UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

T-38C, T/N 68-8121 & T/N 70-1586

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

LOCATION: LAUGHLIN AIR FORCE BASE, TEXAS

DATE OF ACCIDENT: 19 NOVEMBER 2021

BOARD PRESIDENT: BRIGADIER GENERAL GREGORY KREUDER

Conducted IAW Air Force Instruction 51-307

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

T-38C, T/N 68-8121, & T/N 70-1586
LAUGHLIN AIR FORCE BASE, TEXAS
19 NOVEMBER 2021

At 10:14:02L (10:14:02 a.m. Local Time [L]) on 19 November 2021, two T-38C Talon aircraft, Tail Numbers 68-8121 and 70-1586, collided during the landing phase to Runway (RWY) 13 Center (13C) following a formation approach at Laughlin Air Force Base (AFB), Texas (TX). Both aircraft were assigned to the 47th Flying Training Wing (FTW) at Laughlin AFB, TX.

The Mishap Sortie (MS) was a local formation flight and was the Mishap Student Pilot's (MSP) fourth formation event in the T-38C Specialized Undergraduate Pilot Training program. The Mishap Formation (MF) consisted of Mishap Instructor Pilot (MIP1) occupying the front cockpit (FCP) of Mishap Aircraft 1 (MA1), Mishap Instructor Pilot (MIP2) occupying the rear cockpit of Mishap Aircraft 2 (MA2), and the MSP occupying the FCP of MA2.

The MF planned for MA1 to lead the first half of the MS, perform a lead swap in the military operations area, then have MA2 lead the flight for the return to Laughlin AFB. The primary plan was for MA2 to lead the formation approach to RWY 13C, clear off MA1 to land, and perform a low approach to the T-38 pattern, with the caveat that a difference in fuel levels could change who landed. On final approach after MA2 "cleared off" MA1, both aircraft attempted to land and neither performed a low approach. MA1, originally on the right side of the formation in the wingman position, ended up below MA2 on final approach in a position where neither aircraft could see the other. MA1 landed first at 10:14:01L. One second later, at 10:14:02L, MA2's nose landing gear impacted MA1's left horizontal stabilizer. Both aircraft were rendered uncontrollable and subsequently destroyed. MIP1 egressed MA1 on the ground after the mishap with minor injuries. MIP2 and MSP experienced an interrupted ejection sequence due to the inversion of MA2, causing multiple life threatening injuries for MIP2 and fatal injuries for MSP.

I find, by a preponderance of the evidence, there are two causes of the mishap: as the MF returned to base and conducted a formation approach, where one aircraft would land and the other would perform a low approach, (1) MIP2 failed to communicate and MIP1 failed to verify which aircraft would land, resulting in MA1 and MA2 simultaneously attempting to land on RWY 13C; and (2) MIP2 failed to recognize a precarious situation developing after the "cleared off" call and failed to intervene and prevent MA2 from impacting MA1 on landing. Further, I find by a preponderance of the evidence there are two factors that substantially contributed to the mishap: (1) MIP1 and MIP2 used conflicting techniques to perform the 1-up/1-down maneuver and (2) MSP's callsign usage, affected by the "administrative lead" change and various techniques for referencing position number, was improper and confusing.

SUMMARY OF FACTS AND STATEMENT OF OPINION
T-38C, T/N 68-8121, & T/N 70-1586
LAUGHLIN AIR FORCE BASE, TEXAS
19 NOVEMBER 2021

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ACRONYMS AND ABBREVIATIONS

’	Feet or Minutes
”	Inches or Seconds
%	Percent
47 FTW/MXG	47th Flying Training Wing Maintenance Group
ADC	Air Data Computer
ADMIN	Administrative Lead
AETC	Air Education and Training Command
AETCMAN	AETC Manual
AF	Air Force
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFMAN	Air Force Manual
AFMES	Armed Forces Medical Examiner System
AFPET	Air Force Petroleum Office
AGL	Above Ground Level
AIB	Accident Investigation Board
AOA	Angle of Attack
ATC	Air Traffic Control
BAMC	Brook Army Medical Center
BIP	Buddy IP Program
Bldg	Building
BPO/PR	Basic Post-flight and Pre-flight inspection
BWC	Birdwatch Condition
C	Celsius
CAP	Commander’s Awareness Program
CH-2	Fire Chief 2
Col	Colonel
CT	Continuation Training
DoD	Department of Defense
DS	Direct Support
DTS	Data Transfer System
EOD	Explosive Ordnance Disposal
F-2/DO	Second Formation Flight (in training syllabus)
FCP	Front Cockpit
FEF	Flight Evaluation Folder
FTS	Flying Training Squadron
FTW	Flying Training Wing
HPO	Hourly Post Flight Inspection
HUD	Heads-Up Display
IAW	In Accordance With
IC	Incident Commander
IMDS	Integrated Maintenance Data System
IFG	In-Flight Guide
ILS	Instrument Landing System
IP	Instructor Pilot
IPOR	Instructor Pilot of Record
KCAS	Knots Calibrated Air Speed
L	Local Time
LOX	Liquid Oxygen
MA	Mishap Aircraft
MAAF	Mishap Analysis and Animation Facility
MC	Mishap Crew
MEF	Mission Execution Forecast
MF	Mishap Flight
MFD	Multi-Functional Display
MIL	Military Power
MIP	Mishap Instructor Pilot
MLG	Main Landing Gear
MOA	Military Operating Area
MS	Mishap Sortie
MSL	Mean Sea Level
MSP	Mishap Student Pilot
NAV	Navigational Lead
NDI	Non-Destructive Inspection
NLG	Nose Landing Gear
NLT	No Later Than
NM	Nautical Mile
NOTAM	Notice to Airman
OPS SUP	Operations Supervisor
ORM	Operational Risk Management
PA	Proficiency Advance
PHA	Periodic Health Assessment
PIT	Pilot Instructor Training
RCP	Rear Cockpit
RSU	Runway Supervisory Unit
RTB	Return To Base
RWY	Runway
SAR	Search and Rescue
SAS	Stability Augmentation System

SIB	Safety Investigating Board
SP	Student Pilot
SPO	System Program Office
STUS	Student Squadron
SUPT	Specialized Undergraduate Pilot Training
TAC	Tactical Lead
T/N	Tail Number
TOLD	Take Off and Landing Data
UPT	Undergraduate Pilot Training
USAF	United States Air Force
Z	ZULU

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 20 November 2021, Lieutenant General Marshall B. Webb, Commander, Air Education and Training Command (AETC), appointed Brigadier General Gregory Kreuder to conduct an Accident Investigation Board for a mishap that occurred on 19 November 2021, involving two T-38C aircraft, tail numbers (T/N) 68-8121, and 70-1586 at Laughlin Air Force Base (AFB), Texas (TX) (Tabs Y-2 toY-3 and A-5 to A-7). The accident investigation was conducted in accordance with (IAW) Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations*, at Laughlin AFB, TX, from 4 January 2022 to 1 February 2022. The board members included a Medical Member (Lieutenant Colonel), a Legal Advisor (Lieutenant Colonel), a Pilot Member (Major), a Recorder (Technical Sergeant), and a Maintenance Member (Wage Grade-11) (Tab Y-4 to Y-5). An additional board member who is a local recently graduated student pilot (Captain) was appointed to assist shortly after the board commenced the investigation (Tab Y-6).

b. Purpose

In accordance with AFI 51-307, *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 19 November 2021, at 1614:02 Zulu (Z) (10:14:02 a.m. Local Time (L)) two T-38C Talon aircraft collided during the landing phase to Runway (RWY) 13C following a formation approach at Laughlin AFB, Texas (Tabs A-5 to A-7, and AA-9). Both aircraft were assigned to the 47th Flying Training Wing (FTW) at Laughlin AFB, Texas and were destroyed (Tabs A-7 and P-2). Mishap Aircraft 1 (MA1), T/N 68-8121, had one Mishap Instructor Pilot (MIP1) aboard who egressed the aircraft on the ground after the mishap with minor injuries (Tabs A-6 to A-7, and K-4). Mishap Aircraft 2 (MA2), T/N 70-1586, had one Mishap Instructor Pilot (MIP2) and one Mishap Student Pilot (MSP) aboard (Tabs A-6 to A-7, and K-4). MIP2 and MSP experienced an interrupted ejection sequence due to the inversion of MA2, causing multiple life threatening injuries for MIP2 and fatal injuries for MSP (Tabs A-6 and H-14).

3. BACKGROUND

a. Air Education and Training Command (AETC)

AETC was established and activated in January 1942, making it the second oldest major command in the Air Force. AETC's primary mission is to recruit, train, and educate exceptional Airmen. AETC includes Air Force Recruiting Service, two Numbered Air Forces and the Air University. The command operates 12 major installations and supports tenant units on numerous bases across the globe. There are also 16 Active Duty and seven Reserve wings in AETC (Tab DD-2 to DD-9).

b. 19th Air Force (19 AF)

Nineteenth AF is responsible for training aircrews, remotely piloted aircraft crews, air battle managers, weapons directors, and survival, escape, resistance, and evasion specialists to sustain the combat capability of the United States Air Force, other services and our nation's allies. The 19th AF includes 19 training locations, with 16 Total Force wings: 10 Active Duty, one Air Force Reserve, and five Air National Guard units. It commands more than 32,000 personnel and operates over 1,350 aircraft of 29 different models, flying more than 490,000 hours annually, which is 44 percent of the Air Force's total flying hours (Tab DD-10 to DD-11).

c. 47th Flying Training Wing (47 FTW)

The 47 FTW, located at Laughlin Air Force Base, Texas conducts 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-1A, and T-38 aircraft while deploying mission-ready Airman as well as developing professional disciplined leaders. Approximately 400 new military pilots earn their silver wings at Laughlin each year after an intensive 52-week course. The 47th FTW is composed of approximately 1,400 military personnel, 1360 civilian personnel; the flying operation exceeds 80,000 flying hours and 51,000 sorties per year (Tab DD-12 to DD-13).

d. 87th Flying Training Squadron (87 FTS)

The 87 FTS conducts the advanced phase (phase III) of undergraduate pilot training. This phase consists of instruction in the T-38C and includes advanced aircraft handling, tactical navigation, fluid maneuvering, and an increased emphasis in two- and four-ship formations. At the completion of the year-long training program, the graduate is awarded the aeronautical rating of pilot. The squadron mission is to train and prepare United States

