew rest and duty day requirements on the day of the mishap. Fatigue was not indicated and is not a factor in this mishap. The MP did not suffer from stress, pressure, fatigue or lack of rest prior to or during the MS.

10. OPERATIONS AND SUPERVISION

a. Operations

The 13 FS has a high operations tempo which is consistent with other Combat Air Forces (CAF) F-16C units. In the past year and a half, the 13 FS supported two RED FLAG-Alaska trips and eight months of Operation Noble Eagle (ONE) (Tab V1). The 13 FS has been flying the F-16 since 1985.

b. Supervision

PACAF/CC approved the MS mission and the 13 FS commander authorized the mission (Tab K1.7). The MF received a mission brief from DCO and step brief from the Squadron Flying Supervisor (Top 3) and there was a SOF and all operational risk management elements were appropriately addressed (Tab V1, V3, K1.8).

11. HUMAN FACTORS

The board evaluated human factors relevant to the mishap using the analysis and classification system model established by the Department of Defense (DoD) Human Factors Analysis and Classification System (HFACS) guide, implemented by AFI 91-204, *USAF Safety Investigations and Reports,* dated 24 September 2008. A human factor is any environmental, technological, physiological, psychological, psychosocial, or psycho-behavioral factor a human being experiences that contributes to or influences his performance during a task. The DoD has created a framework to analyze and classify human factors and human error in mishap investigations.

The framework is divided into four main categories: Acts, Preconditions, Supervision, and Organizational Influences. Each category is further subdivided into related human factor subcategories. The main categories allow for a complete analysis of all levels of human error and how they may interact together to contribute to a mishap. This framework allows for evaluation from the unsafe acts that are directly related to the mishap through the indirect preconditions, supervision, or organizational influences that may have led to the mishap. The relevant factors to this mishap are discussed below.

a. Causal

(1) There is no evidence that human factors causally contributed to this mishap.

b. Contributory

The following HF's could not be proved or disproved as contributory:

(1) SP005 Proficiency

Proficiency is a factor when and individual is not proficient in a task, mission or event.

The AIB found evidence LM Aero Field Team technician responsible for MFSOV operational check out was not proficient in the task in accordance with Air Force standards. When the LM Aero Field Team technician was asked to show how he would service the cannon plug, he displayed a lack of proficiency (Section 5d, above).

(2) PE203 Visibility Restrictions

Visibility Restrictions are a factor when the lighting system, windshield / windscreen / canopy design, or other obstructions prevent necessary visibility and create an unsafe situation. This includes glare or reflections on the canopy / windscreen / windshield. Visibility restrictions due to weather or environmental conditions are captured under PE101 or PE102.

The AIB found evidence that the visual examination of MFSOV actuator cannon plug receptacle is difficult, during routine inspection, due to limited access (see T.O. IF-16CJ-2-28JG-20-2 and Tab Z 13-19).

(3) OP003 Procedural Guidance/Publications

Procedural Guidance/Publications is a factor when written direction, checklists, graphic depictions, tables, charts or other published guidance is inadequate, misleading or inappropriate and this creates an unsafe situation.

The AIB found evidence that the guidance within the T.O. does not clearly define corrosion inspection criteria of MFSOV actuator cannon plugs. Nor is there a reference to guidance on how to clean corrosion from the MFSOV actuator cannon plug see (T.O. IF-16CJ-2-28JG-20-2).

c. Non-Contributory

(1) SI002 Supervision – Modeling

Supervision – Modeling is a factor when the individual's learning is influenced by the behavior of peers and supervisors and when that learning manifests itself in actions that are either inappropriate to the individual's skill level or violate standard procedures and lead to an unsafe situation.

The AIB was unable to clearly identify any improperly trained maintainers that serviced the MA cannon plug.

