UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

T-38C, T/N 64-3213

87TH FLYING TRAINING SQUADRON
47TH FLYING TRAINING WING
LAUGHLIN AIR FORCE BASE, TEXAS

LOCATION: 12 MILES NW OF LAUGHLIN AIR FORCE BASE, TEXAS

DATE OF ACCIDENT: 20 NOVEMBER 2017

BOARD PRESIDENT: BRIGADIER GENERAL (Sel) JOEL L. CAREY

Conducted IAW Air Force Instruction 51-503

EXECUTIVE SUMMARY
AIRCRAFT ACCIDENT INVESTIGATION
T-38C, T/N 64-3213
LAUGHLIN AIR FORCE BASE TEXAS
20 NOVEMBER 2017

On 20 November 2017, at 15:46:28 hours, local time, a T-38C, tail number 64-3213, crashed approximately 12 miles northwest of Laughlin Air Force Base (AFB), Texas (TX), completely destroying the aircraft and fatally injuring the mishap requalification pilot (MRP) who was occupying the rear seat. The mishap aircrew (MC) consisted of a mishap instructor pilot (MIP) occupying the front seat who was supervising the MRP who was conducting a requalification mission. The MIP successfully ejected and sustained minor injuries. The MRP did not eject and was fatally injured during ground impact. The MIP, MRP and mishap aircraft (MA) were assigned to the 87th Flying Training Squadron, 47th Flying Training Wing, Laughlin AFB, TX. During the mishap sortie (MS), the mishap aircraft (MA) crashed while returning to base following a reported aircraft malfunction. The destroyed aircraft is valued at approximately $11 million.

The MRP was a T-38 instructor pilot undergoing requalification training after return from a non-flying overseas deployment. During a local training sortie, the MA experienced an airframe mounted gearbox failure on the left engine, resulting in the loss of the left alternating current generator and left hydraulic pump. The MC accomplished required checklists and coordinated for immediate landing at Laughlin AFB. Over four minutes later, while maneuvering to final approach, the MC detected additional failed electrical systems accompanied by failure of the right engine hydraulic pump and the right airframe mounted gearbox. With failures of both gearboxes and their associated hydraulic pumps, the MA suffered total hydraulic failure and was uncontrollable by the MC, leaving ejection as the only suitable alternative. The MC transmitted their intent to eject, but delayed ejection over concern for a populated area below.

The Accident Investigation Board President determined, by preponderance of evidence, the cause of the mishap to be dual airframe mounted gearbox failure. A substantial contributing factor to these gearbox failures was a lack of maintenance guidance addressing similar repeated failures of the MA. The Board President also found, by a preponderance of evidence, the cause of fatal injuries suffered by the MRP was the MC's failure to complete the before takeoff checklist item that called for the proper ejection seat system settings. Finally, the Board President found, by a preponderance of the evidence, that factors that substantially contributed to the mishap were Task Misprioritization, Checklist Interference, Instrumentation and Sensory Feedback Systems, and the Delayed Decision to eject.

SUMMARY OF FACTS AND STATEMENT OF OPINION
T-38C, T/N 64-3213
20 November 2017

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

AB	Afterburner
ABU	Automatic Backup Unit
AC	Alternating Current
ACCESS	Attenuating Custom Communications Earphone System
ADDS	Aviation Digital Data Service
ADO	Assistant Director of Operations
AETC	Air Education and Training Command
AF	Air Force
AFB	Air Force Base
ACFT	Aircraft
ACMI	Air Combat Maneuvering Instrumentation
ACP	Armament Control Panel
ADU	Automatic Deployment Unit
AFE	Aircrew Flight Equipment
AFECT	Aircrew Flight Equipment Continuation Training
AFI	Air Force Instruction
AFLCMC	Air Force Life Cycle Management Center
AFLD	Airfield
AFME	Armed Forces Medical Examiner
AFPAM	Air Force Pamphlet
AFRL	Air Force Research Laboratory
AFSEC	Air Force Safety Center
AFSOC	Air Force Special Operations Command
AFTO	Air Force Technical Order
AGL	Above Ground Level
AIB	Accident Investigation Board
AMDS	Aeromedical Squadron
AOA	Angle of Attack
AOR	Area of Responsibility
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
AUP	Avionics Upgrade Program
AUX	Auxiliary
AWC	Air War College
BP	Board President
BPO	Basic Post-Flight Operation
BRK	Battery Replacement Kit
BTRU	Barostatic Time Release Unit
BUFF	B-52 (slang)
CAD	Cartridge Activated Device
CAT	Crisis Action Team
CC	Commander
CE	Civil Engineering
CMD FWD	Command Forward
CND	Cannot Duplicate
COMM	Communications
Coords	Coordinates
CSI	Critical Safety Item
DC	Direct Current
DDU	Drogue Deployment Unit
DNIF	Duties Not Including Flying
DO	Director of Operations
DOT	Department of Training
DoD	Department of Defense
DTC	Data Transfer Cartridge
DTGA	Differential Thermogravimetric Analysis
ECS	Environmental Control System
ELT	Emergency Locator Transmitter
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EO	Emergency Oxygen
EOR	End of Runway
EP	Emergency Procedure
EPE	Emergency Procedures Evaluation
ER	Exceptional Release
ERRC	Expandability Recoverability Reparability Category
ESUP	Escape System Upgrade Program
EVAL	Evaluation
FAIP	First Assignment Instructor Pilot
FCF	Functional Check Flight
FCIF	Flight Crew Information File
FCP	Front Cockpit
FE	Flight Examiner
FERMS	Flight Equipment Records Management System
FO	Foreign Object
FPI	Fluorescent Penetrant Inspection

FTS	Flying Training Squadron
FTW	Flying Training Wing
G	Unit of Gravity
GE	General Electric
GK	General Knowledge
GX	G-Exercise
HAF	Headquarters Air Force
HBDU	Headbox Deployment Unit
HFAC	Human Factors
HPRU	Harness Powered Retraction Unit
HSD	Horizontal Situation Display
HUD	Heads-Up Display
IAW	In Accordance With
ICAO	International Civil Aviation Organization
ICNS	Integrated Chin and Nape Strap
IFE	In-Flight Emergency
IFR	Instrument Flight Rules
IFRR	Individual Flight Record Report
ILS	Instrument Landing System
IMDS	Integrated Maintenance Data System
INIT	Initial
INSP	Inspection
INST	Instrument
IO	Investigating Officer
IP	Instructor Pilot
ISB	Interim Safety Board
ISS	Inter-Seat Sequencing System
ITS	Individual Training Summary
ITS	Index of Thermal Stress
JA	Judge Advocate
JBSA	Joint Base San Antonio
KDLF	Laughlin AFB ICAO Identifier
KDRT	Del Rio International Airport ICAO Identifier
KIAS	Knots Indicated Air Speed
KT	Knot
L	Local Time
LA	Legal Advisor
LH	Left Hand
LLO	Local Land Orientation
LOX	Liquid Oxygen
LRU	Line Replaceable Unit
MA	Mishap Aircraft
MAAF	Mishap Analysis and Animation Facility
MAJCOM	Major Command
MC	Mishap Crew
MDG	Medical Group
MDS	Mission Design Series
MDP	Mission Data Processor
MF	Mishap Flight
MIC	Micrometer
MLG	Main Landing Gear
MEF	Mission Execution Forecast
MEM	Medical Member
METAR	Meteorological Aviation Report
MFR	Memorandum for Record
MIP	Mishap Instructor Pilot
MOA	Memorandum of Agreement
MOA	Military Operations Area
MOR	Manual Over-Ride
MPI	Multi-purpose Initiator
MRP	Mishap Requalification Pilot
MS	Mishap Sortie
MSL	Mean Sea Level
MSN	Mission
MSU	Maintenance Support Unit
MX	Maintenance
NAPA	NorAir Accessory Power Assembly
NAV	Navigator
NAVAIDS	Navigational Aids
NDA	Non-Disclosure Agreement
NDI	Non-Destructive Inspection
NM	Nautical Miles
NLG	Nose Landing Gear
NOTAMs	Notices to Airmen
NPS	National Park Service
NRTS	Non-Repairable this Station
NSW	No Significant Weather
OBS	Observation
OD	Outer Diameter
OG	Operations Group
OGV	OG Standardization/Evaluation
Ops Sup	Operations Supervisor
ORM	Operational Risk Management
OSC	On-Scene Commander
OSS	Operation Support Squadron
PA	Public Affairs
PAD	Propellant Activated Device
PE	Periodic Inspection
PFR	Primary Flight Reference

PIT	Pilot Instructor Training
PLB	Personnel Locator Beacon
PM	Pilot Member
POC	Point of Contact
PSI	Pounds per Square Inch
QC	Quality Control
QRC	Quick Reaction Checklist
QUAL	Qualification
QVI	Quality Verification Inspection
PIREP	Pilot Report
PMP	Propulsion Modernization Program
RADAR	Radio Detection and Ranging
RAPCON	RADIO Approach Control
RC	Radio Control
RCP	Rear Cockpit
REC	Recorder
RH	Right Hand
RPM	Revolutions per Minute
RQ	Requalification
RSU	Runway Supervisory Unit
RTB	Return-To-Base
RXSA	Materials Integrity Branch
SAC	Survival Aids Container
SAMMC	San Antonio Military Medical Center
SAR	Search and Rescue
SARCAP	Search and Rescue Combat Air Patrol
SARM	Squadron Aviation Resource Management
SAYA	Stability Augmenter Yaw
SE	Safety
SELO	Squadron Evaluations Liaison Officer
SEM	Scanning Electron Microscopy
SERE	Survival Evasion Resistance and Escape
SFS	Security Forces Squadron
SI	Seat Initiators
SIB	Safety Investigation Board
SII	Special Interest Item
SIM	Simulator
SJA	Staff Judge Advocate
SOF	Supervisor of Flying
SPO	System Program Office
SSE	Simulated Single Engine
SSK	Seat Survival Kit
STARS	Standard Terminal Arrival Routes
SUV	Sport Utility Vehicle
TAF	Term Aerodrome Forecast
TBA	Training Business Area
TCAS	Traffic Collision Alert System
TCTO	Time Compliance Technical Order
TDU	Time Delay Unit
TEU	Trailing Edge Up
TFR	Temporary Flight Restriction
TH	Thru-Flight Inspection
TI	Theater Indoctrination
TIMS	Training Integrated Management System
TMT	Task Management Tool
T/N	Tail Number
TO	Technical Order
TP	Traffic Pattern
TX	Texas
UCMJ	Uniform Code of Military Justice
UFCP	Up Front Control Panel
UHF	Ultra High Frequency
UPT	Undergraduate Pilot Training
USAF	United States Air Force
USRM	Under-seat Rocket Motor
UT	Ultrasonic Testing
UWARS	Universal Water Activated Release System
VFR	Visual Flight Rules
VHF	Very High Frequency
VIS	Visibility
vRED	Virtual Record of Emergency Data
VTC	Video Teleconference
VVI	Vertical Velocity Indicator
WOW	Weight on Wheels
WSO	Weapon Systems Officer
WX	Flight Visibility and Weather
XRF	X-Ray Fluorescence
Z	Zulu

SUMMARY OF FACTS

1. AUTHORITY, PURPOSE, AND CIRCUMSTANCES

a. Authority

On 21 November 2017, Major General Mark A. Brown, the Air Education and Training Command (AETC) Deputy Commander, appointed Brigadier General (Sel) Joel L. Carey, to conduct an aircraft accident investigation of a mishap that occurred on 20 November 2017 involving a T-38C aircraft, tail number (T/N) 64-3213, 12 miles northwest of Laughlin Air Force Base (AFB), Texas (TX) (Tab Y-3). The investigation was conducted at Laughlin AFB, from 16 January 2018 through 20 January 2018 and at Joint Base San Antonio (JBSA) – Randolph AFB, TX, from 22 January 2018 through 27 March 2018. The following board members were appointed: a Colonel Medical Member, a Major Legal Advisor, a Lieutenant Colonel Pilot Member, a Civilian Maintenance Member, and a Master Sergeant Recorder (Tab Y-3 and Y-5).

b. Purpose

In accordance with AFI 51-503, *Aerospace and Ground Accident Investigations*, this accident investigation board conducted a legal investigation to inquire into all the facts and circumstances surrounding this Air Force aerospace accident, prepare a publicly releasable report, and obtain and preserve all available evidence for use in litigation, claims, disciplinary action, and adverse administrative action.

2. ACCIDENT SUMMARY

On 20 November 2017, at approximately 1545 hours, local time (L), a T-38C, T/N 64-3213, crashed approximately 12 miles northwest of Laughlin AFB, TX, completely destroying the aircraft and fatally injuring the mishap requalification pilot (MRP) who was occupying the rear seat (Tab H-3). The mishap aircrew (MC) consisted of a mishap instructor pilot (MIP) who occupied the front seat and the MRP who occupied the rear seat (Tab H-3). The MIP successfully ejected and sustained minor injuries; the MRP did not eject and was fatally injured during ground impact (Tab H-3). The MIP, MRP and mishap aircraft (MA) were assigned to the 87th Flying Training Squadron (87 FTS), 47th Flying Training Wing (47 FTW), Laughlin AFB, TX. (Tabs G-3, G-11 and H-3). The MRP was flying a daytime rear-cockpit requalification mission under the supervision of the MIP, who was acting as pilot in command (Tabs K-3 and V-9.10). During the mishap sortie (MS), the MA crashed while returning to base from the Military Operating Airspace (MOA) following a reported aircraft malfunction (Tab V-9.8 to V-9.9). The destroyed aircraft is valued at approximately $11 million (Tab P-3).