Air Force (USAF) and Allied officers to fly "Fast Movers" (Fighter/Bomber track) as a component of the 47 FTW (Tab DD-14 to DD-15).

e. 47th Student Squadron (47 STUS)

The 47 STUS is primarily responsible for the administration and day-to-day non-flying support for more than 400 US and international students currently going through Specialized Undergraduate Pilot Training. The squadron also manages over 200 students that are awaiting pilot training and pilot training graduates that are waiting to transition to their next assignment. These students fill critical jobs throughout Laughlin AFB that are vital to day-to-day operations of the 47 FTW. Additionally, the 47 STUS oversees nearly 80 civilian simulator instructors that are key to accomplishing over 40,000 flying hours (Tab DD-16).

f. T-38C Talon

The T-38C 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, and high performance. The T-38C has swept wings, a streamlined fuselage and tricycle landing gear with a steerable nose wheel. Two independent hydraulic systems power the ailerons, rudder and other flight control surfaces. The T-38C incorporates a "glass cockpit" with integrated avionics displays, head-up display and an electronic "no drop bomb" scoring system. AETC is the primary user of the T-38C for joint specialized undergraduate pilot training. AETC uses the T-38C to prepare pilots for front-line fighter and bomber aircraft such as the F-15E Strike Eagle, F-16 Fighting Falcon, B-1B Lancer, A-10 Thunderbolt, F-22 Raptor, and F-35 Lightning II. The instructor and student sit in tandem on rocket-powered ejection seats in a pressurized, air-conditioned cockpit. The Air Force took delivery of over 1,100 T-38s between 1961 and 1972 when production ended. As the T-38 fleet has aged, specific airframe, engine, and system components have been modified or replaced (Tab DD-17 to DD-22).

g. Formation Flying and Procedures

The overall purpose of flying formation is to provide the mutual support required to accomplish a given mission (Tab AA-15). This mutual support can range from the requirement to refuel while airborne, provide aid to another aircraft experiencing a malfunction, or working as any other team would for a variety of mission types (Tab AA-15). Practicing formation approaches during pilot training, both in the lead and wing position, remains important as it prepares pilots for the potential situation where an aircraft in the formation is unable to return to an airfield without assistance (Tab AA-15).

An example of when a formation approach to an airfield would be used in a non-training scenario is if an aircraft experienced a failure of navigational or radio equipment and would otherwise be unable to find their way to an airfield safely, especially due to weather (Tab AA-15). In this case,

the functional aircraft in the formation navigate through any weather to the recovery field and fly an approach to the runway on instruments, while the aircraft experiencing a failure would follow the good aircraft in a formation position (Tab AA-15). In practice, once the formation has clearance to land from the Air Traffic Control Tower (ATCT), is clear of weather, and is approaching the runway, the lead aircraft would typically ensure the wingman has the field in sight, drop the wingman off to land, and then conduct a low approach (Tab AA-). The T-38C Operations Procedures manual mentions this scenario in reference to a radio failure emergency (Tab O-44). The manual states, "A formation approach to a drop off on final [aircraft in number 2 position lands] should be performed unless safety considerations dictate otherwise" (Tab O-44).

A low approach is when an aircraft discontinues the landing, adds power, and remains airborne (Tab AA-15). According to the T-38C Operations Procedures manual, minimum altitudes for formation approaches are as follows:

i. For IPs or Flight Examiners (FE) flying chase position, 50 feel AGL (Tab O-43)

ii. For formation low approaches, 100 feet AGL (Tab O-43)

iii. For chase aircraft during an emergency, 300 feet AGL unless safety or circumstances dictate otherwise (Tab O-43)

It is possible for the malfunctioning aircraft to lead the formation on recovery for certain non-navigational malfunctions, such as when experiencing engine or landing gear issues (Tab AA-15). In these cases, the damaged aircraft usually leads to the airfield of intended landing with the good aircraft flying in a chase positon, during clear weather, where they can provide mutual support to the damaged aircraft (Tab AA-15). Chase position is flown in a 30- to 60-degree aspect cone out to 1,000 feet (Tab AA-15). The malfunctioning aircraft could lead a formation approach through the weather with the chase aircraft on the wing, however this increases the workload and it may make more sense to split up the formation prior to entering any weather (Tab AA-15 to AA-16).

Practice formation approaches are a syllabus requirement for SUPT (Tab AA-12). Although the syllabus also mention formation landings, AETC prohibited formation landings in March of 2020, meaning two aircraft in a formation cannot simultaneously land on the same runway (Tab AA-12 BB-33 to BB-34). This leaves four other ways that practice formation approaches typically terminate in training: 1) with both aircraft performing a low approach; 2) a "Split to Land" on separate runways; 3) a "Visual Meteorological Condition (VMC) Drag" where the wingman will assume a position 3,000 feet minimum behind lead; 4) or with one aircraft landing and the other performing a low approach (Tab AA-16). There is rarely confusion when the formation approach terminates with a low approach for both aircraft as there is no role swap or intra-flight communication required; the wingman continues to fly in formation off of lead as they perform the low approach together (Tab AA-16). Sufficient guidance exists for both the "Split to Land" and "VMC Drag" maneuvers such that there is little potential for confusion as to roles when performing either maneuver (Tab AA-16).

The option where one aircraft lands and the other performs a low approach, however, is not defined in guidance or standards at Laughlin AFB, or Pilot Instructor Training (PIT) which is located at

Randolph AFB, TX (Tab AA-16). Instructors at PIT often refer to this as the "1-up/1-down," which exposes this maneuver and terminology to upgrading instructors who have follow-on assignments to teach students at various SUPT bases (Tab AA-16). In the emergency scenarios previously discussed, it is usually clear which aircraft will be landing out of the approach: the aircraft with the malfunctioning system (Tab AA-16). However, the "1-up/1-down" maneuver is being used during training when neither aircraft has an actual or simulated malfunction and neither aircraft has a fuel concern (Tab AA-16).

There are a variety of techniques among 87 FTS instructors when deciding which aircraft will land out of the "1-up/1-down" approach in a training environment, with the majority believing it is more normal for the aircraft in the number 2 position to land (Tab V-1.41, V-5.5 to V-5.6, V-6.15 to V-6.16, V-10.6, and V-10.13). Once airborne the majority of instructor pilots and students interviewed, including MIP1, stated that they would consider changing the landing order if one aircraft had 100 to 200 pounds (or more) of fuel less than the other aircraft in a training, non-emergency scenario (Tab V-1.13, V-1.38, V-3.19 to V-3.20, V-5.4, V-5.6, V-6.14, V-8.11, V-14.25, V-17.8, and V-17.12). Some instructors, in the minority, stated that any fuel difference (even ten pounds of fuel) was enough to cause a decision change (Tab V-7.7 and V-13.5). Some instructor pilots do not plan for one aircraft landing out of the formation ("1-up/1-down"), and prefer to terminate the formation approach with both aircraft performing a low approach since fuel is planned into the sortie such that the formation is returning to base with sufficient fuel to do so (Tab V-15.16). Some instructors do not make a decision airborne based on fuel, but rather, always plan for the aircraft in the number two position to land unless an aircraft will arrive to the field with less than normal recovery fuel (normal 800 pounds, minimum 600 pounds, emergency 400 pounds) (Tab V-2.19, V-10.6, and V-16.4).

The term "cleared off" has one reference in the 87 FTS standards, where it describes a flight split in the MOA (Tab O-10). Flight splits in the MOA typically occur in a less task-intensive phase of flight compared to on final when an aircraft is about to land (Tab AA-17). Although not specified in SUPT guidance or standards for use during formation approaches, "cleared off" is used by most IPs interviewed during the "1-up/1-down" to allow the wingman to stop flying formation off of lead, ensure deconfliction, then proceed with either a landing or low approach (Tabs O-10, V-1.35, V-2.16, V-3.14, V-5.8, V-6.18, V-8.9, V-10.16, V-13.5, V-14.20, V-18.13 and AA-16). Most IPs interviewed used "cleared off" with nothing further added (Tab AA-16). Only a few pilots interviewed would say "cleared off to land" or "cleared off to low approach" depending on the plan (Tab AA-16).

Responsibility for deconfliction between all aircraft in a formation is critical. Guidance and standards dictate how those responsibilities are assigned to flight members and how they change during dynamic formation maneuvering. When asked which aircraft owns the deconfliction responsibility on a formation approach once "cleared off" is used, there was a wide variety of opinions among the 87 FTS instructors (Tab V-2.17, V-3.17, V-4.8, V-10.16, and V-14.21). As confirmed by interviews, simulated formation approaches in the T-38C simulator, and a local T-38C sortie, pilots landing from a 2-ship formation can often keep the aircraft performing a low approach in their peripheral vision through touchdown (Tabs V-3.24 to V-3.25 and AA-13 to AA-14). The aircraft conducting a low approach would initially rise in the landing aircraft's upper left or right peripheral vision, depending on which side they were on (Tabs V-3.24 to V-

3.25 and AA-13 to AA-14). The low approach aircraft, after retracting landing gear and accelerating, would have then moved slowly forward on the landing aircraft's canopy. This often happens as the landing aircraft approaches the runway threshold (Tabs V-3.24 to V-3.25 and AA-13 to AA-14).

There are three types of lead changes a formation can utilize listed in the T-38C Flying Fundamentals (AETCMAN 11-251): navigational (nav) lead, tactical (tac) lead and administrative (admin) lead (Tab O-39). An admin lead change passes lead responsibilities to another flight member, to include all navigating, radio management, profile decisions and changes (Tab O-39). Specialized Undergraduate Pilot Training (SUPT) and PIT use an admin lead change when both members in a formation want to get wingman and/or flight lead experience during a sortie (Tab V-8.3, V-10.7, and V-17.4 to V-17.5). Whomever has the "admin lead" has the ability to make changes to the profile, or events, of the flight as they see fit; however they still must communicate any changes (Tab AA-8). An admin lead change also requires renumbering of flight members for intra-flight communications. For example, after an admin lead change, STEER 1 is referenced as "2" on intra-flight communications between the aircraft in the formation (Tab O-39).