(2) AV003 Violation - Lack of Discipline

Violation - Lack of Discipline is a factor when an individual, crew or team intentionally violates procedures or policies without cause or need. These violations are unusual or isolated to specific individuals rather than larger groups. There is no evidence of these violations being condoned by leadership. These violations may also be referred to as "exceptional violations." (NOTE: These violations may also carry UCMJ consequences. Boards should consult the Judge Advocate of the convening authority.).

The AIB was unable to find evidence that maintenance supervisors or maintainers intentionally violated procedure by NOT using T.O. specified corrosion preventative. However, it was found that an unapproved solvent was being used to clean cannon plugs, instead of the correct corrosion preventative spray.

(3) Additional Considered Human Factors

The AIB found no evidence that maintenance crew complacency, overconfidence, low motivation, distraction, disruption, supervisory pressure, channelized attention, uncharacteristic mistake or other degradation may have led to the accident.

There is sufficient evidence to rule out MP complacency, overconfidence, under motivation or over-motivation to succeed, distraction, disruption, pressure, channelized attention, uncharacteristic mistake or other degradation as causes of the accident. The AIB evaluated every action the MP took during the mishap sequence using all available evidence, such as witness testimony, radio transmissions, and Heads Up Display (HUD) tape review. The procedures followed by the MP and the manner in which he performed his actions under the emergent circumstances were focused, precise and appropriate. The MP did not display signs of channelized attention, panic, distraction, complacency, overconfidence or overt mental confusion during the mishap. There is no evidence that MP human factors contributed to this mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications

1. AFI 11-2F-16, Volume 1, *F-16—Pilot Training*, 11 August 2011
2. AFI 11-2F-16, Volume 2, *F-16—Aircrew Evaluation Criteria*, 10 December 2009
3. AFI 11-2F-16, Volume 3, *F-16—Operations Procedures*, 18 February 2010
4. AFI 11-202, Volume 1, *Aircrew Training*, 22 November 2010
5. AFI 11-202, Volume 2, *Aircrew Standardization/Evaluation Program*, 13 September 2010
6. AFI 11-202, Volume 2_PACAFSUP_I, *Aircrew Standardization/Evaluation Program*, 11 March 2010
7. AFI 11-202, Volume 3, *General Flight Rules*, 22 October 2010
8. AFI 11-202, Volume 3_PACAFSUP_I, *General Flight Rules*, 11 July 2011
9. AFI 11-207, *Combat Aircraft Delivery,* 24 October 2007
10. AFI 11-214, *Air Operations Rules and Procedures,* 14 August 2012
11. AFI 11-301, Volume 1, *Aircrew Life Support (ALS) Program*, 19 July 2002
12. AFI 11-301 Volume 1_PACAFSUP_I, *Aircrew Life Support (ALS) Program,* 12 April 2012
13. AFI 11-401, *Aviation Management,* 10 December 2010
14. AFI 11-418, *Operations Supervision*, 21 October 2005
15. AFI 11-418_ 35FWSUP, *Operations Supervision*, 15 June 2009, Cert 6 June 2011
16. AFI 11-421, *Aviation Resource Management*, 1 November 2004
17. AFI 48-123, *Medical Examinations and Standards,* 24 September 2009
18. AFI 51-503, *Aerospace Accident Investigations*, 26 May 2010
19. AFI 91-204, *Safety Investigations and Reports,* 24 September 2008

b. Maintenance Directives and Publications

1. AFI 21-101, *Aerospace Equipment Maintenance Management*, 26 July 2010
2. AFI 21-101, *Aircraft Equipment Maintenance Management,* 11 July 2012
3. Technical Order (T.O.) 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies and Procedures*, 27 June 2011
4. T.O. 00-20-2, *Maintenance Data Documentation,* 1 September 2010
5. T.O. 1F-16CM-1, *Flight Manual, USAF Series F-16C and F-16D CCIP Aircraft Blocks 40, 42, 50, and 52*, 1 August 2012
6. T.O. 1F-16CM-1-1, *Supplemental Flight Manual, USAF Series F-16C and F-16D CCIP Aircraft Blocks 40, 42, 50, and 52*, 1 June 2012