3. BACKGROUND

The 87 FTS falls under the 47th Operations Group (OG), which falls under the 47 FTW (Tab CC-3 to CC-6). All fall under 19th Air Force (AF), which is a Numbered Air Force (NAF)

within Air Education and Training Command (AETC) (Tab CC-2 to CC-3).

a. Air Education and Training Command (AETC)

AETC's mission is to recruit, train and educate Airmen to deliver airpower for America (Tab CC-2). AETC, with headquarters at JBSA-Randolph was established and activated in January 1942, making it the second oldest major command in the Air Force (Tab CC-2). AETC includes Air Force Recruiting Service, two numbered air forces and the Air University (Tab CC-2).

The command has more than 29,000 active-duty members, 6,000 Air National Guard and Air Force Reserve personnel, and 15,000 civilian personnel (Tab CC-2). The command also has more than 11,000 contractors assigned (Tab CC-2). AETC flies approximately 1,300 aircraft operating at 12 major installations and supports tenant units on numerous bases across the globe, encompassing 16 active-duty and 7 Reserve wings (Tab CC-2).

b. 19th Air Force (19 AF)

The 19 AF's mission is to train and educate the world's finest Airmen to deliver airpower for America (Tab CC-3). The 19 AF is responsible for the training of more than 30,000 U.S. and allied students annually in numerous specialties ranging from aircrews; remotely piloted aircraft crews; air battle managers; weapons directors; Air Force Academy Airmanship programs; and survival, escape, resistance, and evasion Specialists (Tab CC-3). The 19 AF executes operational-level command and control of all formal aircrew flying training missions within AETC and provides Airmen with a 5th generation, cross-domain warrior mindset to the Combat Air Forces, Mobility Air Forces, and Special Operations Air Forces to sustain the combat capability of the United States Air Force (Tab CC-3).

c. 47th Flying Training Wing (47 FTW)

The 47 FTW's mission is to conduct specialized undergraduate pilot training for the United States Air Force, Air Force Reserve, Air National Guard and allied nation air forces utilizing the T-6, T-38 and T-1A aircraft while deploying mission-ready Airmen as well as developing professional, disciplined leaders (Tab CC-5). The 47 FTW commands a flying operation which exceeds 80,000 flying hours and 54,000 sorties per year (Tab CC-5). It is composed of more than 1,400 military personnel, 1,360 civilian employees and a total base community exceeding 4,300 people (Tab CC-5).

d. 47th Operations Group (47 OG)

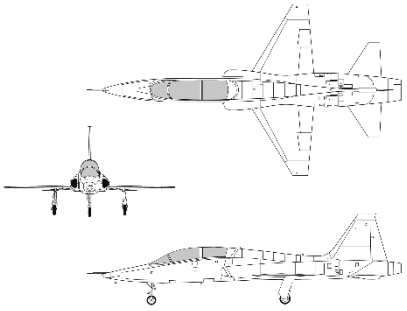
The 47 OG is responsible for training U.S. Air Force and allied nation pilots under the Specialized Undergraduate Pilot Training Program (Tab CC-6). The 47 OG provides management, control, standardization and evaluation of all aspects of flying training operations and airfield management at Laughlin AFB (Tab CC-6). The group consists of four flying training squadrons, an operations support squadron and a student squadron (Tab CC-6). During the 52-week training period, each student pilot flies nearly 200 hours in the T-6A and either the T-38 or T-1A aircraft (Tab CC-6). Flying is supplemented by almost 60 hours in aircraft simulators and more than 500 hours in the classroom (Tab CC-6).

e. 87th Flying Training Squadron (87 FTS)

The 87 FTS flies the T-38C Talon and provides students with advanced flight training in contact, formation, acrobatics, navigation, and instrument procedures for fighter fundamentals (Tab CC-6).

f. The T-38C Talon

The T-38 Talon is a twin-engine, high-altitude, supersonic jet trainer used in a variety of roles because of its design, economy of operations, ease of maintenance, high performance and exceptional safety record (Tab CC-7). The T-38 has swept wings, a streamlined fuselage and tricycle landing gear with a steerable nose wheel (Tab CC-7). Two independent hydraulic systems power the ailerons, rudder and other flight control surfaces (Tab CC-7). Critical aircraft components are waist-high and easily reached by maintenance crews (Tab CC-7).



AETC is the primary user of the T-38 for specialized undergraduate pilot training (Tab CC-7). The instructor and student sit in tandem on rocket-powered ejection seats in a pressurized, air-conditioned cockpit (Tab CC-7).

4. SEQUENCE OF EVENTS

a. Mission

The 87 FTS scheduled and authorized the MIP's and MRP's mission sequence (Tab K-3). On Monday, 20 November 2017, the MRP was to fly a day, single-ship, rear-cockpit transition requalification sortie as part of a formal requalification program to regain the MRP's Instructor Pilot (IP) status. The MRP's IP status had lapsed due to an extended contingency deployment to the Horn of Africa (HOA) Area of Responsibility (AOR) (Tab V-4.1). The MIP was scheduled as the IP and pilot in command of the mission and was tasked with conducting the required training for the MRP on the sortie (Tab K-3). The MS was the third scheduled mission in the MRP's

requalification plan, which consisted of eight training sorties, two evaluation sorties and three simulators (Tabs G-33, G-35, V-4.3 and V-9.3). Prior to the flight, the MRP had completed a self-paced ground study regimen and three emergency procedure simulator missions (Tabs G-32, G-34 and V-4.2 to V-4.3). The MRP had also previously flown five sorties starting in August 2017, including an additional observation flight—or "sandbag" sortie—none of which counted toward his requalification program (Tab G-3). The MS was the MRP's sixth sortie since returning from his deployment (Tab G-9 and G-34). The planned profile for the sortie included a pattern delay for a Simulated Single-Engine (SSE) pattern followed by a departure to the MOA for basic air work including stalls and slow flight followed by a return to base (RTB) for additional pattern work (Tab V-9.12).

b. Planning

On 20 November 2017, both the MIP and MRP arrived at the squadron prior to 0700L (Tabs V-9.3, V-9.11, and AA-2). The MRP met with the MIP at approximately 1000L and discussed the conduct and planning of their upcoming sortie for a brief period of time (Tab V-9.3 and V-9.11). The MRP completed an Operational Risk Management (ORM) assessment (Tab AA-2). The ORM form is a checklist of risk factors, designed to codify all identifiable risks associated with the forecasted mission (Tab AA-2). Each factor, such as weather, briefing time, or lack of sleep, has an associated point value (Tab AA-2). The MRP compiled the total of all identified risks (Tab AA-2). The following scale quantifies the sortie risk: Low (0-12 points), Moderate (13-25 points), High (26-35 points), and Severe (≥36 points) (Tab AA-2). The mission's quantifiable risk assessment was five points, equating to a planned low-risk mission (Tab AA-2). Both the MIP and the MRP checked the Notice to Airmen (NOTAM) and the forecasted weather (Tab V-9.3 and V-9.12). The MRP planned his sortie to conduct a rolling takeoff and execute a pattern delay to perform a SSE pattern and touch and go followed by a departure to the MOA (Tab V-9.12). Once in the MOA, the MRP planned to accomplish a unit of gravity (G) exercise, a traffic-pattern stall series and slow flight exercise (Tab V-9.6 to V-9.7 and V-9.12). Following the maneuvers in the operations area, the MRP planned to return to the Laughlin AFB traffic pattern to conduct multiple landings (Tab V-9.7 and V-9.12).

At approximately 1420L, the MRP briefed the sortie and profile to the MIP (Tab V-9.12). The MRP's brief lasted approximately 30 minutes (Tab V-9.12). The briefing covered all required items in accordance with Air Force Instruction (AFI) 11-2T-38v3, T-38—Operations Procedures, including NOTAMs, two Special Interest Items, forecast weather, and planned flying events (Tab V-9.12 to V-9.13).

c. Preflight

At approximately 1445L, the MIP and MRP travelled to Aircrew Flight Equipment (AFE) to don their flight gear (Tab V-9.4 and V-9.12). Both the MIP and MRP wore a HGU-55/P Combat Edge Flight Helmet (Tab H-29 and H-32). The MIP and MRP each were issued and used a MBU-20/P oxygen mask and a CSU-13B/P Anti-G-Suit (Tab H-29, H-30, and H-32). At approximately

1450L, the MIP and MRP travelled from AFE to the 87 FTS for the T-38 Operations Supervisor's step brief (Tab V-9.4).

The step brief included an updated weather forecast, NOTAMs, and an airfield status update (Tab V-9.4 and V-29.1 to V-29.2). The T-38 Operations Supervisor (Ops Sup) reviewed the MC's ORM sheet and concurred with the mission's risk assessment (Tab AA-2). Several witness accounts indicated the MRP was excited to get back to flying and appeared happy just prior to flying (Tab V-6.5, V-7.5, V-9.4, V-9.14, V-11.3, V-18.5, V-24.6, and V-25.2).

At approximately 1455L, the MRP and the MIP walked to the MA. The MRP inspected the MA (Tab V-9.4 and V-13.2 to V-13.3). The MIP reviewed the aircraft forms and conducted a discretionary limited cursory pre-flight inspection (Tab V-9.4). Neither the MIP nor MRP discovered or discussed any abnormalities prior to operating the MA (Tab V-9.4). The MIP noted no abnormalities during engine start and preflight operations (Tab V-9.4).

d. Summary of Accident

The MIP taxied the MA to the end of runway (EOR) area. During the taxi, the MRP initiated a call to remove ejection seat safety pins, stow them and to verify the seat was still in "SAFE" mode as required for ground operations (Tabs N-4 and BB-28). The MIP and MRP accomplished a final check of the MA and noted no discrepancies (Tab N-3 to N-4). The MRP then requested takeoff clearance from the air traffic control (ATC) tower (Tab N-4). The tower cleared the MA for takeoff at 1520L (Tab N-4).

At 1520L, the MRP taxied the aircraft onto the active runway (Tab N-5). The MRP called for the MIP to actuate a variety of switches (Tabs L-3 and N-4).

The dialogue below occurred after the MC was cleared for takeoff (Tab N-5 to N-6):

> Tower: Bully 29 Laughlin tower runway 13 center, winds 150 at 12, gust 17, cleared for takeoff, patterns.
>
> MRP: Bully 29 cleared for takeoff 13 center. K, ready canopies?
>
> MIP: Ready.
>
> MRP: C… lights on please.
>
> MIP: lights on.
>
> MRP: IFF is good. Confirm pitot heat on.
>
> MIP: Pitot heat on.
>
> MRP: And the speed brakes centered and up.
>
> MIP: Centered and up. This is where I usually go 60 as you're straightening out.

MRP: Oh yeah!... Oops, thanks. Here we go. Max. One, two good swings. MACS, tires, and we're go jet. 145. Come on baby. Gear, flaps. 200 and below 16. Here's 250. One comes out. Two comes out. Lariat, Bully 29, center request crosswind.

The 87 FTS' "Red Bull Flying Standards" outlines procedures for aircrew (Tab BB-2 to BB-33). Tab BB-28 contains a list of 87 FTS intra-cockpit challenge and response items that provide verbal statements to execute required checklist items (Tab BB-28). Multiple witnesses testified that these callouts must be executed and are normally initiated by the pilot flying the aircraft (Tab V-4.9, V-11.4, V-19.4 to 19.5 and V-24.5 to V-24.6). Under the procedures for "Taking the Active (runway)" the callout is to state: "Canopy Closed, lights out, seat hot, check both, guard the brakes" (Tab BB-28). The RCP should normally respond with, "Seat's hot, ISS both, guarding" (Tab BB-28). Items in TO-1T-38C-1CL-1 that are marked with an asterisk are to be confirmed/checked in both cockpits as required (BB-34).

The MRP, who was occupying the rear cockpit, was making call outs for checklist items, and the MIP was confirming (Tab N-5 to N-6). The last item marked with an asterisk that was confirmed/checked was "canopies" (Tab N-5). The checklist call outs and confirmation end after the MIP interrupted the normal flow with the comment, "this is where I usually go 60 as you're straightening out," and the MRP responds with, "Oh, yeah!" (Tab N-6). After the checklist interference, the MRP does not call out the last two "BEFORE TAKEOFF" checklist items: verifying in both cockpits the "SAFE/ARMED lever is "ARMED" and "(RCP) Confirm ISS mode selector – AS REQUIRED" (Tabs N-4, N-6, BB-28 and BB-34). "AS REQUIRED" in the case of dual-pilot operations, should be the "BOTH" position, allowing the pilot in either cockpit to initiate ejection for both pilots (Tabs H-3 to H-8 and BB-34). Out of habit, the MIP armed his own seat; however, the MRP's seat remained in the "SAFE" position, and the ISS remained in the "SOLO" position (Tabs H-19, V-9.5 and V-9.17).

At 15:21:05L, the MA departed Laughlin AFB, TX (Tab N-6). The MA delayed in the local tower controlled pattern and conducted a SSE pattern to a low approach (Tab N-6 to N-8). The MA then departed in accordance with the briefed local departure procedures (Tab N-8).

Following the slow flight exercise, the MRP raised the landing gear and flaps and prepared to depart the MOA by listening to the Automated Terminal Information System (ATIS) broadcast, and contacting ATC (Tab N-10 to N-12).

At 15:40:07L, the MRP contacted Del Rio approach ATC and requested a recovery to Laughlin AFB, TX through a visual navigation point named "West Fork" (Tab N-14). Del Rio approach ATC acknowledged the MRP's radio call and cleared the MRP as requested (Tab N-14).