There are several types of communication that will be referenced in this report:

i. Intercom: Communication between cockpits of an aircraft. For example, MSP in the Front Cockpit (FCP) of MA2 speaks to MIP2 in the Rear Cockpit (RCP) of MA2 (Tab AA-18).

ii. Intra-flight: Communication between two or more aircraft in a flight over a discrete radio frequency. For example, a pilot in one aircraft (MSP in MA2) talking to a pilot in another aircraft (MIP1 in MA1) (Tab AA-18).

iii. Air Traffic Control (ATC): ATC is responsible for monitoring and directing air traffic. ATC controllers communicate with aircraft and can be en route, approach, or terminal controllers. For example, MSP in MA2 spoke with Radar Approach Control and Laughlin Tower controllers (Tab AA-18). In a formation wingmen do not normally need to acknowledge communication between the flight lead and ATC, unless they are directed to do so.

The renumbering for intra-flight purposes should not be confused with a callsign swap, which does not and should not occur. In other words, intra-flight communications use position number while outside agencies use assigned callsign; however, whichever aircraft is leading the formation at any given time will use the scheduled flight lead's callsign when talking to agencies outside the formation (i.e. when they are talking for the formation to ATC) (Tab O-39).

4. SEQUENCE OF EVENTS

a. Mission

The Mishap Sortie (MS) was the fourth sortie in MSP's pre-solo two-ship formation block of training (Tabs V-1.12, AA-5, and AA-12). The Mishap Formation (MF) consisted of three

individuals and two aircraft (Tab K-4). MIP1 was solo in the front cockpit (FCP) of the scheduled Fligth Lead aircraft, call sign STEER 1 (Tab K-4, V-1.12, and AA-6). MSP occupied the FCP of the scheduled Wingman aircraft, call sign STEER 2 (Tab K-4). MIP2 occupied the rear cockpit (RCP) of STEER 2 (Tab K-4). The 87 Flying Training Squadron (FTS) Operations Supervisor authorized the MS (Tab K-3 and K-4).

b. Planning

The MF completed flight planning prior to the MS according to applicable regulations and standard operational procedures (Tabs K-8 to K-12, K-21 and O-5 to O-6,). The scheduled briefing time was 07:52L, one hour and 20 minutes prior to takeoff according to the 87 FTS Standards (Tabs K-4 and O-5). MSP was primarily responsible for planning the MS based on the requirements of F5201-F507 events in the T-38C AETC SUPT P-V4A-A Syllabus, dated October 2019 (Tabs O-5, V-1.18, V-1.21 and, AA-12). MSP planned for MA1 to lead the first half of the MS, perform an administrative lead change in the Military Operations Area (MOA), and then have MA2 lead the Return to Base (RTB) portion from the number one formation position (Tabs K-17, K-19, K-21, and V-4.13).

MSP spent the evening prior to the MS studying with two other students to prepare for the flight (Tab V-4.13 to V-4.14, V-4.17, and V-16.8).

MIP1 arrived to the briefing area the morning of the mishap approximately 10 minutes prior to the briefing time, after checking his flight gear, and had discussions with MSP about the upcoming flight (Tab V-1.50). MIP1 used the time before the briefing to review MSP's grade sheets and conduct a pre-brief with MSP (Tab V-1.18 and V-1.50). In the pre-brief discussion, MIP1 asked what areas MSP wanted to focus on during the flight and they spoke about the formation approach plan (Tab V-1.18). The plan for the formation approach stated between MIP1 and MSP was that MIP1 in MA1 would land, while MSP and MIP2 in MA2 would execute a low approach (Tab V-1.18).

MIP2 arrived to the briefing area four minutes after the scheduled brief time (Tab V-1.12 and V-1.21). MIP2 was not present for the pre-briefing discussion between the MIP1 and MSP (Tab V-1.18 to V-1.22). According to the 87 FTS Standards, "all flight members will be in the squadron at least 15 minutes prior to brief and in-place NLT [no later than] 1 minute prior to brief" (Tab O-5). In interview, MIP1 stated that MIP2 did not provide reasoning for being late (Tab V-1.21 and V-1.49). MIP2 was not interviewed due to his medical condition (Tab X-3).

As required as part of the brief, the MF completed the 87 FTS Operational Risk Management (ORM) worksheet, a standardized checklist identifying common risk factors for a training flight (Tab O-5 to O-6 and O-45). As cumulative risk increases, the level of authority required to approve the mission profile also increases (Tab K-11). The ORM worksheet has three categories – Mission Considerations, Weather and Airfield Conditions, and Human Factors. The categories in which the MF had points on the ORM were:

iv. Mission Considerations: student two-ship formation (Tab K-10)

v. Weather and Airfield Conditions: Bird watch condition (BWC) moderate and turbulence (Tab K-10)

vi. Human Factors: Inexperienced IP (MIP2), IP out of jet greater than 1 week (MIP1) (Tab K-10)

The overall ORM assessment fell into the "low" category (Tab K-10).

MIP1 conducted the pre-mission briefing as required by the 87 FTS Standards and In-Flight Guide (IFG) (Tabs V-1.17 to V-1.18 and BB-8 to BB-10). The mission events planned included a formation takeoff, maneuvers in the Military Operations Area (MOA), and a formation approach via the Instrument Landing System (ILS) to RWY 13C at Laughlin AFB (Tab K-17, K-19, and K-21).

MIP1 briefed the formation approach in the pre-mission briefing, which matched the pre-briefing discussion with MSP; however, a caveat was included about fuel (Tab V-1.18 to V-1.20 and V-1.38). The caveat was that the decision as to which aircraft would land from the formation approach could change if there was a difference in fuel (i.e. if an aircraft was lower on fuel, then that aircraft would land first), however evidence does not clearly show if the decision authority was put on a specific person, or the MF as a team (Tab V-1.38).

In interview, MIP1 could not recall if he used the word "significant" in conjunction with the phrase "difference in fuel", to which there are a variety of techniques in the community when it comes to formation approach decisions (Tab V-1.13, V-1.38, V-2.19, V-3.19 to V-3.20, V-4.7, V-5.4, V-5.6, V-6.14, V-7.7, V-8.11, V-13.5, V-14.25, V-15.16, V-16.4, V-17.8, and V-17.12).

c. Preflight

The callsigns for the formation on the Flight Authorization were "STEER 1" (MIP1) and "STEER 2" (MSP/MIP2), pronounced "STEER one" and "STEER two", respectively(Tab K-4). Normally, the Flight Authorization callsigns match the ones filed with the Flight Plan; however, the MF's filed Flight Plan used "STEER 01" (pronounced "STEER zero-one) instead of "STEER 1"(Tab K-12). Interviews of MIP1, multiple instructor and student pilots, and tower personnel indicated there were differing opinions as to whether "STEER 01" holds the same meaning as "STEER 1" (Tab V-1.32, V-8.5, V-12.2, V-13.10, V-14.15, and V-17.6).

As required, the MF received a briefing from the 87 FTS Operations Supervisor, reviewed the go/no-go items, obtained their aircraft assignment, and donned their aircrew flight equipment (AFE) (Tab R-83). The Mishap Formation (MF) arrived at their aircraft at 08:42L on the ramp at Laughlin AFB (Tab U-7). Ground operations, start, and taxi were uneventful (Tab AA-7).

d. Summary of Accident

At 09:10L, the MF took off from RWY 13C, two minutes prior to their scheduled takeoff time (Tab AA-7). Takeoff, departure, en route, and formation maneuvers in the MOA were uneventful

(Tab AA-7). While still in the MOA, MIP1 in MA1 gave the administrative lead to MA2 for the remainder of the sortie as planned (Tab AA-7).

At 09:57:04L, the MF prepared to RTB from the MOA (Tab AA-7). MSP (in the admin lead position) informed ATC they would be departing the MOA and were RTB for a formation instrument approach to Runway 13C (Tab AA-7 and AA-19). MSP also stated the formation would be splitting during the approach, with one of the aircraft landing to a stop and one performing a low approach (Tab AA-16). The aircraft not landing would be pulling into Lariat's pattern (Tab AA-19). Lariat is the name given to the outside (East) runway, in this case Runway 13 Left (13L) (Tabs O-29 and BB-7). On the mishap day, since Runway 13 was the active direction, Lariat (13L) would have been to the left of 13C, requiring the low-approach (option Lariat) aircraft to pull into the pattern on the left (Tab BB-7). MSP words over the radio were, *"STEER 0-1, er, 1 and 2, request vectors ILS 1-3 Center, 1 will be option Lariat, 2 will be full stop"* (Tab AA-7 and AA-19). MSP's radio call indicates that STEER 2 will be landing. However, since the administrative lead change had occurred, the board concludes based on the evidence that MSP was referring to MA2 as "1" (Tab AA-7 and AA-19).

At 10:00L, MSP initiated a fuel check by contacting MIP1 on the intra-flight (communication between the two aircraft in the flight) radio (Tab AA-7 and AA-20). Both MA1 and MA2 were "1.3" (indicating 1,300 pounds of fuel) for that fuel check (Tab AA-7 and AA-20). MSP then asked over the intercom to MIP2, *"Alright, so we'll go ahead and drop him [MIP1] off then we'll pull into Lariat*?" MIP2 did not answer the question directly, but rather offered a technique of waiting until being closer to the airfield before doing a more precise fuel check (Tab AA-7 and AA-20). When discussing the more precise fuel check, MIP2 suggested using the precise readout from the fuel system (i.e. 1270 vs. 1.2 or 1.3) (Tab AA-7 and AA-20).

At 10:08:08L, MSP initiated a left hand turn to base leg for the Instrument Landing System (ILS) to RWY 13C from a heading of 320 to a heading of 270 per ATC instruction (Tab AA-7 and AA-22). The MF was approximately 13 nautical miles (nm) to the north east of Laughlin AFB at 3,600 feet mean sea level (MSL) in altitude (Tab AA-7). At this time, MIP2 prompted MSP to accomplish the precise fuel check (Tab AA-7, and AA-22 to AA-23). The fuels given over the intra-flight frequency were *"1's 10-40"* (MSP/MA2, indicating 1,040 pounds of fuel), and MIP1 responded with, *"2's 10-70"* (MIP1/MA1, indicating 1,070 pounds of fuel) (Tab AA-7 and AA-22).

At 10:08:21L, MSP stated over MA2's intercom *"Alright so he'll be the full stop"* (Tab AA-7 and AA-23). MIP2 does not respond in a direct manner, but rather asks, *"Well he's heavier right?"* = MSP responds with *"Oh, 10-70, yup,"* but there is no subsequent positive confirmation as to if that had changed the landing order or not (Tab AA-7 and AA-23). There is no communication throughout the sortie between MA2 and MA1 regarding which aircraft is landing and which aircraft will perform a low approach (Tab AA-6 to AA-9 and AA-19 to AA-25).