7. T.O. 1F-16CM-1-CL-1, *Flight Crew Checklist USAF Series F-16C/C CCIP Aircraft Blocks 40,42, 50, and 52,* 1 August 2012
8. T.O. 1F-16CM-34-1-1, *Avionics and Non-Nuclear Weapons Delivery Flight Manual USAF CCIP Aircraft,* 1 May 2012
9. T.O. 1F-16CJ-2-00GV-00-1, *General Vehicle Organizational Maintenance Description USAF Series F-16C and F-16D Aircraft Blocks 50 and 52,* 1 May 2011
10. T.O. 1F-16CJ-2-00WD-00-4, *Wiring Data Manual Wiring Diagrams USAF Series F-16D Aircraft Blocks 50 and 52,* 1 August 2011
11. T.O. 1F-16CJ-2-28GS-00-1, *General System Organizational Maintenance Fuel System USAF Series F-16C and F-16D Aircraft Blocks 50 and 52,* 1 September 2011
12. T.O. 1F-16CJ-2-70FI-00-1, *Fault Isolation Organizational Maintenance Power Plant Model F110-GE-129/129B USAF Series F-16C and F-16D Aircraft Block 50,* 1 September 2011
13. T.O. 1F-16CJ-2-70GS-00-1, *General System Organizational Maintenance Power Plant Model F110-GE-129/129B USAF Series F-16C and F-16D Aircraft Block 50,* 1 September 2011
14. T.O. 1F-16CJ-6-11, *Scheduled Inspection and Maintenance Requirements USAF Series F-16C and F-16D Aircraft Using F110-GE-120/129B Engine Block 50,* 1 July 2011
15. T.O. 1F-16CJ-4-28, *Illustrated Parts Breakdown Organizational Maintenance Fuel Systems USAF Series F-16C and F-16D Aircraft,* 1 March 2012
16. T.O. 1F-16CJ-14-39-2, *Maintenance Instructions With Illustrated Parts Breakdown 370-Gallon External Fuel Tank 27-370-48260-5, 27-370-48260-6, 27-370-48260-8, 27-370-48260-9, 27-370-48260-10, 27-370-48260-11, 27-370-48260-13 and Tank/Pylon Assembly (TPA) 200925156-10,* 28 September 2009
17. T.O. 1F-16CJ-14-40-2, *300-Gallon External Centerline Fuel Tank Maintenance Instructions With Illustrated Parts Breakdown2-300-48150-4, 2-300-48150-5, 2-300-48150-6, 2-300-48150-7, 2-300-48150-8, 2-300-48302, 2-300-48302-1, 2-300-48302-2, 2-300-48302-5, 2-300-48302-6,* 21 August 2012

NOTICE: The AFIs listed above are available digitally on the AF Departmental Publishing Office internet site at: http://www.e-publishing.af.mil.

13. ADDITIONAL AREAS OF CONCERN

Not Applicable.

28 October 2012

TERRY SCOTT, Colonel, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

F-16C, T/N92-003886
N 4633.3, E 15631.4
22 July 2012

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

1. OPINION SUMMARY

I find by clear and convincing evidence, the cause of the mishap was an un-commanded closure of the main fuel shutoff valve. The main fuel shutoff valve in the closed position stopped fuel from reaching the engine and thus the engine stopped producing thrust. By a preponderance of evidence, I determined the MA experienced a partial closure of the MFSOV for over three minutes, which limited the thrust of the engine to sub-idle RPM of 70%, and then fully closed after three minutes at which time the engine rolled back to jet fuel starter assisted RPM of 20% until impact. The board could not determine with reasonable certainty the reason for the un-commanded closure of the MFSOV, due to the loss of several vital pieces of evidence. Specifically, the wreckage of the cockpit fuel control panel, fuel control wiring harness from the cockpit to the engine and other associated fuel system components were not recovered from the ocean floor, and the Crash Survivable Data Unit was crushed by extreme water pressure.