At 15:40:21L, the MIP received and verbally acknowledged a Master Caution Warning (Tab N-14). The MIP identified and confirmed with the MRP the indications and began to diagnose the emergency condition (Tab N-14 to N-15). The MIP diagnosed that the MA had experienced an airframe mounted gearbox failure on the left side (Tabs N-14 to N-15 and V-9.7). The MIP referenced and executed the appropriate and applicable emergency procedures checklists (Tabs N-14 to N-16 and BB-36 to BB-37). MIP and MRP discussed and reached the decision to land as soon as possible in accordance with (IAW) the checklist (Tabs N-14 to N-15).

At 15:41:37L, the MIP directed the MRP to make contact with Del Rio arrival ATC (Tab N-15). At 15:42L, the MRP informed Del Rio arrival ATC of the MA's emergency condition stating the nature of the emergency as an airframe mounted gearbox failure, that there were two souls on board and that the MA had 30 minutes of fuel remaining (Tab N-15). Additionally, the MRP requested RADAR vectors for a visual approach to runway 13 center at Laughlin AFB, TX (Tab N-15). Del Rio arrival ATC asked the MRP if he had the airfield in sight to which the MRP responded in the affirmative prompting Del Rio arrival ATC to approve the MA for a visual approach to runway 13 center (Tabs N-15- N-16). The MRP, at the prompting of the MIP, informed Del Rio arrival ATC that the MA would stop straight ahead on the runway after landing causing a closure of the runway (Tab N-16). After completing necessary emergency checklist items, the MIP resumed control of the MA (Tab N-16).

At 15:43:52L, the MRP contacted the Ops Sup via radio and stated, "we're about 2 minutes from landing here. We're gonna shut down the center runway. Airframe mounted gearbox fail on the left" (Tab N-17). Additionally the MRP asked the Ops Sup to pass this pertinent information to the Supervisor of Flying (SOF) in the tower via phone (Tab N-17).

At 15:44:51L, the MRP and MIP simultaneously received a second master caution warning light accompanied by audio tones and failure of multiple electrical cockpit systems (Tab N-17). The MIP observed a flight hydraulic caution light, the associated flight hydraulic pressure indicator decreasing to zero, and a right generator caution light (Tab V-9.8). The MIP associated these indications with a right side airframe mounted gearbox failure (Tab N-17, and V-9.8). The failure of both the left and right side airframe mounted gearboxes resulted in a dual hydraulic failure condition (Tab J-2). In this condition, both hydraulic systems were inoperative and the MA was unresponsive to inputs made by the MIP and MRP (Tab J-2). The MIP and MRP discussed this new condition, and at 15:45:06L, the MIP stated, "No I can barely control it. Can you control it from the back?" (Tab N-18) At that point, control of the aircraft was positively transferred to the MRP, who indicated that he had limited control from the backseat (Tab N-18).

At 15:45:26L, the MIP made a broadcast transmission on the emergency frequency, "Guard" (243.0) stating, "Bully 29 is emergency aircraft. We have a dual hydraulic fail. Expect that we're going to be getting out of the aircraft" (Tab N-18). Following the Guard call, the MRP told the MIP that he wanted to try to avoid a populated area on the ground. The MIP agreed and instructed the MRP to stow loose items (Tab N-18).

At 15:45:54L, the MRP stated, "OK. let's see. I'm full left stick. Oh man, I don't like these houses," indicating potential difficulty controlling the aircraft and a concern for a populated area on the ground (Tab N-18).

At 15:46:10L, the MRP stated, "It's going to roll on us dude, we're going to have to go in a sec," referring to needing to eject (Tab N-18). Still concerned with the populated area the MIP and MRP delayed the command to eject until 15:46:19L (Tab N-18).

At 15:46:20L, both the MIP and MRP simultaneously initiated the ejection sequence by both stating the appropriate "BAIL OUT" command three times in rapid succession (Tab N-18). At the time of the bailout call, the MA was approximately 25 degrees right wing low and increasing right

bank in a slightly nose low attitude (Tab V-9.9). The MIP pulled the ejection handle and two seconds after the bailout call, the MIP successfully ejected from the MA (Tabs N-18 and V-9.9). The MRP attempted to eject, but was unsuccessful due to the seat configuration (Tabs N-18, J-2, X-2 and DD-6).

At the time of the ejection, the MA was between approximately 2,500 feet above ground level (AGL) to 2,000 feet AGL (Tab V-9.19). Off-board RADAR data collected during the investigation reinforces this altitude estimation; the last recorded RADAR plot shows the aircraft at 2100 feet AGL (Tab M-8). This RADAR plot is the last reinforced plot, meaning it had data from both the aircraft and the RADAR to analyze (Tab M-8). This coincided with the time of the second failure, as the devices located on the MA that would emit this data would have discontinued operation once the MA completely lost AC power (Tabs J-2 and M-8).

At 15:46:29L, the MA impacted the ground and the MRP was fatally injured (Tabs N-19 and X-2).

e. Impact

The MA crashed approximately twelve miles northwest of Laughlin AFB, TX at N 29 27’53.71”, W 100 57’10.66”, at 1,127 feet MSL (Tab DD-5). The crash site surface was flat, dry desert terrain with sparse vegetation (Tabs S-2 to S-7). The MA impacted the ground in an estimated 60 to 70 degree nose low, near 90-degree right wing down attitude (Tab H-10).

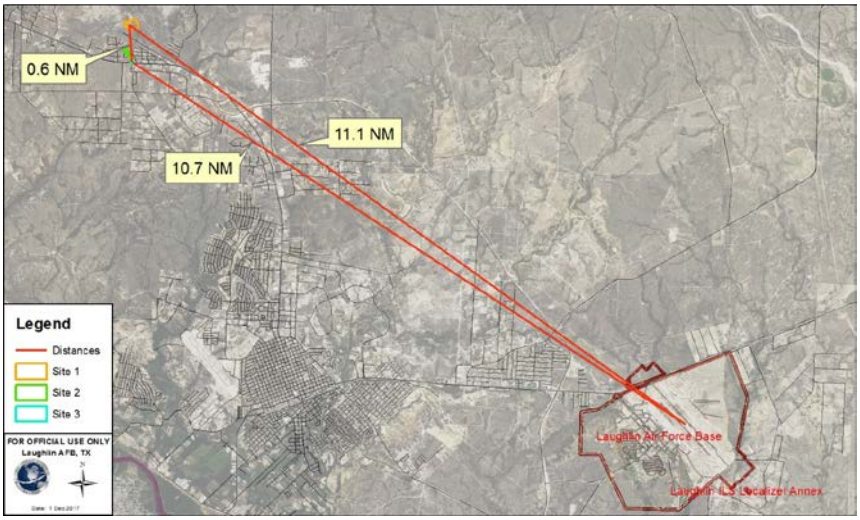


Figure 1: Impact Site Location (Tab S-9)

Aircraft ground scarring was consistent with a steep impact angle (estimated 60-70 degrees nose down) and right wing down (90 degrees) (Tab H-10).

Figure 2: Aircraft Orientation at Impact (Tab Z-3)

Figure 3: Chase View of Aircraft Orientation at Impact (Tab Z-4)

The impact crater created was round, measuring 15 feet in diameter and four feet deep (Tab H-10). A relatively small amount of wreckage was contained in the crater, with the majority of wreckage being small broken pieces (Tab H-10). Debris was found scattered over a 400-yard diameter debris field (Tab H-10). Large mass items (engines with attached structure) were located approximately 50 yards north from the impact crater (Tab H-10). The majority of small wreckage pieces were scattered in the northeast direction of the debris field (Tab H-10).

Figure 4: Aerial View of Impact Crater (Tab S-3)

Figure 5: Aerial View of impact site looking South (Tab S-2)

The MIP landed approximately 800 yards south of the crater; the front canopy was located 1,000 yards south of the crater (Tab H-10).

The National Park Service owns the land the MA impacted (Tab W-2). The crash caused a small brush fire (Tab S-4). Local residents and law enforcement authorities witnessed the crash and responded along with emergency crews to the crash site and MIP's location (Tabs V-9.9 to V-9.10 and DD-5 to DD-6).

f. Egress and Aircrew Flight Equipment

(1) Egress

The MIP ejected successfully with minor injuries (Tabs H-25 and X-4). The front ejection seat was recovered 800 yards south of the impact site and transported to Laughlin AFB for examination and analysis (Tab H-11).

The MRP attempted to eject but did not before he was fatally injured upon impact (Tabs H-25, N-18 to N-19 and X-2). The rear ejection seat was in the MA at the time of impact and the rear canopy and other ejection system components were located among the wreckage in the northeast area of the debris field of the impact site (Tab H-10). These components were collected and returned to Laughlin AFB for examination and analysis (Tab H-12).

Aircrew guidance in the required "Before Takeoff" checklist mandates both the "SAFE/ARMED lever – ARMED" and that the "(RCP) Confirm ISS mode selector – AS REQUIRED", which in the case of dual-pilot operations, should be the "BOTH" position, allowing the pilot in either cockpit to initiate ejection for both pilots (Tabs H-3 to H-8 and BB-34).

The MIP testified that the MRP and MIP completed challenge and response items pertaining to arming the ejection seats and that upon taking the runway the MIP completed the required actions (Tab V-9.5). Cockpit recording transcripts reflect no completion of verbal "challenge and response" communications relating to arming the ejection seats in accordance with the "Before Takeoff" checklist (Tab N-2 to N-6). Additionally, transcripts indicate that the MRP attempted to initiate an ejection, and this coupled with physical evidence gathered from the crash site concludes the MRP did not properly complete the "Before Takeoff" checklist items pertaining to the arming of the ejection seat (Tabs H-16 to H-19 and N-2 to N-6). This left the ejection seat improperly configured to operate when the MRP attempted to eject (Tab H-16 to H-19). The disparity between the transcript evidence and the MIP's testimony is attributed to the MIP arming his seat out of habit (Tab V-9.5 and V-9.17).

Witness marks (scratches and indentations) on the Arming Lever of the MRP's ejection seat at the crash site indicated the arming lever was improperly placed in the "SAFE" mode, preventing self-initiated ejection (Tab H-16 to H-19). Damage analysis of other related seat components confirmed the seat was in the "SAFE" mode at ground impact (Tab H-16 to H-19). Additionally, the ISS mode selector, located in the rear cockpit, improperly remained in the "SOLO" mode, preventing the MIP in the front cockpit from initiating ejection for himself and the MRP, possible even with MRP's seat in the "SAFE" mode (Tab H-3 to H-8 and H-16 to H-19).

(2) AFE

The MIP's AFE gear was recovered post-ejection and analyzed for malfunction (Tab H-25 to H-30). All inspected gear was operational within technical order standards at the time of the MIP's ejection (Tab H-25 to H-30). While minor deficiencies were noted among some of the items, none of these deficiencies were noted as significant to the outcome of the MS (Tab H-25 to H-30).

Failure of the MRP to eject resulted in the MRP's flight equipment experiencing significant damage during ground impact and subsequent fire (Tab H-31). Due to the condition of the gear, limited analyses and determinations were made (Tab H-31). A majority of the MRP's equipment was not recovered (Tab H-31).

g. Search and Rescue (SAR)

Two simultaneous search and rescue operations immediately commenced upon impact (Tabs N-40 to N-41, V-28.4 to V-28.6, V-29.2 and DD-8). Two T-38s and two T-6s from the 47 FTW located the crash site from the air (Tabs N-40 to N-41, V-28.4 to V-28.6, V-29.2 and DD-8). On the ground, local law enforcement authorities and Laughlin AFB emergency response crews responded (Tabs N-40 to N-41, V-28.4 to V-28.6, V-29.2 and DD-8).

(1) Air SAR

After hearing the MIP's Guard call and repeated attempts by Del Rio approach ATC to reach the MA, a T-38 assigned to the 87 FTS departed the local Laughlin AFB traffic pattern to approach the impact site (Tab N-23). Del Rio approach ATC provided vectors toward the MA's last known RADAR position (Tab N-20). A second T-38 assigned to the 87 FTS was recovering visually and proceeded to the impact site at the same time as the first T-38 (Tab N-21). At 15:52L, the first responding T-38 reported visual contact on the impact site reporting smoke on the ground (Tab N-22).

At approximately 15:50L, the Laughlin AFB SOF directed a 47 FTW assigned T-6 aircraft to depart Laughlin AFB and proceed to the impact site to assume the duties of the airborne on scene commander (OSC) (Tab N-49). When the T-6 OSC aircraft arrived on-scene, a Texas Department of Safety helicopter was already orbiting the impact area (Tabs N-26, V-8.2, V-8.5, V-28.4, and DD-6). This helicopter was repeatedly hailed on appropriate emergency frequencies, but contact was not established (Tab N-26 and N-28). The responding T-6 was overhead the impact site at approximately 15:58:20L (Tab N-25).

All three Air Force aircraft on scene began to relay to Del Rio approach ATC what they could see regarding the impact site and provided rough coordinates of the impact location (Tab N-22 and N-33). Additionally, as ground rescue entities approached the general area, they were able to help guide the responders to the impact location from their vantage point in the air using Del Rio approach ATC as an intermediary (Tab N-22 and N-33).

Following an ejection, an ejection personal locator beacon should have transmitted a continuous and recognizable radio signal, often referred to as an emergency locator transmitter (ELT) on an emergency radio frequency (Tab V-28.5). The airborne OSC and another airborne pilot did not observe any ELT beacon transmissions (Tab V-8.4 and V-11.3).