At 10:10:07L, when realizing that MA1 is on the right side of the formation, MSP states, *"Oh, excuse me, I need to put him on the left side, he's going to Lariat"* (Tab AA-8 and AA-23). MIP2 responded to MSP with a technique of keeping MA1 on the right side, saying, *"Say we have to go around and he's, like both of us? We actually want to be on the left so we can pull…"* at which

point MSP interrupts MIP2 and says *"But he's still going into Lariat?"* (Tab AA-8 and AA-23). MIP2 then states, *"Ya it's fine"* (Tab AA-8 and AA-23). See Figure 1 showing MA2 and MA1's relative positions at this point during the MS.

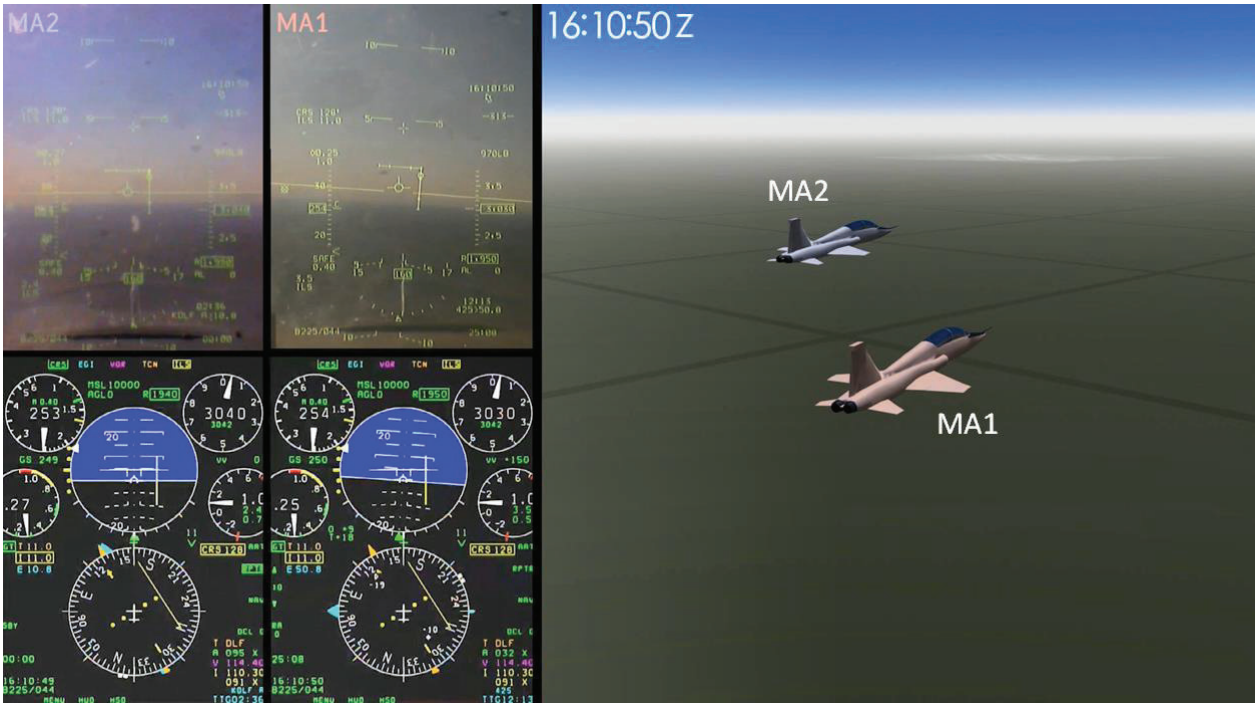

Figure 1 - (Tabs Z-2 and AA-9)

At 10:11:12L MSP informed Laughlin Air Traffic Control Tower (ATCT), *"Tower, STEER 0-1, 9 and a half out ILS 1-3-Center, STEER 2 will be full stop, STEER 1 will be option Lariat"* (Tab AA-8 and AA-24). Tower did not respond to this call (Tab AA-24). In general, tower frequency communications in the pattern were busy due to other aircraft (Tabs N-4 and AA-8). To listeners (i.e. tower), MSP's radio call indicates the MF was 9.5 nm from the runway and STEER 2 would be landing. The words of which aircraft will be landing in this radio call match MSP's earlier radio call at 09:57L in which he had stated, "*…1 will be option Lariat, 2 will be full stop."* However, based on the fuel check and MIP2's prompts, MSP planned to land (Tab AA-8). Therefore, the AIB concludes MSP in this instance (10:11:12L) was referring to MA2 as "STEER 2," which is opposite of the 09:57L call in which he referred to MA2 as "1" (Tab AA-7 and AA-24). The word meanings to ATC had remained the same (STEER 2 will be landing), yet MSP's intentions had been reversed (Tab AA-8 and AA-24).

At 10:11:40L, after the turn to align to the 13C localizer, MSP rocked MA2's wings as a visual signal for MA1 to move to the fingertip position (right side) (Tab AA-8 and AA-24). There was also some instruction from MIP2 to MSP over MA2 intercom about being a stable lead, use of throttle settings, and lowering the landing gear (Tab AA-8 and AA-24).

Figure 3 - (Tabs Z-4 and AA-9)

At 10:12:36L, Laughlin Tower cleared the MF for the option saying, *"STEER Flight, runway 1-3-Center, winds 1-5-0 at 1-0, cleared for the option,"* to which MSP responded at 10:12:41L, *"STEER 0-1 Flight, cleared for the option 1-3-Center, and STEER 1 will be full stop."* (Tab AA-8 and AA-24). According to the Federal Aviation Administration (FAA) when an aircraft is cleared for the "option," it means an aircraft is cleared to land, perform a touch and go, low approach, or stop and go (Tabs BB-3 and V-12.4).

In this moment, the evidence indicates MSP was now referring to MA2 as *"STEER 1."* This radio call indicates another incorrect change in callsign usage from MSP (Tab AA-8 and AA-24). The "STEER 1" callsign, when talking to outside agencies (i.e. tower, ATC) is reserved for referring to the formation of the two aircraft, or MA1 (V-12.2). When discussing an action that MA2 will be doing apart from the formation (i.e. landing) the callsign "STEER 2" should be used (Tabs O-39, R-88, V-6.10, V-14.14, and V-12.2). According to MIP1 in interview, having MA1 on the right side of the formation in conjunction with the "STEER 1 will be full stop" radio call from MSP, caused MIP1 to further believe that MA1 should be the aircraft to land (Tab V-1.14).

Between the call with tower at 10:12:36L, and 10:13:27L, there was some prompting from MIP2 to MSP about following the glideslope (vertical instrument guidance to the runway) (Tab AA-8 and AA-24 to AA-25). At 10:13:27L (500 feet AGL), MIP2 stated over intercom to MSP, *"And right around here I'll be like hey, uh, STEER 2, have the runway in sight?"* (Tab AA-8 and AA-25). MSP then asked MA1 over the intra-flight frequency, *"STEER 2 do you have the runway in sight?"* (Tab AA-8 and AA-25). MA1 responded with *"Affirm."* (Tab AA-8 and AA-24 to AA-25). It is common for the lead aircraft in a formation approach to confirm that the wingman has the runway in sight prior to the wingman landing because until that point on the approach, the

wingman primarily has been looking at the flight lead in order to fly a stable close formation position (Tab V-8.13, V-7.9, V-13.13, and V-15.19).

At 10:13:33L (380 feet AGL), MIP2 said *"STEER 2 cleared off"* over the intercom frequency, prompting MSP to say to MA1 over the intra-flight frequency, *"STEER 2 cleared off"* (Tab AA-8 and AA-25). MIP1 responded with *"STEER 2's cleared off"* (Tab AA-8 and AA-25). MIP1 then lowered MA1's nose six degrees below the horizon in order to transition to a normal landing with a 3.5 to 3 degree glidepath (Tab AA-9). MIP1 remembers seeing MA2, on the left, appear to be leveling off or climbing in relation to MA1 (Tab V-1.35). It would have been difficult for MIP1 to discern the difference between MA2's continued rate of descent and MA2 leveling off during MIP1's transition to a slightly steeper glidepath.

From this point forward, the digital evidence shows MIP1, MIP2, and MSP's actions were consistent with both MA1 and MA2 landing on the centerline of Runway 13C (Tab AA-8 to AA-9).

At 10:13:39L (250 feet AGL) MIP2 started a series of prompts to MSP regarding glide path correction and airspeed corrections (Tab AA-9). MSP had let MA2 get slower than final approach speed by two knots calibrated airspeed (KCAS) (Tab AA-9 and AA-25). It is unknown what visual cues, if any, MIP2 or MSP saw after the "cleared off" call because neither pilot was, or could be, interviewed; however, based on other unit pilot interviews and the board's simulator replications, MIP2 would have seen MA1 descend after the "cleared off" call, which would have been an immediate indication that there was confusion between the aircraft (Tabs V-2.17, V-10.17, V-14.22, V-14.34, and AA-14). At this time, MIP2's communications were focused on instructing MSP on landing the aircraft (glide path and airspeed). Based on the positions of the aircraft, MIP2 would have been able to see MA1 descending and preparing for landing, which would have been alarming and prompted immediate action. Therefore, evidence indicates that MIP2 was not looking at MA1 after the "cleared off call" (Tab AA-9 and AA-14).

Figure 6 - (Tabs Z-5 and AA-9)

At 10:13:45L (180 feet AGL), MSP pulls the nose of MA2 up slightly, causing MA2's descent to slow, as he simultaneously stated to MIP2, *"I don't have sight of him"* (referring to MA1) (Tab AA-9 and AA-25). At this point there was unrelated communications on Laughlin Tower's frequency, followed by MSP asking MIP2, *"Do you have sight of him?"* to which MIP2 responded (10:13:51L, 150 feet AGL), *"Yeah, he's…he's gone."*(Tab AA-9 and AA-25) MSP responds with, *"OK, so he's…"* and does not finish his sentence. MA2's airspeed during this time dropped to six KCAS below final approach speed (Tab AA-9 and AA-25). The board concluded this airspeed deviation was due to MSP not being focused on aircraft parameters, but rather trying to visually search for MA1.