On 22 July 2012 at approximately 1109L, an F-16C tail number 92-003886, assigned to the 14th Fighter Squadron, 35th Fighter Wing, Misawa Air Base, Japan, experienced a loss of thrust from the engine that the mishap pilot (MP) could not restore. The MP safely ejected from the aircraft and was recovered without injury. The mishap aircraft crashed into the Pacific Ocean approximately 750 miles northeast of Misawa Air Base, Japan and was destroyed. There was no damage to private property. The estimated loss to the United States government is $32,610,492.34.

I developed my opinion by analyzing factual data, historical records, Air Force directives and guidance, engineering analysis, witness testimony, flight data, flight simulations, and information provided by technical experts.

2. DISCUSSION OF OPINION

Cause: Un-Commanded Closure of the Main Fuel Shutoff Valve (MFSOV).

In the recovered aircraft wreckage, the MFSOV was found in the fully closed position at the time of recovery. In flight, only an electrical signal will close the MFSOV. I determined the two most probable ways the MFSOV closed in flight were, commanded from the pilot via switch activation, or un-commanded via an electrical short. I determined the pilot DID NOT place the Fuel Master Switch in the cockpit to the OFF position based on the following evidence. At the first loss of thrust the engine ran at 70% RPM (sub-idle) for approximately three minutes, indicating a partial closure of the MFSOV. Then the MFSOV closed fully and the engine rolled back to 20% RPM sustained by the jet fuel starter until impact. According to TO 1-F-16CM-1 and F-16 simulator testing accomplished by the board, had the pilot activated the fuel master switch, the MFSOV would have closed fully upon activation of the fuel master switch within 2-4 seconds. At the power setting for the flight parameters at the time of the loss of thrust, the engine would have experienced fuel starvation in 9-12 seconds, at which time the engine RPM would have immediately rolled back to wind-milling (~7% RPM) until activation of the jet fuel starter. From first loss of thrust to wind-milling RPM would have been approximately 20-30 seconds. The fact the engine ran at 70% RPM for three minutes means the engine was receiving some fuel and indicative of a MFSOV that was partially closed. The pilot could not have commanded a partially closed MFSOV, as the only option for the pilot to command is fully open or fully closed. Additionally, the fuel master switch in the cockpit requires three movements to activate, break the safety wire on the red guarded cover, lift and move the guarded cover, and then activate the switch. Since full closure of the MFSOV took over three minutes, I determined an un-commanded electrical input caused the MFSOV to partially close and then completely close after approximately three minutes. I could not conclusively determine the exact cause of the un-commanded closure of the MFSOV. However, the F-16 has a history of problems with the MFSOV closing partially or fully un-commanded. Corrosion has been the culprit in most of these cases. During the investigation, it was determined that the approved corrosion preventive compound was not on base and was not on base for the previous two years. Additionally, the investigation revealed the last technician that performed the most recent inspection and corrosion prevention measures on the MFSOV actuator cannon plug, when asked to perform the same process for the investigation board, the technician lacked proficiency in the task. Specifically, the technician skipped steps in the TO, failed to use a magnifying glass when required by TO, and used a cleaning compound when he should have used the TO approved corrosive preventive compound. Corrosion was observed on the tin pin connector and in the socket of the recovered MFSOV actuator cannon plug. Corrosion in the MFSOV actuator cannon plug could cause a short potentially closing the MFSOV. Technical analysis of the MFSOV cannon plug could not determine if the corrosion was caused by lack of corrosion preventive compound or from being submerged for two months on the ocean floor.

3. CONCLUSION

I find by clear and convincing evidence, the cause of the mishap was an un-commanded closure of the main fuel shutoff valve. Additionally, by a preponderance of evidence, I determined the MA experienced a partial closure of the MFSOV for over three minutes, which limited the thrust of the engine to idle RPM of 70%, and then fully closed after three minutes at which time the engine rolled back to jet fuel starter assisted RPM of 20% until impact.

28 October 2012

TERRY SCOTT, Colonel, USAF
President, Accident Investigation Board