(2) Ground SAR

At approximately 15:48L, the secondary crash network reported that an aircraft had crashed near the San Pedro Campground, which notified emergency responders stationed at Laughlin AFB (Tab DD-5). Upon that notification, at approximately 16:00L, the 47th Security Forces Squadron (SFS)

dispatched two security forces Airmen to accompany responding fire, crash rescue units (Tab DD-5). Civilian authorities arrived first and Laughlin AFB units arrived on scene at 16:36L (Tab DD-5). Several civilian authorities responded including, Val Verde County Sheriff personnel, U.S. Border Patrol personnel, Val Verde Medical Center Emergency Medical Services personnel, National Parks Services personnel, Texas Highway Patrol personnel, and U.S. Immigration and Customs Enforcement personnel (Tab DD-5). At 20:30L, a 47 SFS investigator arrived and assumed responsibility from the 47 SFS Airmen (Tab DD-5).

Upon the MIP's landing, a civilian resident approached the MIP and he directed the individual to call 911 (Tab V-9.9 to V-9.10). The MIP then immediately used his own personal cell phone to call the T-38 Ops Sup to report his physical condition and relay his position, which he did by using a Google Maps pin drop (Tab V-9.10). Border Patrol and other civilian first responders also made contact with the MIP shortly after he landed (Tab V-9.10). After assessing that the MIP only had minor injuries and learning another pilot was involved in the mishap, the first responders left the MIP's location to search for the MRP and to eventually secure areas containing components of the MA (Tabs V-9.10 and DD-5). A short time later, an ambulance arrived and transported the MIP to the emergency room at Val Verde County Regional Medical Center (Tab V-9.10).

h. Recovery of Remains

On 21 November 2017, Regional Medical Examiners from the San Antonio Military Medical Center (SAMMC) responded to the crash site in Del Rio, TX to assist with the recovery of the MRP's remains (Tab X-2). The Regional Medical Examiners performed a comprehensive post mortem examination of the human remains (Tab X-2).

5. MAINTENANCE

a. Forms Documentation

(1) Summary

On 20 November 2017, the MA flew two mission flights earlier in the day, with a total flight time of 2.1 hours (Tab D-2). During the MS, the MA experienced a left-side airframe mounted gearbox failure causing a loss of utility hydraulic power that is a backup to the primary flight control system (Tab N-12). The left gearbox assembly had five previous failures related to the gearbox, none being a sheared shaft (Tab U-306). The left gearbox was installed in the MA on 22 August 2016 (Tab U-289 and U-306). Following the left-side failure, the right-side also failed (Tabs J-16, J-19, J-22 to J-23 and V-9.7 to V-9.8). Between 14 January 2016 and 20 November 2017, including the MS, the right gearbox assembly (S/N 5889) had failed seven times, all resulting in a sheared shaft (Tabs J-23 DD-9 and U-306). The right gearbox was installed on the MA on 8 October 2015 (Tab U-288 and U-306).

Active Air Force Technical Order (AFTO) Forms 781A series and historical record AFTO Forms 781A for the period of 90 days prior to the MS indicate eight actions that were classified as major maintenance items that included engine changes, a generator replacement, and a 25-hour inspection on the gearbox servicing (Tab U-306). Documentation of Time Compliance Technical Orders (TCTO) was complete (Tab D-9).

The MA flew 45 sorties (50 Hours) in the 90 days prior to the mishap (Tab U-290 to U-294 and U-306). A review of the maintenance records indicated on 15 sorties, aircrew reported no major maintenance problems (Tab U-18 to U-285 and U-306). On three sorties, aircrew reported some degraded performance (aircraft remained flyable) (Tab U-18 to U-285 and U-306). On one sortie that resulted in a ground abort (GA), aircrew reported maintenance problems that required repair before the MA was returned to flying status (Tab U-87 and U-306).

The historical AFTO 781 series forms indicate the MA did not fly from 6 November 2017 through 19 November 2017 (Tab U-2 to U-6 and U-306).

(2) Major Maintenance

Major maintenance is any maintenance action that requires the aircraft be removed from flying status to be checked for potential failures, to have major components (such as flight control surfaces, engines, etc.) removed, or to accomplish special inspections (Tab U-306). The following is a list of the MA's major maintenance actions for the 90 days preceding the MS:

i. On 21 August 2017, the aircraft was due for a 25-hour inspection (Tab U-72 and U306). The inspection was completed and reported no major discrepancies or unfavorable conditions (Tab U-72 and U-306). The MA was returned to service (Tab U-123 and U-306).

ii. On 29 August 2017, the aircrew reported pursuant to a Pilot Reported Discrepancy (PRD), the flaps were slow to retract three times during their sortie (Tab U-73 and U-306). Maintenance performed the prescribed operational checks in accordance with Technical Order data and found the flaps to be in good working order (Tab U-73 and U-306). The MA returned to service with no defects noted (Tab U-73 and U-306).

iii. On 11 September 2017, maintenance discovered the number one (left) engine to have stage one compressor blade damage, which could potentially be catastrophic at engine start (Tab U-124 and U-306). A replacement number one engine (left), S/N 00232904, was installed on the MA and checked for operational performance and release from impound. (Tab U-124 and U-306). The MA returned to service with no defects noted (Tab U-124 and U-306).

iv. On 14 September 2017, the MA was due for a 25-hour inspection (Tab U-85, U-130 and U-306). The 25-hour inspection of the gearbox requires the removal of access panels to allow for visibility of the oil sight glass to facilitate servicing of the airframe-mounted gearboxes and verify there is sufficient oil for safe operation (Tab U-85, U-130 and U-306). The inspection was completed with no action taken and the MA returned to service with no defects noted (Tab U-85, U-130 and U-306).

v. On 21 September 2017, pursuant to a PRD, the aircrew ground aborted the mission due to the number one (left) engine nozzle displaying "OFF" during pre-flight ground operations (Tab U-87 and U-306). In response, maintenance replaced the nozzle position transmitter (Tab U-87 and U-306). The MA was returned to service with no further defects noted (Tab U-87 and U-306).

vi. On 12 October 2017, pursuant to a PRD, the MA was reported to have had a left generator fail with no crossover availability (Tab U-88 and U-306). A technician performed a maintenance engine run on the MA and could not duplicate the left generator fail with no crossover availability malfunction (Tab U-88 and U-306). The MA was returned to service and flew on 17 October 2017 with no defects noted (Tab U-89 and U-306).

vii. On 25 October 2017, pursuant to PRD, the MA had a number one (left) engine RPM out of limits (Tab U-90 and U-306). Maintenance technicians performed a trim pad maintenance run (Tab U-90 and U-306). Maintenance determined number one engine (left) was within limits and returned to service with no defects noted (Tab U-132 and U-306).

There was no evidence to indicate that any of these major maintenance actions contributed to the mishap.

(3) Recurring Maintenance Problems

Recurring maintenance are actions that have occurred once and reappear after two to four flown sorties per AFI 21-101 (Tab O-2 and U-306). The AIB reviewed both active and historical AFTO 781 series forms and found no evidence of recurring maintenance of the right air frame gearbox that follow the definition given by AFI 21-101 (Tab O-2 and U-306). Maintenance personnel performed all actions required per the technical data (Tab T-79).

The right airframe mounted gearbox had problems dating back to 14 January 2016 (Tab J-23). While the trend was evident, the gearbox failures did not exceed the four-flight standard for defining them as recurrent maintenance issues (Tab U-306). However, there is evidence of six previous right gearbox coupling shaft failures of S/N 5889 in the 22 months prior to the MS, with the failure during the MS accounting for a seventh (Tabs J-23, J-26, U-306 and DD-9). Maintenance records show the last maintenance action on the right airframe gearbox was for an engine coupling shaft failure (Tab U-8 and U-306). The records further show the right gearbox was removed, bench checked satisfactorily, and reinstalled on 11 May 2017 (Tab U-8 and U-306). The timing of the gearbox failures fell outside the definition of Recurring Discrepancy as defined by AFI 21-101 and a pattern of failure, was therefore, not discovered or identified (Tab O-2 and U-306). The left gearbox assembly had five previous failures related to the gearbox, none being a sheared shaft (Tab J-23). On 22 August 2016, the left gearbox was installed in the MA (Tab U-289 and U-306). The left-side failures were documented as generator-related issues in Integrated Maintenance Data System (IDMS) as follows:

i. 5 December 2016: Left Generator will not crossover; corrective action was replacing the left power production panel (Tab U-18 and U-306).

ii. 28 January 2017: At 85% power left generator will not cross; corrective action was to replace the left power production panel (Tab U-33 and U-306).

iii. 6 February 2017: Generator light on after extending the landing gear; corrective action was to replace the bus tie contactor (Tab U-34 and U-306).

iv. 25 April 2017: Generator will not come online; corrective action was to reset the generator switch (Tab U-40 and U-306).

v. 12 October 2017: Generator will not crossover; corrective action was to perform operational check, which showed no deficiencies (Tab U-88 and U-306). Because maintenance could not duplicate the fault, MA was released and returned to service (Tab U-88 and U-306).

Material analysis revealed that there was a significant amount of wear on the internal gearbox clutch components and highlighted the previous six shaft failures dating back to 14 January 2016 (Tab J-22 to J-23).

Tail Number	JCN	Start Date
6400013213	160140051	January, 14 2016
6400013213	160970211	April, 07 2016
6400013213	161390164	May, 19 2016
6400013213	162860068	October, 13 2016
6400013213	163330130	November, 28 2016
6400013213	171290227	May, 12 2017

Figure 6: Right-Side Shaft Failure History (Tab J-23)

The 47 FTW maintainers lacked the tools necessary to conduct the level of analysis that would be required to detect the type of wear and tear identified by the T-38 System Program Office (Tabs J-22, J-25 to J-27, and V-17.2 to V-17.5).

(4) Unscheduled Maintenance

Unscheduled Maintenance is any maintenance action that is not the result of a scheduled inspection (Tab U-306). Unscheduled maintenance is typically the result of a PRD during flight operations or maintenance-personnel discovered discrepancy during ground operations (Tab U-306). During the 90 days prior to mishap, the MA had three unscheduled maintenance actions taken (Tab U-29, U-87, U-131 and U-306). First, the number one engine (left) was not producing revolutions per minute (RPM) causing a loss of thrust power (Tab U-29 and U-306). Next, the left generator was not operating as it was designed to, leading to a lack of redundant safety, failure of the right side power system, loss of avionics indications and electrical functionality of the aircraft (Tab U-131 and U-306). Finally, the number one engine's (left) nozzle position transmitter failed to function (responsible for controlling the position of the nozzle to help increase or decrease thrust based on position of the throttle setting) (Tab U-87 and U-306).

(5) AFTO 781A

The AFTO Forms are maintenance forms used to document maintenance actions taken on an aircraft (Tab U-306). The MA active AFTO Form 781A had a start date of 19 November 2017, with no grounding discrepancies at the time of the mishap (Tab D-3 to D-6). One discrepancy was discovered in the forms for a 60-day document review of the MA's forms but had no contributing effects to the mishap (Tab D-5). AFTO Forms 781A historical hard copy documents indicate a 60-day document review had been completed on 7 November 2017, whereas the active AFTO

Forms 781A indicates at time of MS, the 60-day document review was past due as of 12 November 2017 (Tab D-8). However, this appears to be a transcription error in the AFTO Form 781A because IMDS, the final authority on this issue, indicates the review was completed on 17 November 2017 (Tab U-4 and U-306).

(6) AFTO 781K

The AFTO 781K active forms, which document required inspections, indicated the 60-day document review inspection was overdue as of 11 November 2017 (Tab D-8). However, as stated above, this appears to be a transcription error in the AFTO 781K because IMDS represents the final authority and indicates the review was completed on 17 November 2017 (Tab U-4 and U-306).

(7) Pre-Flight Operational Checks

AFTO Form 781H provides the current flight condition of the aircraft, current flight hours, and current fuel status (Tabs D-3 and U-306). In accordance with T.O. 00-20-1, when a period of 72-hours has elapsed with no maintenance or flight activity, an aircraft requires an updated 72-hour pre-flight inspection before aircraft release (Tab U-306). The MA AFTO Forms 781H dated 2 November 2017 to 6 November 2017 indicate the appropriate maintenance personnel completed all basic post-flight/pre-flight inspections on 6 November 2017 (Tab U-2 and 306). The attendant supervisor signed the inspections (Tab U-2 and U-306). Between 6 November and 19 November 2017, the MA did not fly (Tab U-2 to U-6 and U-306). On 19 November 2017, the aircraft attendant performed updated pre-flight inspections of the MA, which are annotated in the AFTO 781H active forms (Tab D-3).

b. Inspections

(1) Mishap Aircraft

On 6 November 2017, the aircraft attendant annotated in the AFTO Form 781A that maintenance personnel performed a basic post-flight/pre-flight inspection of the MA at the end of the flying day (Tab U-4 and U-306). On 19 November 2017, the aircraft attendant annotated in the AFTO Form 781H that he performed the 72-hour preflight requirement inspection (Tabs D-8 and V-21.1 to V-21.3).

On 20 November 2017, the expeditor signed the Exceptional Release (ER) verifying the 72-hour inspection had been completed and that the MA was airworthy (Tab V-16.2). When the ER was accomplished, the MA was ready for flight status (Tabs D-2 and V-16.2). The ER serves as a certification that the expeditor reviewed all active forms, acknowledging that the aircraft inspections are complete, and that the aircraft was safe for flight in accordance with AFI 21-101 (Tab U-306). Maintenance Records show all inspections required prior to the MS were performed IAW T.O. and AFI guidance's and no anomalies were found (Tab U-306).