Also at 10:13:50L, MA2's Radar Altimeter (RALT) indicated 150 feet AGL, then shortly (10:13:51L) showed 60 feet AGL, prior to switching back to 150 feet AGL (Tab AA-9 and AA-25). MA1's RALT at this moment read 90 feet AGL. The board determined the momentary RALT deviation of MA2 was due to MA1 being 60 feet under MA2 (Tab AA-9 and AA-25).

Figure 10 - (Tabs Z-8 and AA-9)

Figure 11 (Top View) – (Tabs Z-8 and AA-9)

At 10:14:01L, MA1's main landing gear made contact with the runway in a normal landing attitude, at 138 KCAS (Tab AA-9).

e. Impact

At 10:14:02L, MA2's nose landing gear impacted MA1's left horizontal stabilizer at 148 Knots Calibrated Air Speed (KCAS), approximately 10 KCAS faster than MA1(TabAA-9).

Figure 21 - (Tab Z-13 and AA-9)

The impact caused MA1 to abruptly pitch up (Tab J-3 and J-6). MA2's RCP canopy scraped the left side of MA1's vertical stabilizer followed by MA1's rudder and aft portion of its vertical stabilizer being wedged between MA2's #2 (right) engine inlet and fuselage (Tab J-3 and J-6). The forces on MA1's tail section caused MA1 to abruptly turn to the right (Tab AA-9).

As MA1 approached approximately 180 degrees of turn, MA2's right wing tip made contact with MA1's #2 (right) engine bay cooling air inlet duct, causing MA2 to roll to the right into an inverted attitude (Tabs J-3,J-6 to J-9, and AA-9). MIP2 initiated the ejection sequence for MA2 and MIP2 ejected from the rear cockpit as the aircraft was near 90 degrees of bank (Tabs J-3, J-9, and H-10). MIP2's ejection sequence was partially successful, interrupted by the ground, resulting in life-threatening injuries (Tab H-14). The T-38C is equipped with an inter-seat sequencing system, which for MA2 was properly configured to the "both" setting (Tab H-3 to H-4, H-12). This means when either pilot initiates ejection, both ejection seats will fire in sequence with the second seat firing 1.3 seconds after the first (Tab H-6). MSP's ejection was fully interrupted by the ground, as the aircraft was inverted, causing fatal injuries (Tab H-14). MA2 slid down the runway inverted and came to rest on the right side of the runway approximately 2,000 feet past the threshold of RWY 13C (Tabs C-2 and J-9).

Simultaneous with MA2 rolling to an inverted attitude, the right side of MA1's nose dropped, made contact with the ground, and righted itself. MA1 then spun in circles across the runway until coming into contact with the Taxiway Bravo sign on the left hand side of the runway (Tab J-8). MIP1 egressed the aircraft on the ground with minor injuries (Tabs H-24 and X-3).

f. Egress and Aircrew Flight Equipment (AFE)

(1) Ejection Seats

Post-mishap engineering analysis determined that MIP2 initiated the ejection sequence for MA2 (Tab H-14). The ejection seats in both aircraft were properly armed and configured for their flight (Tab H-14). The ejection seat associated with MA1 was not evaluated for performance as an ejection was not attempted (Tab H-10). No anomalies were identified during visual confirmation of MA1 for proper seat configuration, indicating the escape system would have initiated an ejection sequence (Tab H-14).

Evidenced by the unseated ejection seat firing handle and both seat initiator sears removed from their respective receptacles, MIP2 initiated the ejection sequence just prior to ground impact; however, the inversion of MA2 resulted in the ejection sequences being interrupted by the ground (Tab H-10). Analysis revealed that interference with the ground damaged numerous gas connections, causing failure of MIP2's ejection seat parachute deployment and the seat-occupant separation function (Tab H-14). MIP2 was found still strapped in his ejection seat approximately 280 feet away from MA2 with life-threatening injuries (Tab H-14).

Given the inter-seat sequencing system was properly set to BOTH, MIP2's initiation of the ejection sequence caused the subsequent ejection of the MSP approximately 1.3 seconds later (Tab H-12). Though the system functioned as designed, the continued roll and eventual inversion of MA2 interrupted the MSP's canopy jettison and seat ejection sequence, leading to fatal injuries for the MSP (Tab H-15).

g. Search and Rescue (SAR)

The impact occurred at 1014:02L (Tab AA-9). Personnel in the Control Tower observed the mishap and immediately (1014:11L) initiated a crash response via the crash phone (Tab N-5). This call was acknowledged by Fire, Base Operations, and the Medical Group less than one minute after the crash (1014:53L, time of last acknowledgement) (Tab N-5).

The T-6 Runway Supervisory Unit (RSU) Observer, stationed near the approach end of Runway 13 Right, observed the collision of MA1 and MA2 (Tab R-42 and R-46). He exited the RSU and ran toward the scene (Tab R-42 and R-46). He first encountered MIP2, who was unconscious and still strapped in his ejection seat in the infield approximately 280' from the initial impact location away from where MA1 and MA2 came to rest (Tabs R-46 to R-47, H-14). He removed MIP2's oxygen mask, and observed MIP1 exit MA1 from this position (Tab R-42, and R-46*)*. He then moved to MA1, where he guided MIP1 clear of the immediate crash site (Tab R-42 and R-46). The RSU Observer noted it was at this time that he saw the first crash response vehicle arrive (Tab R-49 to R-50, and R-42).

At that time of the mishap, multiple firefighters were participating in an exercise away from the station (Tab R-115). Chief 2 (CH-2), who was at the station, proceeded to the crash site in his vehicle when the crash notification was broadcast over the station public address system by the dispatcher (Tab R-112 to R-113). CH-2 requested clearance to the runway for himself and other fire response vehicles that he knew would follow him momentarily because they were already prepared for a response due to the exercise (Tab R-113 and R-115). CH-2 requested to cross the runway at approximately 1017L (Tab AA-27). CH-2 then approached the scene, established command, and directed fire crews upon their arrival (Tab R-112 and R-114).

CH-2 directed a firefighter to pull a hand line off a fire engine at approximately 1020:03L, Flight Medicine personnel arrived at approximately 1020:38L, CH-2 directed another firefighter to do a primary search of the area at approximately 1020:41, and CH-1 arrived and took command at approximately 1023:10L (Tab AA-28 and AA-31).

At approximately 1024:17L, CH-2 reported one fatality, two injured personnel, and no personnel missing (Tab AA-28). The T-6 RSU Observer also approached CH-2 before the arrival of the other fire units and directed CH-2 towards MIP2, as he believed MIP2 was most in need of assistance (Tab R-42, R-43, R-47, and R-112 to R-114).

The first medical responders (MED-1) arrived on scene at approximately 1020L (Tab AA-31). Additional medical personnel (MED-2) utilized vehicles of opportunity and were on scene at approximately 1030L (Tabs R-80, R-94, R-162, R-191, and AA-33).

The first ground ambulance arrived at approximately 1036L (22 minutes after impact) (Tab AA-28). The life flight helicopter arrived at approximately 1045L (Tab AA-28).

Ground ambulance transported MIP1 from the scene at approximately 1055L (Tab AA-28) and took MIP1 to the local hospital where he was treated for minor injuries and released (Tab X-3).

MIP2 was stabilized at the scene and transported via life flight helicopter to Brook Army Medical Center, Joint Base San Antonio-Fort Sam Houston, TX (BAMC) at approximately 1131L (Tabs R-162 to R-163, R-191 to R-192 and Tab AA-29).

In total, the following emergency response equipment responded to the scene: two fire command vehicles, one engine (P22 pumper), two crash/rescue vehicles (P34 rapid intervention vehicles), one medical response vehicle, two ambulances, one life flight helicopter, and multiple auxiliary vehicles (Tab AA-33 to AA-34).

h. Recovery of Remains

An explosive ordinance disposal (EOD) team was requested by the incident commander at 1050L to disarm any unfired ejection seats. (Tab AA-28). An EOD team from Lackland AFB, TX arrived on scene at 1436L (Tab AA-31). EOD recovered MSP at 1530L away from MA2 (Tabs CC-6 and AA-31). A local Justice of the Peace officially pronounced MSP dead at 1558L (Tab X-3). After pronouncement, MSP was transported to a local funeral home at 1629L (Tab X-

3). The MSP was later transferred from the local funeral home to BAMC for autopsy, which was accomplished at 0800L on 22 November 2021 (Tab X-3).

5. MAINTENANCE

a. Maintenance Documentation

The AIB reviewed all active and recently pulled 781-series forms, historical jacket files, and Integrated Maintenance Data System (IMDS) history over the past year for MA1 and MA2 (Tabs D-8 to D-33, D-50 to D-75, and U-2 to U-6). All documentation was reviewed for accuracy, completeness, and compliance with applicable technical data and published guidance (Tab U-2 to U-6). Though minor discrepancies related to historical data integrity were identified, the AIB found no evidence to suggest maintenance documentation was a factor in the mishap (Tab U-2 to U-6).

b. Inspections

(1) MA1

MA1 last flew an uneventful sortie on 18 November 2021, accruing 1.1 hours (Tab D-15). MA1 had 17101.4 flight hours at the time of the combined basic post-flight and pre-flight (BPO/PR) inspection that was accomplished on 18 November at 1800L with no defects noted (Tab D-11).

MA1's last phase inspection was a 450 flight hour minor periodic inspection accomplished on 18 February 2020 (Tab U-3). The inspection and associated non-destructive inspection (NDI) revealed composite disbonds in the left aileron surface, rudder surface, right flap surface, and left main landing gear inboard door skin (Tab U-3). The flight control surfaces were replaced and the gear door repaired (Tab U-3). The phase inspection concluded on 5 March 2020 (Tab U-3).

MA1's last scheduled 225 flight hour post-flight inspection (HPO) was completed on 2 April 2021, with no deficiencies noted (Tab U-3). A review of MA1's maintenance records reflected no overdue special, calendar, hourly, or required inspections, and no grounding discrepancies that would have affected the airworthiness of the MA (Tab U-4).

(2) MA2

MA2 last flew two uneventful sorties on the morning of 16 November 2021, accruing 1.9 hours (Tab U-5 and U-6). MA2 had 17624.7 flight hours at the time of the combined basic post-flight and pre-flight inspection that was accomplished at 2200L on 16 November with no discrepancies noted (Tab D-53).

MA2's last phase inspection was a 450 flight hour minor periodic inspection accomplished on 17 May 2021, (Tab U-4). The scheduled inspection and NDI revealed delamination in the right main landing gear inboard door skin and a crack in the right lower wing skin at fastener #444 (Tab U-4). The T-38 Engineering System Program Office (SPO) provided a doubler repair for the door,

and ream and bushing repair procedure for the wing skin, as well as required follow-on and recurring NDI (Tab U-4). The phase concluded at on 2 June 2021 (Tab U-4).

MA1's last scheduled 225 flight HPO inspection was completed on 23 September 2020 with no deficiencies noted (Tab U-4). A review of MA2's maintenance records reviewed no overdue special, calendar, hourly, or required inspections, and no grounding discrepancies that would have affected the airworthiness of the MA (Tab U-6).

c. Maintenance Procedures

The 47th Flying Training Wing Maintenance Group (47FTW/MXG) performs all T-38C maintenance at Laughlin Air Force Base, adhering to Air Force guidance to conduct regular and unscheduled maintenance (Tab U-5). Of note, MA2 had vibration problems 5, 9, 16, and 17 November 2021 (Tab U-4 and U-5). Aircraft technical orders prescribe vibration troubleshooting that procedures that isolate the engine from the airframe-mounted accessory power assembly (Tab U-5). If vibrations continue, the engine is inspected for interference with surrounding structure, and the engine mounts are inspected for serviceability (Tab U-5). If the vibrations cease, technical data then requires inspection of power shaft couplings, gearbox lubrication filters, accessory component mounting and security, and replacement of both couplings, and subsequent testing of the hydraulic pump and accessory power assembly if conditions do not improve after taking the previous steps (Tab U-5).

The 47FTW/MXG did not follow proper vibration isolation and repair procedures when troubleshooting the pilot-reported discrepancies on 9 and 16 November 2021, or while troubleshooting the maintenance-reported discrepancy on 17 November 2021, after generator repair and replacement of the airframe-mounted gearbox (Tab U-5). The 5 November 2021 discrepancy could not be duplicated during troubleshooting (Tab U-5). Though the airframe-mounted gearbox and generator were bench tested and reinstalled on 12 November 2021, a true corrective action according to published guidance was not taken (Tab U-5). An appropriate corrective action would have followed the above-mentioned troubleshooting steps, and contained associated repairs (Tab U-5). On 17 November 2021, once maintenance crews identified the vibration still existed after generator repair and replacement of the airframe-mounted gearbox, further follow-on troubleshooting and corrective actions were not taken to properly explore or resolve the persisting discrepancy (Tab U-5). Though poor troubleshooting procedures were utilized, there is no evidence to indicate these discrepancies contributed to the mishap (Tab U-6).

As determined from the HUD recording, MA1's ground operations prior to the mishap sortie were uneventful (Tab U-4). A review of MA2's HUD recording revealed that maintenance ground crew operations prior to the mishap sortie were not compliant with published guidance (Tab U-5 to U-6). Technical data prescribes that wheel chocks be removed at aircrew's direction just prior to taxi (Tab U-6). The technician that launched MA2 introduced a non-standard safety hazard by removing chocks immediately after engine start, and without aircrew direction (Tab U-6). Though poor maintenance practices were utilized in this instance, there is no evidence to indicate this discrepancy contributed to the mishap (Tab U-6).

d. Maintenance Personnel and Supervision

There is no evidence to indicate maintenance personnel were not fully qualified and appropriately supervised (Tab U-3).

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

Air Force Petroleum Office (AFPET) analyzed fluid samples taken from the following equipment at Laughlin AFB: liquid oxygen (LOX) from the servicing cart, and engine oil from the servicing cart (Tab D-2, D-3, and D-6). AFPET determined the fluid samples revealed no abnormal conditions (Tab D-2, D-4 and D-6).

Additionally, AFPET analyzed the following fluid samples taken from MA1: oil from Engine 1, oil from Engine 2, forward fuel system, and the aft fuel system (Tab D-35 to D-42). The following fluid samples were taken from MA2: oil from Engine 1, oil from Engine 2, forward fuel system, and the aft fuel system (Tab D-77 to D-82). AFPET determined the fluid samples revealed no abnormal conditions (Tab D-35 to D-42 and D-77 to D-82).

AFPET analysis revealed samples from the flight (right) and utility (left) hydraulic fluid reservoirs of both MA were slightly below limits for viscosity at 40°C and 100°C, and exceeded established foaming tendencies set for unused fluid (Tab D-43 to D-46 and D-83 to D-86). Samples of fuel from the servicing truck were analyzed and showed insufficient conductivity as compared to standard Jet-A (Tab D-4 and D-5). However, analysis by the AF T-38 SPO, found no evidence of malfunction or failure in either MA's hydraulic systems prior to the mishap sequence (Tab J-22).

Liquid oxygen samples were not recovered from MA1 or MA2 during the Interim Safety Board or Safety Investigation Board (Tab U-6). The Accident Board concluded damage to the aircraft either prevented recovery or caused it to leak out after the mishap (Tab U-6).

f. Unscheduled Maintenance

(1) MA1

Since its last scheduled inspection, MA1 experienced two cabin pressure problems, one on 5 October 2021 and one on 4 November 2021 (Tab U-3 and U-4). The first malfunction was corrected with replacement of the front and rear canopy expansion seals, and the latter with replacement of the cabin altimeter (Tab U-3 to U-4).

Additionally, MA1 experienced five flap indication issues between 16 May and 14 October 2021, ranging from erratic, stuck, or failed surface position indicators as well as erroneous warning system alerts relating to flap position (Tab U-4). The front and rear cockpit flap position indicators were replaced, as well as the flap position transmitter (Tab U-4). Subsequent and final corrective actions included adjustments of the Angle of Attack-flap synchronizer (AOA flap synchro) and associated hardware (Tab U-4).

On 27 April and 7 July 2021, MA1 encountered Air Data Computer (ADC) failures (Tab U-4). The first failure was corrected with replacement of the ADC, and the second with an adjustment

of the AOA flap synchro, simultaneously correcting one of the aforementioned flap malfunctions (Tab U-4).

On 2 November 2021, MA1 had two recurring failures of the landing and taxi light (Tab U-4). MA1 flew 1.1 flight hours after initial replacement of the bulb and subsequent failure and replacement of the entire assembly (Tab U-4). MA1 flew 9.7 flight hours between replacement of the landing and taxi light assembly and the mishap (Tab U-4).

Overall, MA1's recent unscheduled maintenance history was unremarkable as it relates to the mishap (Tab U-3 and U-4).

(2) MA2

On 15 June 2021, MA2 experienced an Engine 2 fuel flow sensor fail, and a recurring discrepancy of zero fuel flow on 16 June 2021 (Tab U-4). The initial discrepancy was addressed with replacement of the transmitter fuse, and the subsequent discrepancy by replacement of the transmitter itself (Tab U-4).

MA2 had a history of airframe vibrations spanning from 5 November 2021 to 16 November 2021, specifically when the right generator was turned off during ground checks (Tab U-4). On 5 November 2021, MA2 had a pilot-reported discrepancy of vibrations noted from Engine 1; maintenance crews could not duplicate the malfunction later that day (Tab U-5). On the next scheduled flight on 9 November 2021, aircrew experienced a right generator failure and subsequent vibration (Tab U-5). This discrepancy was not captured as a repeat discrepancy due to it being written up as engine vibrations on the first event, and gearbox vibrations on the second (Tab U-5). Maintenance then removed the airframe-mounted gearbox and generator and sent them to the appropriate maintenance back shops for bench testing where they were found to be serviceable; the components were reinstalled and MA2 was returned to service after operational checkouts were accomplished (Tab U-5). On the third attempted sortie on 16 November 2021, MA2 ground aborted (did not fly its scheduled mission) for excessive vibration during crossover checks of the right generator (Tab U-5). The generator was repaired, and the airframe-mounted gearbox was replaced (Tab U-4 to U-5). On 17 November 2021, during operational checks, technicians identified a vibration on Engine 1 from 61-67% power with the Engine 2 generator turned off (Tab U-5). A different maintenance crew ran the aircraft test using the same technique and were unable to duplicate the discrepancy, returning MA2 to service on 18 November 2021 (Tab U-5).

6. AIRFRAME

a. Structures and Systems

(1) Engines

i. MA1

MA1's left and right engines had a total of 8062.4 and 14332.9 flight hours respectively, with 228.7 and 186.5 flight hours since the HPO (Tab J-27). MA1's engines were not required to be disassembled or tested due to the flight data findings and events of the mishap (Tab J-29).

Visual inspections of the engines were performed, wherein no contributory anomalies were identified (Tab J-29). The Heads-Up Display (HUD) and Data Transfer System (DTS) recordings indicated the engines were operating normally prior to collision (Tab J-29). Upon initial evaluation at the mishap site, MA1's throttles were in the "OFF" position and the fuel cutoff switches were in the "CLOSED" position (Tab J-29). MA1's aft fuselage and Engine 1 were damaged by the right inlet of MA2 upon impact. (Tab J-6 and J-29). Both of MA1's engines ingested ground debris (Tab J-30, and J-32). Engine 1 had compressor damage as a result of debris ingestion; the compressor section of Engine 2 did not have notable compressor damage (Tab J-30 and J-32).

ii. MA2

MA2's left and right engines had a total of 12921.1 and 10688.2 flight hours respectively, with 565.6 and 396.1 flight hours since the HPO (Tab J-28). MA2's engines were also not required to be disassembled or tested due to flight data findings and the events of the mishap (Tab J-32).

Visual inspections of the engines were performed, wherein no contributory anomalies were identified (Tab J-30 to J-32). The HUD and DTS recordings indicated the engines were operating normally prior to the collision (Tab J-30 to J-32). Evidence indicates that Engine 1 was operating between Military (MIL) power and maximum afterburner (Tab J-30 to J-34). Ground debris and related foreign object damage was found in the inlet of Engine 1 (Tab J-30 to J-34). The power setting for Engine 2 was found to be between idle and MIL (Tab J-30 to J-35). Ground debris and large amounts of MA1's empennage, rudder, and vertical tail were found in the inlet of Engine 2 (Tab J-35 and J-36).