(2) Engines

Analysis of the cockpit recording and MIP testimony indicate that the engines were functioning properly at the time of the mishap (Tabs N-14 to N-18 and V-9.7).

c. Maintenance Procedures

Maintenance Records show all maintenance procedures prior to the MS were performed IAW T.O. and AFI guidance's and no anomalies were found (Tab U-306).

d. Maintenance Personnel and Supervision

A comprehensive training records review revealed maintenance personnel that worked on the gearboxes were civil servants assigned to a Maintenance Support Unit who were qualified and competent to complete their assigned tasks (Tab T-12 to T-79).

e. Fuel, Hydraulic and oil inspection Analyses

MA received the appropriate amount of fuel after the previous mission (Tabs D-4 and K-5). The MA did not require oil service of either engine prior to the MS (Tab D-4).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structure and System

The MA configuration for the MS was as follows:

The MA is not capable of carrying any station pylons, armament, and is not capable of carrying a travel pod (Tab D-2).

(1) Flight Controls

i. Analysis indicates that all flight controls were in the expected position upon impact commensurate with the failures experienced by the MA in flight (Tab J-4 to J-16).

ii. The recovered aileron actuators were recovered relatively undamaged and in the near neutral position. Further analysis indicates that both actuators passed all testing requirements (Tab J-4, J-6 to J-7, J-12 to J-13 and J-15). The neutral position of the aileron actuators is expected when the system is operating normally with no additional input at the control stick and with loss of both hydraulic systems (Tab J-15).

iii. The horizontal stabilizer actuators were recovered in relatively good condition (Tab J-7). Analysis of the horizontal stabilizer actuators determined they were in a near neutral position, which is expected with loss of both hydraulic systems (Tab J-15).

iv. The rudder actuators were recovered in good condition; analysis revealed the rudder actuators functioned as designed (Tab J-7, J-13, and J-16). The rudder actuators were in the neutral

position, which is expected with no additional input at the rudder pedals or loss of both hydraulic systems (Tab J-16).

v. The Stability Augmenter Yaw Actuator (SAYA) was recovered in the neutral position, which is expected with no additional input at the rudder pedals or loss of both hydraulic systems (Tab J-8, J-14, and J-16).

vi. The left flap motor was recovered in the fully retracted position, consistent with the flap being up; due to extensive damage, the position of the right flap could not be determined, but there is no evidence to suggest the right flap was not in the fully retracted position (Tab J-15 to J-16).

(2) Engines

The MA was equipped with two (2) J85-GE-5 afterburning engines (Tab CC-7). On 11 September 2017, the number one engine (left) S/N GE00232904 was installed on the MA (Tab U-75 and U-81). The number one engine (left) had 11,929.5 hours of flight time to include the two previous flights at time of mishap (Tab D-3 and D-7). At the time of the MS, the number one engine (left) was due for its next 900-hour inspection in approximately 129.2 hours (Tab D-3 and D-7). On 24 July 2017, the number two engine (right) S/N GE00232285 was installed on the MA (Tab U-67). The number two engine (right) had 10,329.2 hours of flight time to include the two previous flights at time of the mishap (Tab D-3 and D-7). At the time of the MS, the number two engine (right) was due for its next 900-hour inspection in approximately 659.9 hours (Tab D-3 and D-7). The cockpit transcript and MIP testimony both show the engines were performing as designed and neither engine contributed to the mishap (Tabs N-12, and V-9.7).

(3) Hydraulic

The utility control (left) and flight control (right) hydraulic systems supply pressure through an engine driven hydraulic pump powered via a gearbox drive shaft system (Tab J-21 and J-62). The system is connected through couplings at the engine and the airframe mounted gearbox for each engine (Tab J-62 and J-68 to J-69).

Each engine of the T-38 drives an accessory power assembly, which contains a hydraulic pump and electrical generator (Tab J-62). Power is transferred from the engine, through an engine-mounted gearbox, an input drive assembly, a power shaft, an output drive assembly, and an airframe mounted gearbox to the accessories (Tab J-62).

Within each coupling on the engine gearbox, or “input” end of the gearbox drive shaft, there is a splined shaft designed to shear at a given location in the event of a torsional overload (Figure 8 (Tab J-16, J-68 and J-73)). The shear point is an intentional failure point designed to limit damage to the electrical and hydraulic systems (Tab J-62). Manufactured to shear within a range of 1,900-2,200 inch-lbs, the coupling shafts are integrated into the power transfer drive assembly for each engine (Tab J-19).

Figure 8: Designed Shear Point (Tab J-73)

During the MS, the MA's left engine coupling shaft experienced a shear when torsional loading exceeded designed limits during a power reduction (Tab J-16, J-19 and J-64 to J-65). The coupling shaft experiences peak torsional loads during engine RPM changes that transit the shift range (65 – 75% RPM) of the gearbox (Tabs J-22 and BB-38). When the MA's left engine coupling shaft sheared, it caused an associated loss of electrical power and hydraulic pressure to the utility system, thus reducing flight control response (Tab J-20 to J-21). The electrical system and hydraulic system of the right side airframe mounted gearbox is designed to accept the additional torsional load and compensate for the loss (Tab J-22 and J-25).

The MA's right side system accepted the additional torsional load from the left side adding to the torsional load of the right engine's coupling shaft (Tab J-22 and J-25). This torsional load appears to have been in excess of the designed shaft capacity, which was unable to accommodate the increased load (Tab J-19 to J-20 and J-35). While the system is designed to be able to handle this loading, the right side gearbox and generator system had pre-existing degradation (Tab J-21, J-25 to J-26 and J-35). As outlined below in Section 5 Electrical, the right side generator demonstrated evidence of a single phase short, which would have created increased torsional loading on the right side prior to the introduction of the left side loading (Tab J-21, J-25 to J-26, and J-35). Additionally, subsequent systems program office (SPO) analysis of the gearbox revealed the presence of significant wear on internal components of the right airframe mounted gearbox, which would have also created an increase in torque (Tab J-22). These two conditions combined would have been sufficient to increase the torsional load on the coupling shaft (Tab J-22). These two pre-existing conditions, along with the introduction of the torsional load from the failed left side, cumulatively exceeded the design limits of the coupling shaft causing it to shear (Tab J-22). The condition created by dual gearbox coupling shear resulted in the total loss of hydraulic pressure (Tab J-2 and J-21). Without available hydraulic pressure, control of the aircraft is not possible (Tabs J-2, J-21, and V-9.8).

(4) Fuel

MA received the appropriate amount of fuel after the previous mission. (Tabs D-4 and K-5). Laboratory tests determined that JP-8 aviation turbine fuel, hydraulic fluid, and aircraft engine oil samples taken post-accident from servicing equipment were within limits and free of contamination (Tab U-295 to U-296).

(5) Electrical

The electrical system receives operational input in the same way as the hydraulic system as outlined above in Section 6(a)(3). The MA suffered a left generator failure due to left engine coupling shaft failure through rotational torque overload while in the power shift range (Tabs J-19, J-65 and V-9.7). Subsequently, the left torsional overload resulted in an excess load to the right generator as it assumed the additional load (Tab J-26).

Subsequent SPO analysis of the right generator discovered an internal system short, which could have happened at any time prior to the MS (Tab J-21 and J-35). The existence of this fault could have contributed to higher than normal torsional loading and the shearing of the right engine coupling shaft under the added stress of the left side failure (Tab J-25 to J-26).

(6) Emergency Power System

Not Applicable (N/A). The MA did not have an emergency power system.

(7) Egress System

Review of AFTO Forms 781A, AFTO Forms 781K maintenance documents and IDMS revealed all maintenance, Time Change Technical Orders (TCTOs) and Time Change Item (TCI) items were accomplished and up to date for both the front and rear ejection seats (Tab D-8).

The MA was equipped with the latest Escape System Upgrade Martin Baker MKUS16T ejection seat (Tabs H-3 and U-286 to U-287). The system is qualified for use from zero to 50,000 feet altitude (Tab H-3). The Inter-seat Sequencing System (ISS) mode selector is mounted to the rear ejection seat only and has three ISS modes: SOLO, BOTH, and Command Forward (CMD FWD)(Tab H-3). In the SOLO mode, when the front seat firing handle is pulled only the front seat ejection sequence is started; if the rear seat firing handle is pulled only the rear seat ejection sequence is started (Tab H-4). This mode is designed to be utilized only when the aircraft is occupied by a single front crew-member to accomplish the fastest possible ejection from the aircraft (Tab H-4). In the CMD FWD mode, when the front seat firing handle is pulled, the ejection sequence is started for both seats (Tab H-4). If the rear seat firing handle is pulled, only the ejection sequence for the rear seat is started (Tab H-4). In the BOTH mode, the ejection sequence is started for the two seats when the front or rear seat firing handle is pulled (Tab H-4). In accordance with 87 FTS flying standards, the BOTH mode is utilized when both cockpits are occupied (Tab BB-28 and BB-34 to BB-35). In BOTH mode, the ejection sequence operates with the rear ejection seat leaving first, followed by the front ejection seat after a 1.3 seconds delay (Tab H-6 to H-7). Analysis indicates there was no evidence of gas pressure flowing through the system for the rear seat, indicating the SAFE/ARMED Handle was in the SAFE position (Tab H-13 to H-17).

Analysis of the MRP's seat revealed identifying witness marks (scratches and indentations) indicating the ISS mode selector was set in the SOLO mode position instead of BOTH at the time of impact (Figure 9 (Tab H-18)). The expected position of the ISS for dual-pilot operations is BOTH (Tab BB-28 and BB-34 to BB-35). Additionally, witness marks on the Arming Lever indicate the MRP seat was in SAFE mode and not ARMED at the time of impact (Figure 10 (Tab H-16)). The improper position of ISS mode selector and arming lever would have prevented the seat from successfully ejecting from the aircraft despite the ejection handle being pulled in either seat (Figure 10 (Tab H-16 to H-18)).

Figure 9: Exemplar and Mishap ISS Valve with Witness Marks (Tab H-18)

Figure 10: Arming Lever with Witness Marks (Tab H-16)

b. Evaluation and Analysis

All maintenance was performed in accordance with applicable technical data (Tab U-306). The flight control system was operating as designed and in the expected position upon impact (Tab J-15 to J-16).

The MA was operating normally and within expected parameters during the MS until the engine coupling shafts sheared (Tab V-9.7). The left shaft shear resulted in a left generator failure and a left side hydraulic failure (Tabs J-22 and V-9.7). Redundancies designed into the T-38 transferred both the electrical load and hydraulic load to the right side components thus increasing the torsional load on the right engine gearbox coupling (Tab J-21 to J-22). The highest loading of the coupling shaft occurs as the aircraft gearbox shifts from one gear ratio to the other (Tab J-22). These torque spikes (referred to as transient shifting torque) caused during shifting have been a problem with the T-38 since its introduction; in response, the gearbox was overhauled in 1960 to reduce these spikes/reduce the number of failed coupling shafts (Tab J-22). However, once installed on the aircraft, several factors increase the transient shifting torque, including wear of internal gearbox components (Tab J-22). SPO teardown of the right gearbox indicated that there was a significant amount of wear on the internal gearbox clutch components (Tab J-22). Additionally, the right generator displayed evidence of an electrical short, which cumulatively would have created increased strain on the gearbox couplings prior to the acceptance of the additional left side load (Tab J-22 and J-25 to J-26). The right engine's history of coupling shaft failures is indicative of a less than optimal performance of the right side gearbox assembly and further indicates that the right side coupling was likely experiencing higher than normal (but still within limits) loading prior to the failures on the MS (Tab J-23 and J-25). The pre-existing unfavorable condition of the right gearbox would have likely increased the transient shifting torque produced by that gearbox, exceeding the designed torsional load and causing it to shear (Tab J-22 and J-25). After both shafts sheared, the engine-driven hydraulic pumps immediately ceased to operate, and therefore, no hydraulic pressure was available to control the aircraft (Tabs J-2, J-21 to J-22, and V.9-7).

7. WEATHER

a. Forecast Weather

Laughlin AFB (KDLF) weather forecast at the time of the MA takeoff was few clouds at 12,000 feet MSL, few clouds at 25,000 feet MSL with winds out of the south at 10 knots gusting to 15 knots (Tab F-2 to F-3). Additionally, light to moderate turbulence was forecast between 22,000 feet and 41,000 feet (Tab F-2 to F-3). No significant icing or convective activity was forecast (Tab F-2 to F-3).

The Ranch MOA weather forecast was reported as cloud layers from 22,000 feet MSL to 26,000 feet MSL (Tab F-2 to F-3).

b. Observed Weather

On 20 November 2017 at 14:56:00L, the observed weather was as follows:

Weather at takeoff at Laughlin AFB, TX (KDLF) according to a meteorological aviation report (METAR) was 10 miles of visibility and an observed broken layer of clouds at 19,000 feet MSL (Tab F-7). The observed winds from the automated weather report were from 160 degrees at 14 knots (Tab F-7). During the takeoff clearance issued by Laughlin Tower, the winds were reported as being from 150 degrees at 12 knots with gusts to 17 knots (Tab N-4).

Another METAR issued at 15:51:00L, observed the weather again as 10 miles of visibility and an observed broken layer of clouds at 19,000 feet MSL (Tab F-7).

At 14:53:00L, the Del Rio International Airport (KDRT) METAR reported clear skies, and 10 miles of visibility, winds from 140 degrees at 10 knots (Tab F-8). At 15:53:00L, the KDRT METAR reported clear skies, 10 miles visibility with winds from 150 degrees at 13 knots with gusts to 17 knots (Tab F-8).

At the time of the mishap, the environmental conditions were full daylight with a fully discernible horizon and no impediment to visibility (Tab F-2).

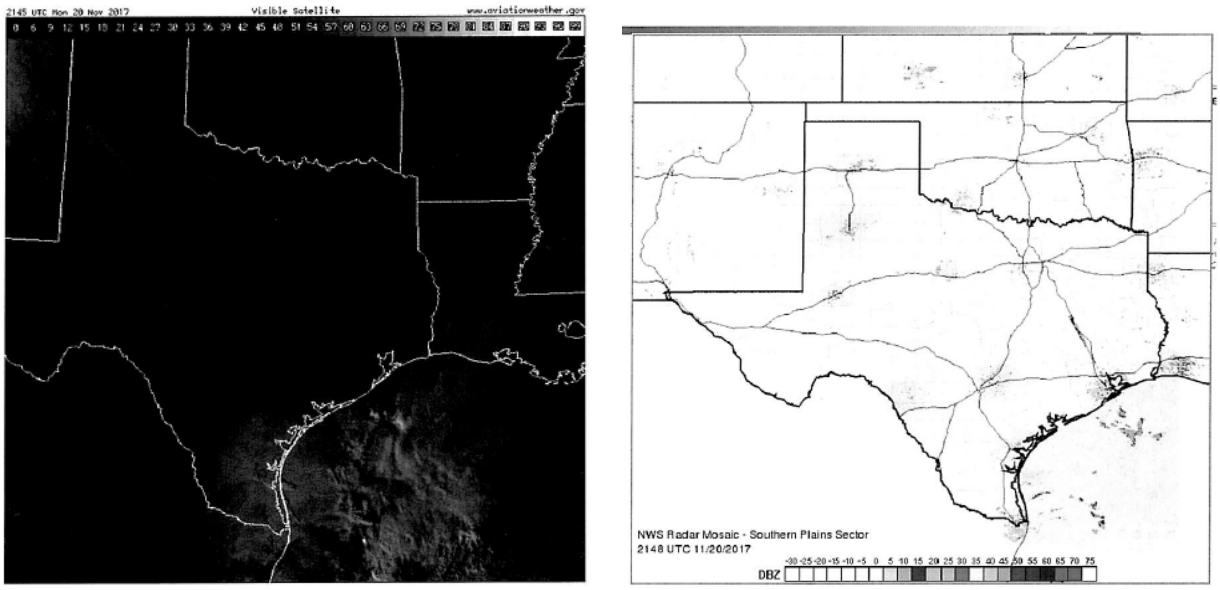


Figure 11: Visible satellite weather (Left) and Radar Weather (Right) (Tab F-12 to F-13)

c. Space Environment

Not applicable.

d. Operations

Review of the applicable weather data did not disclose any weather phenomena that met or exceeded any operational limitation for the MA (Tab F-7 to F-8).

8. CREW QUALIFICATIONS

a. Mishap Instructor Pilot

The MIP had approximately 861.8 total flight hours at the time of the mishap (Tab G-11). The MIP had 330.3 hours in the T-38C (Tab G-11). Prior to his assignment as an Undergraduate Pilot Training (UPT) Instructor, the MIP had approximately 506.0 hours in the A-10C and 25.5 hours in the T-38C as an Introduction to Fighter Fundamentals (IFF) student (Tab G-11). Additionally, the MIP had logged approximately 138 hours combined in A-10 and T-38 simulators throughout his aviation career (Tab G-11).

The MIP's recent flight time was as follows:

	Total Time	**Primary Time**	**Instructor Time**	**Total Sorties**
30 Days	19.0	1.1	17.9	17
60 Days	36.2	3.2	33.0	34
90 Days	58.6	7.9	50.7	57

Table 1: MIP 30/60/90 Day Totals (Tab G-11)

	Total Time	**Primary Time**	**Instructor Time**	**Other**
T-38C IFF	25.5	22.2	0.0	3.3
A-10C	506.0	506.0	0.0	0.0
T-38C	330.3	129.4	176.6	24.3
Total	861.8	657.6	176.6	27.6

Table 2: MIP Total Flight Time Breakdown (G-11)

The MIP had a current AF Form 8 (Certificate of Aircrew Qualification) instrument qualification flying evaluation dated 11 October 2017 (Tab G-55 to G-56). The MIP completed an initial instructor mission flying evaluation on 13 September 2016 upon graduation of initial Pilot Instructor Training (PIT) at Randolph AFB, TX (Tab G-57 to G-58). The MIP was in his third month of a 6-month eligibility period for a renewal of his mission qualification evaluation; however, the MIP was current and qualified in all aspects of the mission (Tab G-55 to G-58).

The MIP's training records indicate that prior to the MS his last emergency egress and ejection seat training occurred on 7 June 2017 (Tab T-5). His most recent aircrew flight equipment and emergency parachute training prior to the MS was conducted on 27 June 2017 (Tab T-4).

The MIP's AF Form 4348 (USAF Aircrew Certifications) shows the MIP was certified as an experienced level instructor pilot on 28 April 2017 and certified to instruct Theater Indoctrination (TI) and requalification sorties on 23 June 2017 (Tab T-2).

b. Mishap Requalification Pilot

The MRP had approximately 1,027.3 total flight hours at the time of the mishap (Tab G-3). Prior to his assignment as a UPT Instructor, the MRP had approximately 822.0 hours in the B-52 (Tab G-3). Of this time in the B-52, 398.3 hours were listed as primary time and 347.2 hours as secondary time (Tab G-3 to G-4). The remainder was listed as "other" time (Tab G-3 to G-4). The MRP also had 239.0 hours of B-52 simulator time and 25.8 hours of T-38 simulator time (Tab G-3 to G-4).

The MRP's recent flight time was as follows (Tab G-3 to G-4):

	Total Time	Primary Time	Instructor Time	Other Time	Total Sorties
30 Days	3.3	2.2	0.0	1.1	17
60 Days	3.3	2.2	0.0	1.1	34
90 Days	3.3	2.2	0.0	1.1	57

Table 3: MRP 30/60/90 Day Totals

	Total Time	Primary Time	Secondary Time	Instructor Time	Other Time
B-52H	822.0	398.3	347.2	0.0	76.5
T-38C	205.3	114.1	0.0	86.1	5.1
Total	1027.3	512.4	347.2	86.1	81.6

Table 4: MRP Total Flight Time Breakdown

	Total Time	Primary Time	Instructor Time	Other Time	Total Sorties
T-38C	4.3	3.2	0	1.1	5

Table 5: MRP Sortie Breakdown Post Deployment Return

The MRP's AF Form 4348 (USAF Aircrew Certifications) shows the MRP was certified as a mission ready instructor pilot when he first arrived at Laughlin on 25 April 2016 (Tab T-7). This is the moniker given to an incoming instructor pilot who has completed TI and authorized to fly with student pilots (Tab V-1.2).

The MRP had an expired AF Form 8 instrument qualification flying evaluation dated 9 September 2015 completed during PIT at Randolph AFB (Tab G-26 to G-29). The MRP completed an initial instructor mission flying evaluation on 9 December 2015 upon graduation of PIT (Tab G-26 to G-27). The MRP was expired in his mission qualification evaluation at the time of the MS (Tab G-26 to G-27). The MRP's expiration of these two qualifications was due to a recent deployment during which the MRP's qualifications expired (Tabs T-169 and V-4.1). Upon return to Laughlin

AFB, the MRP entered into a locally developed and 19 AF approved requalification (RQ) plan beginning 7 August 2017 (Tabs G-32 and V-4.1 to V-4.2).

The MRP's approved RQ plan was comprised of three basic phases: A ground training phase, a requalification phase, and a recertification phase (Tab G-32). The ground phase required a self-study regimen of rules, regulations, aircraft limitations, local area procedures, emergency procedures and a variety of required tests (Tab G-33). Additionally, the ground phase of the RQ plan required interviews with the squadron commander and operations officer (Tab G-33). Many of the ground phase items were prerequisites to starting the flight phase and were annotated in the MRP's RQ paperwork with an "*" denoting required completion prior to flight (Tabs G-32 and V-4.4). The RQ phase required two practice simulators (Tab G-34 to G-35). In addition, the flight phase consisted of eight training sorties (Tab G-32 and G-34). The sortie breakdown was one instrument sortie, three transition sorties, three formation sorties (two as a 2-ship, one as a 4-ship), and a low-level sortie (Tab G-32 and G-34). The recertification phase required an Emergency Procedures Evaluation (EPE) simulator and two recertification sorties (Tab G-32 and G-34). The EPE is a required portion of the AF Form 8 aircrew qualification missions (Tab G-32 and G-34). The evaluation sorties consisted of an instrument qualification sortie and an instructor mission qualification sortie conducted in accordance with AFI 11-202, Volume 2 and TO 11-2T-38C Volume 2 to satisfy the requirements for a complete AF Form 8 checkride (Tab G-32 and G-34). The EPE was not a prerequisite that needed completion prior to the MRP participating in RQ sorties (Tab V-4.3).

The MRP's training records indicate that his last emergency egress and ejection seat training occurred on 8 August 2017 (Tab T-8). His most recent AFE and emergency parachute training was conducted on 8 August 2017 (Tab T-8). This training was conducted as a prerequisite to the MRP's first requalification sortie (Tab G-32).

At the time of the mishap, the MRP had flown a total of five sorties since his return from deployment (Tab G-2). The MRP had begun his RQ training in early August 2017 and completed three simulators and two RQ sorties (Tab G-3 to G-4 and G-32). On or about 22 August 2017 the MRP was put on Duties Not Including Flying (DNIF) status due to an ongoing and chronic injury (Tab X-3). On 13 November 2017, the MRP was once again cleared to fly (Tab X-6). Due to the excessive break in training continuity, squadron leadership decided the previously-flown sorties would be counted as "additional sorties," meaning the MRP would re-accomplish these sorties in the new block of training following an observation or "sandbag" flight (Tab V-4.4 to V-4.5). Between the time the MRP returned to flying status and the MS, he had flown one observation sortie in the rear seat, one instrument sortie in the front seat, one transition sortie in the front seat, and the MS was a transition sortie from the rear seat (Tab G-3 to G-4, G-32).

9. MEDICAL

a. Qualifications

The MIP and the MRP were medically qualified for Flying Class II duties at the time of the MS (Tab X-7 and X-8). The MIP's most recent periodic health assessment (PHA) was completed on 26 June 2017, and he was issued a DD 2992 valid until 23 September 2018 (Tab X-8). The MRP's

most recent PHA was conducted on 17 November 2017, and he was issued a DD 2992, valid until 14 February 2019 (Tab X-7). Neither the MIP nor the MRP had medical flying waivers (Tab X-4, X-5, and X-7). Neither was required to wear corrective lenses for flying duty (Tab X-5 and X-7).

b. Health

The Medical Member of the AIB reviewed the medical records and 7-day/72-hour histories of the MIP and the MRP (Tab X-3, X-5, and X-9 to X-16). Both the MIP and the MRP were medically qualified for flying duty on the day of the MS (Tab X-2, X-4, X-5, X-6, and X-9).

The MIP suffered minor injuries following the ejection from the MA, and he was returned to flying duty after brief grounding period (Tab X-4, X-5, and X-9).

The MRP was fatally injured in the mishap (Tab X-2).

c. Pathology

The MRP's autopsy findings and photographic evidence were consistent with the nature of the crash (Tab X-2). The autopsy showed the cause of death to be "multiple injuries" (Tab X-2).

d. Lifestyle

Witness testimony and 7-day/72-hour histories for both the MIP and the MRP revealed no unusual lifestyle factors (Tabs X-3, X-5 and X-9 to X-16, V-2.3, V-5.4V-7.4 to V-7.5, V-9.14, V-9-20 to V-9.21, V-11.2, V-11.4, V-11.5, V-18.3 to V-18.5 to V-18.6, V-18.8, V-19.3 to V-19.4, V-24.6, V-25.4, X-10 to X-17 and X-18 to X-19). Additionally, the PHA questionnaires for both the MRP and MIP revealed no areas of concern (Tab X-3 and X-5).

e. Crew rest and flight duty period (FDP)

Crew rest and FDP are addressed in AFI 11-202, Volume 3. According to AFI 11-202, Volume 3, dated 10 August 2016, crew rest is mandatory before performing flight-related duties and is a minimum of 12 non-duty hours prior to when the FDP begins. Crew rest must include an opportunity for 8 hours of uninterrupted sleep. The FDP begins when the crew member reports for official duties.

Crew rest and FDP information for the MIP were obtained from the 72-hour history that he provided to the AIB (Tab X-18 to X-19). The MIP had more than 12 hours of crew rest prior to the start of the FDP of the day of the MS (Tab X-18). He reported seven hours of good quality sleep on the night prior to the MS. On the day of the MS, the MIP's FDP began at 0620 hours (Tab X-18). According to AFI 11-202, Volume 3, the maximum FDP for trainer aircraft is 12 hours.

Crew rest and FDP information for the MRP were obtained from the 72-hour history provided by his spouse (Tab X-10 to X-17). The MRP had 9.5 hours of good quality sleep prior to the MS and the day prior to the MS was a non-duty day; as such, crew rest requirements were met (Tab X-10).

10. OPERATIONS AND SUPERVISION

a. Operations

The AIB found no evidence that indicated opertations tempo or other operational factors contributed to the mishap.

b. Supervision

The MIP was fully current and qualified to conduct the assigned mission on the day of the mishap sortie (Tab AA-4). The MIP was acting in the instructor role and supervising the MRP's requalification backseat sortie (Tab V-9.3). The MIP had an adequate number of sorties in the previous three months indicating currency and proficiency in his mission set (Tab G-11).