(2) Airframe

i. MA1

Portions of all flight controls, wing, and vertical fixed surfaces were located in the scatter pattern or attached to the aircraft (Tab J-10). The fuselage remained relatively intact with the exception of the nose section that had broken free during ground impact (Tab J-11). The nose section separated at approximately fuselage station 144 and came to rest near the right engine inlet (Tab J-11).

The wing and attached surfaces were all damaged but remained attached to the aircraft (Tab J-10). The horizontal stabilizer and rudder were still attached to the aircraft, however pieces of them had

broken free during the collision with MA2 (Tab J-10). The vertical stabilizer, including the detachable tip, remained attached to the aircraft, but was also damaged in the collision with MA2 (Tab J-10). The speed brakes were found undamaged, but sagging due to loss of hydraulic pressure resulting from engine shutdown as expected (Tabs J-10, U-2, and U-3).

The forward windscreen was damaged but still attached to the aircraft (Tab J-11). Both the front and rear canopies of MA1 were still attached to the aircraft, though the front canopy transparency broke during the mishap sequence (Tabs J-11 and H-10).

ii. MA2

Portions of all flight controls, wing, and vertical fixed surfaces were located in the scatter pattern or attached to the aircraft (Tab J-12). The upper surface of the cockpits were heavily damaged during the inverted slide (Tab J-12). The nose section of the aircraft was bent, but remained attached to the aircraft (Tab J-12). The right engine inlet had been torn away from the fuselage during contact with the empennage of MA1, but remained attached by the outboard skin (Tab J-13). The rear canopy was found intact on the east side of the runway as a result of the jettison system (Tab J-13 and H-10).

The wing and attached surfaces were all damaged but remained attached to the aircraft, with the exception of the right wingtip that was located approximately 10 feet from the right wing (Tab J-12). The horizontal stabilizer and rudder surfaces were still attached to the aircraft with the exception of the upper portion of the rudder that had liberated during the inverted slide (Tab J-12). The vertical stabilizer remained attached to the aircraft but was also heavily damaged during the slide (Tab J-12). The speed brakes were found closed and free of damage (Tab J-12).

(3) Landing Gear

i. MA1

The nose and main landing gears were in the extended position prior to the mishap (Tab J-17, and J-18). All components were inspected and no indication of pre-mishap issues were identified (Tab J-18).

The right main landing gear (MLG) strut door had broken free from MA1, but was found in close proximity to the right wing (Tab J-10). The left MLG strut door and both inboard doors were still attached to the aircraft (Tab J-10). The nose landing gear (NLG) door was found attached to the forward fuselage of the aircraft (Tab J-10). The NLG remained within the separated nose section of the aircraft (Tab J-11).

ii. MA2

The nose and main landing gears were in the extended position prior to the mishap (Tab J-22). All components were inspected and no indication of pre-mishap issues were identified (Tab J-22).

The MLG strut doors and inboard doors, as well as the NLG forward door were still attached to the aircraft (Tab J-12). The NLG strut was severely damaged from impact with the left horizontal tail surface of MA1 (Tabs J-5, U-2, and U-3).

(4) Flight Control Actuators and Motors

i. MA1

The left and right horizontal tail surface actuators were found to be installed properly and in good working condition (Tab J-14 and J-15). Both actuators passed operational and leak checks (Tab J-24). A thorough inspection was performed on the piston cavity, pistons, servo valves, spool/sleeve, O-rings, strainers, etc. (Tab J-24). All components were found to be in good operating condition (Tab J-14, and J-24).

Testing of the horizontal stabilizer trim actuator indicated the trim actuator was in good functioning condition at the time of ground impact (Tab J-15, and J-24). No indications of pre-mishap damage were observed (Tab J-14).

The left and right aileron actuators were found to be in good condition with no notable damage due to the mishap (Tab J-15). Both aileron actuators were tested on the hydraulic test stand and were found to be in good functional condition (Tab J-15, J-16, and J-24). The actuators and actuator servo valves were disassembled and were found to be in functioning condition (Tab J-16 and J-24). Of note, the right aileron actuator had the neutral point slightly out of adjustment, which is not uncommon for a used actuator, nor would it cause any functional issues in flight (Tab J-16 and J-24). Additionally, the right aileron actuator's outboard cylinder had foreign object damage that appeared to be a result of the mishap (Tab J-16 and J-24).

Testing of the aileron trim actuator indicated the actuator was in good functioning condition at the time of ground impact (Tab J-16 and J-24). The left and right rudder actuators were found intact and undamaged within the center section of the aircraft fuselage (Tab J-16 and J-24). Both actuators passed functional testing with no failures (Tab J-16 and J-24). The actuators and actuator servo valves were disassembled and found to be in good condition with no noted issues (Tab J-17 and J-24).

The Stability Augmentation System (SAS) actuator was found to be installed properly and in good condition (Tab J-17). The actuator was removed and passed functional testing (Tab J-17 and J-24). Internal leakage resulting from mishap damage was noted and prevented completion of all required testing (Tab J-17 and J-24).

The speed brake surfaces were found intact and properly attached to the aircraft slightly sagging, which is typical after removal of hydraulic power (Tab J-17 and J-24). There were no indications the surfaces were deployed before or during the mishap sequence (Tab J-17 and J-24). Both speed brake actuators were found properly installed and in good condition (Tab J-17 and J-24). The actuators were removed and passed all required testing (Tab J-17 and J-24). No anomalies were noted during disassembly and inspection of the speed brake actuators (Tab J-17 and J-24).

The flap motors were tested for proper operation and passed all required checks (Tab J-17 and J-24). The flap system showed no indication of pre-impact damage (Tabs J-24 and U-2 to U-3). The system was found in the 100% configuration (Tab J-17 and J-24). There was no evidence indicating the flaps were functioning improperly at the time of the mishap (Tabs J-14, J-17, J-24, and U-2 to U-3).

ii. MA2

The left and right horizontal tail surface actuators were found to be installed properly and in good working condition (Tab J-19). Both actuators passed operational and leak checks (Tab J-19, and J-25). A thorough inspection was performed on the piston cavity, pistons, servo valves, spool/sleeve, O-rings, strainers, etc. (Tab J-25). Aside from a small chip off the right actuator body that would not cause any issues in flight, all components were found to be in good operating condition (Tab J-18 and J-25).

Testing of the horizontal stabilizer trim actuator indicated the trim actuator was in good functioning condition at the time of ground impact (Tab J-18 to J-19, and J-25). No indications of pre-mishap damage were observed (Tab J-18).

The left and right aileron actuators were found to be in good condition (Tab J-19). Both aileron actuators were tested on the hydraulic test stand and were found to be in good functional condition (Tab J-20 and J-25). The actuators and actuator servo valves were disassembled and were found to be in functioning condition (Tab J-20 and J-25). Of note, small foreign objects were recovered from the left aileron actuator strainer and servo valve (Tab J-25). This debris resulted from mishap impact and would not have caused any functional issues in flight (Tab J-25).

Testing of the aileron trim actuator indicated it was in good functioning condition at the time of ground impact (Tab J-20 and J-25).

The left and right rudder actuators were found intact and undamaged within the center section of the aircraft fuselage (Tab J-20, J-21, and J-25). Both actuators passed functional testing with no failures (Tab J-21 and J-25). The actuators and actuator servo valves were disassembled and found to be in good condition (Tab J-21 and J-25).

The SAS actuator was found to be installed properly and in good condition (Tab J-21). The actuator was removed and passed all required testing (Tab J-21 and J-25).

The speed brake surfaces were found intact in the retracted position (Tab J-21 and J-25). Both speed brake actuators were found properly installed and in good condition (Tab J-21 and J-25). The actuators were removed and passed all required testing (Tab J-22 and J-25). No anomalies were noted during disassembly and inspection of the speed brake actuators (Tab J-22 and J-25).

The flap motors were tested for proper operation and were found to function properly (Tab J-21 and J-25). The brakes in both flap motors were in need of replacement and the over travel indicator switch was broken; however both discrepancies were likely caused by impact (Tab J-21 and J-25). System components were found in the 70% configuration and the cockpit switches in 60%, indicating surface position selection had likely been moved from 100% to 60% at initial impact

(Tabs J-21, J-25, U-2 to U-3, AA-6, and AA-8). The flap position transmitter was found out of place (Tab J-21). The transmitter position was likely a result of the mishap, but there was no confirming evidence (Tab J-21). There was no evidence indicating the flaps were functioning improperly at the time of the mishap (Tabs J-18, J-21, J-25, U-2, U-3, AA-6, and AA-8).

b. Evaluation and Analysis

NOTE: After looking at the physical evidence of the two aircraft and the heads-up display (HUD) and multi-functional display (MFD) recordings, the board noted the Mishap Analysis and Animation Facility (MAAF) animation is slightly off in how the two aircraft's relative positions are depicted (Tab AA-9). The MAAF animation has MA2 slightly too far to the left (by 2-3 feet) due to a lack of fidelity in the T-38's global positioning system (Tab AA-9).

(1) Engines

i. MA1

Both of MA1's engines were operating at the time of impact, and flight data analysis did not identify any anomalies that contributed to the mishap (Tab J-27 and J-29). There is no evidence to indicate their operation contributed to the mishap (Tab J-27 and J-29).

ii. MA2

Both of MA2's engines were operating at the time of impact, and flight data analysis did not identify any anomalies that contributed to the mishap (Tab J-27 and J-32). There is no evidence to indicate their operation contributed to the mishap (Tab J-27 and J-32).

(2) Aircraft Structure, Flight Controls, Landing Gear Systems

i. MA1

No evidence of malfunction or failure was found in the aircraft structure, flight controls, or landing gear systems prior to the mishap sequence (Tab J-14, J-18, and J-22).

ii. MA2

No evidence of malfunction or failure was found in the aircraft structure, flight controls, or landing gear systems prior to the mishap sequence (Tab J-14, J-18, and J-22).

7. WEATHER

a. Forecast Weather

The local Mission Execution Forecast (MEF) was issued at 0610L on 19 November 2021 (Tab F-2). The MEF for Laughlin AFB at 0900L was clouds broken at 5,000 feet above ground level (AGL), 7 statute miles visibility, 13 degrees Celsius and winds from the south east (120 degrees) at 8 knots (Tab F-2). The MEF showed no change at the 1000L hour with the exception of a temperature change to 15 degrees Celsius (Tab F-2).

b. Observed Weather

The local observed weather at Laughlin AFB at the time of takeoff was clouds broken at 5,500 feet AGL, visibility 10 statute miles, temperature 12 degrees Celsius, winds from the east southeast at 10 knots. The local observed weather at Laughlin AFB at the time of landing was clouds broken at 5,500 feet AGL, visibility 10 statute miles, temperature 14 degrees Celsius, winds from the southeast at 10 knots (Tab AA-6).

c. Space Environment

The space environment and associated weather are not applicable to this incident.

d. Operations

The MS was conducted within prescribed weather requirements and in accordance with published restrictions.