The MRP was not fully qualified to perform IP duties and was in a requalification program to regain the required qualifications (Tab G-30 to G-50). The MRP had become non-current due to a contingency deployment where he was not on flying status (Tab V-4.1 to V-4.2). Through the duration of the deployment, his flying currencies and qualifications had lapsed (Tab V-4.1 to V-4.2). The MRP had meet all requirements and currencies to fly the MS under the supervision of a TI instructor pilot. In the previous week, the MRP had flown three other sorties: one observation flight in the rear seat, a front-seat instrument sortie, and another rear-seat transition sortie (Tab G-3, G-30 to G-50, and AA-6).

The Supervisor Of Flying (SOF) was a T-6 pilot who had been SOF qualified for 2 months at the time of the mishap (Tab V-20.2). The SOF supervised ground operations, ATC operations, and established airfield divert bases, as required (Tab V-22.3). In this flight emergency, the SOF supported the MA by coordinating with control agencies and squadron operations (Tabs N-46 to N-57 and R-2 to R-6). The SOF reported directly to the 47 OG/CC (Tab V-20.3). On the day of the mishap, the SOF executed the Downed Aircraft Checklist and coordinated the SAR operations (Tabs N-46 to N-57 and R-4).

The AIB found no evidence that supervison or supervisory practices contributed to the mishap.

11. HUMAN FACTORS

a. Summary

AFI 91-204, *Safety Investigations and Reports*, Attachment 6 outlines the Department of Defense Human Factors Analysis and Classification System (DoD HFACS). A human factor (HF) is any environmental, technological, physiological, psychological, psychosocial, or psycho-behavioral factor a human being experiences that contributes to or influences his or her performance during a task. The DoD HFACS is divided into four pillars of failure: acts, preconditions, supervision, and organizational influences.

To aid in the analysis of the HFs, the AIB separated the events into three areas of concern: (1) Maintenance; (2) Prior to takeoff; and (3) Ejection sequence.

b. Human Factor #1

Maintenance
SI004 Supervision – Policy

Supervision – Policy is a factor when policy or guidance or lack of a policy or guidance leads to an unsafe situation.

AFI 21-101, *Aircraft and Equipment and Maintenance Management*, dated 21 May 2015, para. 15.2.3, requires that Aircraft Document Reviews (ADR) are to be conducted every 60 days on the aircraft forms. The purpose of the ADR is to verify that the forms are completed properly and to correct any maintenance documentation deficiencies. There is a lack of guidance with regard to examining the records for duplicate maintenance entries or maintenance trends.

Between 14 January 2016 and 20 November 2017, the date of the MS, the right gearbox failed seven times (Tabs J-23 and DD-9). On two occasions, the MA had write-ups for a right gearbox failure that occurred within 60 days of one another (Tab J-23). Since the ADR is time driven, not event driven, the duplicate gearbox failures that occurred within 60 days of one another may not have shown up on the ADRs depending upon the timing (Tab U-306). Had two gearbox failures shown up on the same ADR, the duplicate malfunctions would not be readily apparent to maintenance personnel since this is not the purpose of the ADR (Tab U-306).

AFI 21-101 addresses duplicate failures. A repeat discrepancy is defined as a discrepancy that "occurs on the next sortie or attempted sortie after corrective action has been taken and the system or sub-system indicates the same malfunction when operated." A recurring discrepancy is defined as a discrepancy "that occurs on the second through fourth sortie or attempted sortie after corrective action has been taken and the system or sub-system indicates the same malfunction when operated." However, there is a lack of guidance or policy regarding duplicate maintenance problems and identifying trends after the fifth sortie.

c. Human Factor #2

Prior to Takeoff
AE202 Task Misprioritization

Task Misprioritization is a factor when the individual does not organize, based on accepted prioritization techniques, the tasks needed to manage the immediate situation.

The following dialogue occurred after the MC was cleared for takeoff (Tab N-5 to N-6)"

> Tower: Bully 29 Laughlin tower runway 13 center, winds 150 at 12, gust 17, cleared for takeoff, patterns.
>
> MRP: Bully 29 cleared for takeoff 13 center. K, ready canopies?
>
> MIP: Ready.

MRP: C… lights on please.

MIP: lights on.

MRP: IFF is good. Confirm pitot heat on.

MIP: Pitot heat on.

MRP: And the speed brakes centered and up.

MIP: Centered and up. This is where I usually go 60 as you're straightening out.

MRP: Oh yeah!... Oops, thanks. Here we go. Max. One, two good swings. MACS, tires, and we're go jet. 145. Come on baby. Gear, flaps. 200 and below 16. Here's 250. One comes out. Two comes out. Lariat, Bully 29, center request crosswind.

The MRP who was occupying the rear cockpit was making call outs for checklist items, and the MIP was confirming (Tab N-5 to N-6). The checklist call outs and confirmation end after the MIP states, "this is where I usually go 60 as you're straightening out," and the MRP responds with, "Oh, yeah!" (Tab N-6).

Items in TO-1T-38C-1CL-1 that are marked with an asterisk are to be confirmed/checked in both cockpits as required (BB-34). The last item marked with an asterisk that was confirmed/checked was "canopies" (Tab N-5). The last two items in the "BEFORE TAKEOFF" checklist were "SAFE/ARMED lever – ARMED" and "(RCP) Confirm ISS mode selector – AS REQUIRED" were not called out (and not completed by the MRP) (Tabs N-6 and BB-34).

d. Human Factor #3

PC108 Checklist Interference

Checklist Interference is a factor when an individual is performing a highly automated/learned task and is distracted by anther cue/event that results in the interruption and subsequent failure to complete the original task or results in skipping steps in the original task.

The dialogue above in AE202 Task Misprioritization shows checklist interference when the MIP interrupts the normal flow with the comment, "[c]entered and up. This is where I usually go 60 as you're straightening out" (Tab N-5). After the checklist interference, the MRP does not complete the last two "BEFORE TAKEOFF" checklist items, verifying in both cockpits that the SAFE/ARMED lever is ARMED and that the ISS mode selector is in the appropriate position. (Tab BB-34). Consequently, the MRP's seat remained in the "SAFE" position, and the ISS remained in the "SOLO" position (Tab H-19).

e. Human Factor #4

PE202 Instrumentation and Sensory Feedback Systems

Instrumentation and Sensory Feedback Systems are factors when instrument factors such as design, reliability, lighting, location, symbology or size are inadequate and create an unsafe situation. This includes night vision devices, HUDs, off-bore-site and helmet-mounted display systems and inadequacies in auditory or tactile situational awareness or warning systems such as aural voice warnings or stick shakers.

The only indication that the ejection seat is not armed is the position of the arming lever on the left side of the seat (Tab H-17). During flight, unless the pilot looks down at the lever, the mistake is not visibly apparent (Figure 12). In addition, the arming lever is at least partially obscured, if not completely obscured, by the pilot's leg when the seat is occupied (Figure 12). Furthermore, the CSU-13B/P anti-G-suit would limit tactile feedback that a pilot may sense from the lever being in the "up" or "SAFE" position.

Figure 12: Seat Arming Lever Location in Rear Cockpit.

Figure 13: Position and Relative Size of Seat Arming Lever.

In addition, the ISS mode selector is not ergonomically located, as it is behind the pilot, requiring a deliberate action to change the mode (Figure 14).

Figure 14: Location of ISS Mode Selector.

f. Human Factor #5

Ejection sequence
AE204 Necessary Action – Delayed

Necessary Action – Delayed is a factor when the individual selects a course of action but elects to delay execution of the actions and the delay leads to an unsafe situation.

The dialogue below occurred after the second hydraulic/generator failure when the MIP realized that he had poor control of the MA (Tab N-17 to N-18).

MIP: Yeah. Oh dude!

MRP: MDP fail?

MIP: No. Alright.

MRP: Engines good?

MIP: No I can barely control it. Can you control it from the back?

MRP: K. I have the aircraft.

MIP: You have the aircraft.

MRP: Nope, looks like the trim's trying to run away.

MIP: Ok. Left. Left bank. I got the radio.

MRP: K.

MIP: (On Guard, 243.0) Bully 09.

MRP: 29

MIP: (On Guard, 243.0) Bully 29 is emergency aircraft. We have a dual hydraulic fail. Expect that, we're going to be getting out of the aircraft (End Guard Call). Alright, dude, let's chill out.

MRP: K. I can hold it for now, let's get away from these houses.

MIP: Agreed, get all your loose items and stow 'em.

MRP: K. let's see. I'm full left stick. Oh man, I don't like these houses.

MIP: Keep going and then pull the power. What's your airspeed?

MRP: It's going to roll on us dude, we're going to have to go in a sec.

MIP: K.

MRP: You ready?

MRP: Wait let's….wait for the houses

MIP: Ok, yea, definitely

MRP: Ok, there's the power

MIP: (Simultaneously) "BAIL OUT, BAIL OUT, BAIL OUT"
MRP: (Simultaneously) "BAIL OUT, BAIL OUT, BAIL OUT"

With a dual hydraulic failure, ejection is required because the aircraft is uncontrollable (Tab BB-36 to BB-37). After properly assessing a dual airframe mounted gearbox failure and corresponding dual hydraulic failure, the MIP and the MRP failed to eject immediately out of a well-intentioned concern that the MA could crash into the residential area below them (Tab N-18). Fifty-six seconds elapsed from the time the MC made the guard call to the time the MC commanded ejection (Tab N-15 to N-16). Had the MC initiated ejection immediately after making the Guard call, the MRP would have had more time to focus on ejection procedures and might have discovered that his seat was not ARMED, although there is no way of knowing whether this would have occurred (Tab N-17 to N-18). As the events transpired, 7 seconds elapsed from the time MIP ejected until the MA impacted the ground.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

(1) AETCMAN 11-251 Volume 1, *T-38C Flying Fundamentals*, 4 April 2017
(2) AFH 11-203 Volume 1, *Weather for Aircrews*, 12 January 2012
(3) AFI 11-2T-38 Volume 1, *T-38 Aircrew Training*, 5 August 2017
(4) AFI 11-2T-38 Volume 1, AETC Supplement, *T-38 Aircrew Training*, 12 July 2011
(5) AFI 11-2T-38 Volume 2, *T-38 Aircrew Evaluation Criteria*, 5 August 2014
(6) AFI 11-202 Volume 2, *Aircrew Training*, 22 November 2010
(7) AFI 11-202 Volume 1, AETC Supplement, *Aircrew Training*, 26 June 2014
(8) AFI 11-202 Volume 2, *Aircrew Standardization/Evaluation Program*, 13 September 2010, Incorporating Change 1, 18 October 2012
(9) AFI 11-202 Volume 2, AETC Supplement, *Aircrew Standardization/Evaluation Program*, Incorporating Change 1, 30 January 2014
(10) AFI 11-202, Volume 3, *General Flight Rules*, 10 August 2016
(11) AFI 11-301 Volume 1, *Aircrew Flight Equipment (AFE) Program*, 25 February 2009

(12) AFI 11-301 Volume 1, AETC Supplement, *Aircrew Flight Equipment (AFE) Program*, 18 August 2009, Certified Current on 9 May 2014
(13) AFI 11-401, *Aviation Management*, 10 December 2010, Certified Current 9 January 2013
(14) AFI 11-401 AETC Supplement, *Aviation Management*, 29 February 2016
(15) AFI 11-418, *Operations Supervision*, 14 October 2015
(16) AFI 11-418 AETC Supplement, *Operations Supervision*, 16 February 2016
(17) AFI 11-418 47 OG Supplement, *Operations Supervision*, 9 July 2015
(18) AFI 21-101, *Aircraft and Equipment Maintenance Management*, 21 May 2015
(19) AFI 48-123, *Medical Examinations and Standards*, 5 November 2013
(20) AFI 51-503, *Aerospace And Ground Accident Investigations*, 14 April 2015
(21) AFI 91-204, *Safety Investigations and Reports*, 12 February 2014

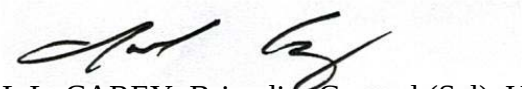
NOTICE: All directives and publications listed above are available digitally on the Air Force Departmental Publishing Office website at: http://www.e-publishing.af.mil.

b. Other Directives and Publications Relevant to the Mishap

(1) Squadron Standards, *87 FTS Red Bull Flying Standards*, 31 July 2017
(2) T-38C IFG, *47th Operations Group T-38C In-Flight Guide*, Nov 2015
(3) TO 00-20-1, *Technical Manual Aerospace Maintenance Inspection, Documentation, Policies and Procedures*, 11 July 2016.
(4) TO 16G2-7-2-3WA-1, *Technical Manual Overhaul Instructions with Illustrated Parts Breakdown Drive Assembly*, 29 June 2016.
(5) TO 1T-38C-1CL-1 Change 2, *Flight Crew Checklist Pilots Abbreviated USAF Series T-38C Aircraft*, 4 May 2017
(6) TO 1T-38C-2-2, *Ground handling, Servicing and Air Frame Maintenance USAF Series T-38C Aircraft*, 29 November 2017.
(7) TO 1T-38C-2-3, *Technical Manual Organizational Maintenance Flight Control Systems USAF Series T-38C Aircraft*, 7 September 2017.
(8) TO 1T-38C-2-4, *Technical Manual Organizational Maintenance Pneudraulic Systems USAF Series T-38C Aircraft*, 2 February 2018.
(9) TO 1T-38C-2-6, *Technical Manual Organizational Maintenance Power Plant USAF Series T-38C Aircraft*, 8 November 2017.
(10) TO 1T-38C-6WC-1-WA-1, *Technical Manual Workcards Preflight/Basic PostFlight Inspection USAF Series T-38C Aircraft*, 13 December 2017.

c. Known or Suspected Deviations from Directives or Publications

Not applicable.



15 May 2018

JOEL L. CAREY, Brigadier General (Sel), USAF
President, Accident Investigation Board

STATEMENT OF OPINION

T-38C, T/N 64-3213
LAUGHLIN AIR FORCE BASE, TEXAS
20 NOVEMBER 2017

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

1. OPINION SUMMARY

On 20 November 2017, at 15:46:28 hours, local time, a T-38C, tail number 64-3213, crashed approximately 12 miles northwest of Laughlin Air Force Base (AFB), Texas (TX), completely destroying the aircraft and fatally injuring the mishap requalification pilot (MRP) who was occupying the rear seat. The mishap aircrew (MC) consisted of a mishap instructor pilot (MIP) occupying the front seat who was supervising the MRP who was conducting a requalification mission . The MIP successfully ejected and sustained minor injuries. The MRP did not eject and was fatally injured during ground impact. The MIP, MRP and mishap aircraft (MA) were assigned to the 87th Flying Training Squadron, 47th Flying Training Wing, Laughlin AFB, TX. During the mishap sortie (MS), the MA crashed while returning to base following a reported aircraft malfunction. The destroyed aircraft is valued at approximately $11 million.

I find, by a preponderance of evidence, the cause of the mishap to be dual airframe mounted gearbox failure. A substantial contributing factor to these gearbox failures was a lack of maintenance guidance addressing similar repeated failures of the MA. I also find, by a preponderance of evidence, the cause of fatal injuries suffered by the MRP was the MC's failure to complete the before takeoff checklist item that called for the proper ejection seat system settings Finally, I find, by a preponderance of the evidence, that factors that substantially contributed to the mishap were Task Misprioritization, Checklist Interference, Instrumentation and Sensory Feedback Systems, and the Delayed Decision to eject.

2. CAUSE

The cause of the mishap was left and right gearbox coupling shaft failures and subsequent dual airframe mounted gearbox failure, resulting in total hydraulic failure and an uncontrollable aircraft. Because the T-38 requires hydraulic pressure for operation of the primary flight controls, following total hydraulic failure, the MC was incapable of safely landing the MA and their only viable option for safe recovery, as detailed in TOs, was to eject from the aircraft. The MRP was unable to eject because he improperly failed to place the rear cockpit ejection seat SAFE/ARMED lever in the "ARMED" mode prior to takeoff, preventing self-initiated ejection. Additionally, the ISS mode selector, located in the rear cockpit, was improperly left in the "SOLO" mode instead of placed in

"BOTH," preventing the MIP in the front cockpit from initiating ejection for the MRP, which is possible even with MRP's seat in the "SAFE" mode.

The MS was planned to include a practice approach after takeoff from Laughlin AFB, maneuvers in the nearby military operating area, and return to base for practice landings. After the area maneuvers, while descending through 13,000 feet on recovery at 15:40:21L, the MA experienced an airframe mounted gearbox failure on the left engine resulting in the loss of the left side alternating current generator and hydraulic pump. Continuing their descent, the MC assessed the situation then accomplished appropriate emergency checklists and coordinated with air traffic control and other base agencies while preparing to land as soon as possible at Laughlin AFB. While maneuvering to final approach, slightly over four minutes later, at 15:44:51L, the MC received indications of multiple additional failed electrical systems accompanied by a Flight Hydraulic caution light resulting from a failure of the remaining, right side airframe mounted gearbox. With failures of both airframe mounted gearboxes and their associated hydraulic pumps, the MA suffered total hydraulic failure and was then unresponsive to the flight control inputs of the MC and incapable of sustained, controlled flight.

Post-mishap analysis by the T-38 System Program Office (SPO) showed both left and right airframe mounted gearboxes failed due to shearing of their respective gearbox input drive coupling shafts. Manufactured to shear within a range of 1,900-2,200 inch-lbs, the coupling shafts are integrated into the power transfer drive assembly for each engine. These assemblies transfer torque from their respective engines to the separate right and left airframe mounted gearboxes, which in turn, provide power input to their alternating current (AC) generator and hydraulic pumps. The airframe mounted gearboxes are designed to keep both the generator and hydraulic pump within their normal operating range through a two-speed transmission system based on engine revolutions per minute (RPM). The input coupling shafts are designed to fail prior to any excessive torque loads induced along the transfer assembly, isolating the engine and other aircraft components from potential further damage. Following a shaft shear, the opposite airframe mounted gearbox is designed to provide redundant electrical and hydraulic power for safe aircraft recovery. Causes of increased torque can include mechanical failure of a component in the power transfer drive assembly, including the airframe mounted gearbox, increased electrical load on the generator, increased load on the hydraulic pump, momentary torque spikes caused by gearbox "shifting" through 65-75% engine RPM, or wear within one of the components.

Accident Investigation Board (AIB) analysis into sources of potential increased torque loading of the power drive assemblies included both left and right generators, left and right hydraulic pumps, and both airframe mounted gearboxes. Regarding the initial, left gearbox failure, the AIB determined a minor electrical fault in the left transformer assembly was fed by the left generator for an indeterminate amount of time, increasing the left generator's torque requirement. Additionally, as the MA descended on recovery back to Laughlin AFB, both engine RPMs were slowing through the gearbox shift range of 65-75%, adding additional torque loading. No anomalies were detected with the left side hydraulic pump. The AIB also analyzed the sheared coupling shafts (both left and right) for any sign of materiel abnormalities or fatigue leading to unexpected shearing. None were found and engineering analysis confirmed the coupling shafts sheared from excessive torque. Finally, SPO teardown analysis of the left airframe mounted gearbox revealed signs of normal wear and no failure of the internal components. Although

increased torque from the left transformer assembly fault and transiting the shift range were assessed to be below the 2,200 inch-lbs specification of the input drive coupling shaft, the increases would have reduced the margin between torque load and designed shaft strength, increasing potential for shear.

Regarding the second, right gearbox failure, the right generator showed signs of a minor system short, which would have increased the right generator's torque requirement an undetermined amount. Additionally, although data available stopped the moment of the right gearbox failure and its respective generator, as with the left gearbox, it is reasonable to conclude that engine RPMs at the time of the second failure were still slowing through the gearbox shift range of 65-75%, adding additional torque loading. No anomalies were detected with the right side hydraulic pump. Next, SPO teardown analysis of the right airframe mounted gearbox revealed signs of excessive wear of the gearbox clutch assembly, most likely contributing to yet additional torque loading. No other failures of the internal components were noted. Altogether, increased torque from the right generator system short, transiting the shift range, excessive wear of the right gearbox, and the right generator taking on the entire aircraft requirement following failure of the left generator appear to have provided a sufficient torque spike to exceed the shear specifications of the right input drive coupling shaft.

I find by the preponderance of evidence the cause of the mishap to be dual airframe mounted gearbox failure from sheared gearbox coupling shafts due to cumulative torque overload from minor electrical faults, engine RPM transiting the gearbox shift range, a single generator carrying entire electrical load (right gearbox) and excessive gearbox wear (right gearbox).

Although the AIB found no evidence the conduct of maintenance inspections, scheduled maintenance, or servicing actions contributed to the mishap, I found it significant the MA experienced six input coupling shaft shears on the right side since January 2016, a 22-month span. The MS was its seventh. The same right airframe mounted gearbox was involved in all seven. Based on coupling shaft procurement rates and additional analysis, the AIB identified that shafts are typically replaced every two years on average, most commonly for wear detected during the periodic 450-hour inspection. Also of note, in accordance with current maintenance guidance, when an aircraft system fails on back-to-back sorties, it is a "repeat" malfunction and warrants additional scrutiny by maintenance leadership. Likewise, if the subsequent sortie is flown without issue, but the same malfunction occurs at any time in the next four sorties, it is labeled a recurrent maintenance issue, or "recur," and also gains additional scrutiny. If the same malfunction happens on the fifth sortie, there is no repeat or recur entered into the maintenance system. The AIB found no evidence of lack of or improper documentation contributing to the mishap, and furthermore, there was no evidence that previous coupling shaft shears or airframe gearbox malfunctions required additional scrutiny due to repeat/recur rule sets. Based on current guidance at the time of the mishap, there was no requirement for additional inspection or maintenance for an aircraft requiring seven coupling shaft replacements in less than two years.

I find by the preponderance of evidence the lack of maintenance guidance addressing similar repeated failures of the right gearbox was a substantial contributing factor to the mishap.

After the second airframe mounted gearbox failure at 15:44:51L, and following an attempt to transfer aircraft control between the MIP and MRP to definitively assess the status of the MA, the MC concluded the MA was indeed uncontrollable and transmitted their intention to eject at 15:45:23L over Guard frequency (243.0). Following the transmission, the MRP told the MIP he wanted to try to avoid a populated area on the ground. The MIP agreed and instructed the MRP to stow loose items. At 15:45:54L, the MRP stated "OK, let's see. I'm full left stick. Oh man, I don't like these houses," indicating potential difficulty controlling the aircraft and continued concern for a populated area on the ground. At 15:46:11, the MRP stated, "It's going to roll on us dude, we're going to have to go in a sec," referring to the need to eject. The MC delayed the command of ejection until 15:46:19, at which point they simultaneously commanded "BAIL OUT, BAIL OUT, BAIL OUT," with the MA at approximately 25 degrees right wing low and increasing, slightly nose low and approximately 2,000 feet above the ground. The MIP successfully ejected at 15:46:21L, and the MRP did not eject and was fatally injured when the MA impacted the ground at 15:46:28L, at an estimated 60-70 degrees nose low and 90 degrees of right bank.

The MRP's ejection seat at the crash site was found to be improperly placed in the "SAFE" mode, preventing self-initiated ejection. Damage analysis of other related seat components confirmed the seat was in the "SAFE" mode at ground impact. Additionally, the ISS mode selector, located in the rear cockpit, improperly remained in a mode preventing the MIP in the front cockpit from initiating ejection for himself and the MRP, possible even with MRP's seat in the "SAFE" mode. Aircrew guidance in the required "Before Takeoff" checklist mandate both the "SAFE/ARMED lever – ARMED" and that the "(RCP) Confirm ISS mode selector – AS REQUIRED," which in the case of dual-pilot operations, should be the "BOTH" position, allowing the pilot in either cockpit to initiate ejection for both pilots. It is widely viewed by the T-38C pilot community that these items are to be "challenge and response" checklist items, meaning a verbal exchange is required to verify these actions are complete. In addition, the MC's squadron, 87 FTS, standardized the challenge and response dialogue through creating "standards" prescribing the verbiage to be used. The MIP testified this was indeed his understanding and believed it had been accomplished prior to takeoff. The AIB determined the MIP armed his own seat out of habit. The AIB also determined through cockpit voice recording during the time before takeoff when this verbal exchange would normally occur, it did not happen (nor did it occur at any time thereafter). Instead, the recording detailed an unrelated discussion initiated by the MIP regarding takeoff technique, and the error was compounded by the MRP failing to properly actuate the SAFE/ARMED lever and ISS mode selector in accordance with the required checklist items.

I find by the preponderance of evidence Task Misprioritization was a substantial contributing factor to the mishap.

Checklist Interference is a factor when an individual is performing a highly automated/learned task and is distracted by another cue/event that results in the interruption and subsequent failure to complete the original task or results in skipping steps in the original task. The above Task Misprioritization led to the MC not completing key steps of the "Before Takeoff" checklist. Additionally, witness testimony and the unit flying standards obtained over the course of the investigation indicated that the standard operating practice for the unit was for the pilot flying the aircraft to initiate challenge and response items. Ultimately, the MIP acting as the aircraft

commander was responsible for ensuring accomplishment of these items and the proper overall operation of the aircraft.

I find by the preponderance of evidence Checklist Interference was a substantial contributing factor to the mishap.

Due to placement of both the SAFE/ARMED lever in both cockpits as well as the ISS mode selector, a pilot is required to look down and aft to check position of the lever and selector. Based on positioning of the lever and selector, it will typically remain partially, if not completely obscured, unless the pilot moves his/her head or leg.

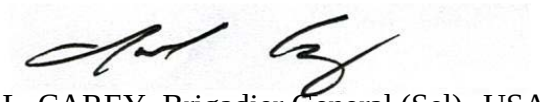
I find by the preponderance of evidence that aircraft Instrumentation and Sensory Feedback Systems were a substantially contributing factor to the mishap.

The time that elapsed between when the MC determined the need to eject from an uncontrollable aircraft and communicated that intent (15:45:23L), and when MC initiated ejection (15:46:19L), was 56 seconds. The time between successful MIP ejection (15:46:21L) and MA impacting the ground (15:46:28L) was seven seconds. The AIB could not determine whether the MRP would have discovered the incorrect position of the SAFE/ARMED lever following MIP ejection. Although well-intended, the continued concern expressed over populated areas on the ground, and subsequent delay in ejection, was misplaced due to the MA suffering total hydraulic failure, and therefore, being uncontrollable.

I find by the preponderance of evidence Delaying Necessary Action of ejection was a substantial contributing factor to the mishap.

3. CONCLUSION

I find, by a preponderance of evidence, the cause of the mishap to be dual airframe mounted gearbox failure. A substantial contributing factor to these gearbox failures was a lack of maintenance guidance addressing similar repeated failures of the MA. I also find, by a preponderance of evidence, the cause of fatal injuries suffered by the MRP was the MC's failure to complete the before takeoff checklist item that called for the proper ejection seat system settings Finally, I find, by a preponderance of the evidence, that factors that substantially contributed to the mishap were Task Misprioritization, Checklist Interference, Instrumentation and Sensory Feedback Systems, and the Delayed Decision to eject.



15 May 2018

JOEL L. CAREY, Brigadier General (Sel), USAF
President, Accident Investigation Board

INDEX OF TABS