8. CREW QUALIFICATIONS

a. Mishap Instructor Pilot 1 (MIP1)

MIP1 is an active duty officer assigned to the 47th Flying Training Wing (FTW), Laughlin AFB, TX (Tab AA-2). MIP1 is a current and qualified T-38C IP and holds a Command Pilot Aeronautical Rating (Tab G-2). MIP1 is respected as both an individual and a pilot by the vast majority of interviewees that met him (Tab V-3.28, V-5.9, V-6.20, V-14.36 to V-14.37, and V-17.16). A review of MIP1's training records revealed average career progression (Tab AA-2). MIP1 has a total of 1,229.4 hours in the T-38C, with 794.2 of those being instructional hours (Tabs G-3 and AA-2). Additionally, MIP1 has over 600 hours in the F-15C (Tab AA-2). MIP1's total flying experience is 2,125.7 hours (Tabs G-3 and AA-2). MIP1 has previous assignments as both an Undergraduate Pilot Training (UPT) IP and an Introduction to Fighter Fundamentals (IFF) IP in the T-38C (Tab AA-2). MIP1's previous assignments also included multiple F-15C tours (Tab AA-2). The highest rating achieved in the F-15C by MIP1 was Flight Lead (FL) (Tab AA-2). MIP1's Flight Evaluation Folder (FEF) was unremarkable (Tab AA-2).

In early 2021, MIP1 accumulated 30.0 flight hours over the course of 26 sorties for T-38C Pilot Instructor Requalification course at Joint Base San Antonio-Randolph, TX (Tabs G-4 and AA-2). Three sorties in the instrument block were Proficiency Advanced (PA) (Tab AA-2). There were no significant trends noted based on instructor comments or grades (Tab AA-2). MIP1 accomplished two formation approaches during the 2021 requalification training (one from lead, one from wing) but neither of the associated grade sheets specify the approach termination type with any certainty (Tab AA-2). Overall, MIP1 received ratings of "Excellent" in the Qualification, Instrument, and Formation blocks, and "Good" in the Transition block (Tabs G-4 and AA-2).

MIP1 completed Theatre Indoctrination (TI) with the 87 FTS, accumulating 9.1 hours over the course of eight sorties (Tabs G-5 and AA-3). Of MIP1's TI sorties, three were formation sorties

(Tab AA-3). MIP1 received an "Unsatisfactory" grade on "F-2/DO" (Tabs G-6 to G-7, and AA-3) According to the TI Instructor's comments for F-2/DO, most of the issues seen "stemmed from unfamiliarity w/recovery options" and recommended MIP1 fly both "F-3 & F-4" sorties (Tabs G-7 and AA-3). MIP1 did well on the subsequent F-3 sortie, and did not complete the recommended F-4 sortie (Tab G-7 to G-8). MIP1was certified TI complete and Mission Ready on 8 October 2021 (Tabs G-10 and AA-3). The 87 FTS Director of Operations waived completion of the "Buddy Instructor Pilot" (BIP) Program for MIP1 on 26 October 2021 (Tabs G-10 and AA-3). Since that date, MIP1 was considered an experienced instructor pilot on the squadron Letter of X (Tabs G-10 and AA-3).

The Mishap Sortie (MS) was the first sortie flown by MIP1 in 10 calendar days (Tab G-11). MIP1's supervisor stated MIP1's schedule was manageable, and the goal for flying was two flights per week (Tab P-11 to P-12). The last formation sortie and formation approach that MIP1 flew and instructed was on 9 November 2021 (Tab G-11). On the day of the mishap, MIP1's recent flight time in the T-38C was as follows: (Tabs G-12 and AA-3)

Days	Hours Flown	Sorties Flown
30	4.5	5
60	9.2	9
90	11.4	11

b. Mishap Instructor Pilot 2 (MIP2)

MIP2 is an active duty officer assigned to the 47 FTW, Laughlin AFB, Texas (Tab AA-3). MIP2 is a current and qualified T-38C IP and holds a Senior Pilot Aeronautical Rating (Tabs G-13 and AA-3). A review of MIP2's training records revealed average career progression (Tab AA-3). In total, MIP2 has accumulated 3,259.4 flight hours (Tabs G-14 and AA-3). Of those hours, 185.9 are in the T-38C and 66.9 of those are T-38C instructional hours (Tabs G-15 and AA-3). After graduating from Undergraduate Pilot Training in 2011, MIP2 flew the C-17 for 1,301.4 hours prior to being sent to T-6A Pilot Instructor Training (PIT) at Joint Base San Antonio-Randolph, Texas in 2016 (Tabs G-16 and AA-3). During MIP2's T-6A instructor assignment at Laughlin AFB, MIP2 gained 1,335.8 hours, with 1,131.3 of those being T-6A instructional hours (Tabs G-16 and AA-3). After completion of the T-6A instructor assignment, MIP2 received a qualification in the KC-10 in 2020 at McGuire AFB, New Jersey (Tabs V-11.2 and AA-3). Shortly thereafter in 2021, MIP2 returned to Joint Base San Antonio-Randolph, Texas for T-38C PIT, with a follow-on assignment at Laughlin AFB (Tabs V-11.2 and AA-3).

MIP2 flew 81.7 hours under the Track-C version of the T-38C PIT Training course at Joint Base San Antonio-Randolph AFB, Texas (Tabs G-25 and AA-3). Upon review, MIP2's training records indicate that many PIT instructors recognized MIP2's prior T-6A instruction (Tab AA-3). However, on five grade sheets, PIT instructors made comments relating to flight leadership or intervention stating that MIP2 was slow to intervene with student instruction and should take more charge as flight lead during formation sorties (Tabs G-26 to G-31 and AA-3). Additionally, one PIT instructor stated, "Don't handcuff [student] to a technique unless you absolutely have to…aka know technique vs procedure," in grade sheet comments (Tabs G-29 and AA-4).

Ultimately, MIP2 was rated "Excellent" in the Low-Level and Transition blocks, and "Good" in the Qualification, Instruments, and Formation blocks (Tabs G-25 and AA-4).

MIP2 accomplished nine sorties for a total of 9.8 hours in the TI program with the 87 FTS (Tabs G-32 and AA-4). Of those sorties, four were formation sorties (Tabs G-32 and AA-4). On the first formation sortie (F-1), one of MIP2's TI instructors made a grade sheet comment about MIP2 needing to be more direct, instead of asking questions (Tabs G-33 and AA-4).

MIP2 accomplished a "short" BIP program under waiver, flying five formation sorties and five transition sorties (Tabs G-35 and AA-4). There was a lack of documentation from the 87 FTS regarding performance during this program (Tab AA-4). MIP2's short BIP program included waivers for all Instrument, Low-Level, and Cross-Country sorties (Tabs G-35 and AA-4). MIP2 completed the BIP program on 9 November 2021 (Tabs G-36 and AA-4).

On 18 November 2021, MIP2 flew a solo Continuation Training (CT) sortie (Tabs G-18 and AA-4). The last formation sortie that was on 16 November 2021, wherein MIP2 flew solo as Direct Support (DS) (Tabs G-18 and AA-4). The last formation sortie for which MIP2 was an IP of Record (IPOR) was with the MSP on 12 November 2021(Tabs G-18 and AA-4). On the day of the mishap, the MIP2's recent flight time in the T-38C was as follows: (Tabs G-19 and AA-4)

Days	Hours Flown	Sorties Flown
30	25.5	24
60	33.1	31
90	63.3	59

c. Mishap Student Pilot (MSP)

MSP was an active duty officer assigned to the 47 FTW, Laughlin AFB, Texas (Tab AA-4). According to all interviewed, MSP was highly thought of and respected both in the 87 FTS and outside of work (Tab V-4.13 and V-5.14). MSP was a hard worker who inspired other students to work hard and better themselves (Tab V-4.13). According to one student, MSP "was the kind of guy you aspire to be" (Tab V-5.14). Instructors stated that MSP had a fanastic willingness to accept instruction and and ask questions, while having a personality they enjoyed flying with (Tab V-2.27 and V-3.31).

MSP began T-6A training on 2 November 2020 with Class 22-02 and flew with the 434 FTS (Tabs G-41 and AA-4). MSP graduated the T-6A program in class 22-05 (Tabs G-41 and AA-4). MSP was on the Commander's Awareness Program (CAP) (Flying CAP) for four days preceding the initial T-6A solo due to two unsatisfactory sorties in a row (Tabs G-43 to G-44 and AA-4). Overall, MSP did very well in the T-6A program (Tab AA-4). MSP received an overall grade of "Excellent" in the T-6A Formation block of training and "Good" in the Advanced Formation block (Tabs G-42 and AA-4). MSP flew a formation approach three times from the #2 position, one time from the #1 position, and observed IP's fly four additional formation approaches in the T-6A (Tab AA-4). The Flight Commander waived sorties F4403 and F4404, the last two formation flights in the syllabus, for the MSP due to good performance (Tabs G-45 and AA-4). MSP flew a total of 94.7

hours in the T-6A (Tabs G-42 and AA-4). MSP completed T-6A training on 28 July 2021, and entered T-38C academics training on 29 July 2021 (Tab AA-4).

Prior to the MS, MSP completed 36 sorties and 17 syllabus simulators in the T-38C (Tabs G-46 to G-47 and AA-4). MSP completed 25 sorties to a "Good" or "Excellent" level, four sorties to an "Unsatisfactory" level, and accomplished seven ungraded sorties (Tab AA-4). Training records indicate MSP performed 16 simulator events to a "Good" or "Excellent" level and one simulator to an "Unsatisfactory" level (Tab AA-4 and AA-5).

MSP's most recent flight was a single-ship transition sortie a day prior to the mishap (Tabs G-71 and AA-5). MSP flew a total of three formation sorties in the T-38C prior to the MS and received an overall grade of "Good" on each sortie, to include F5203 on 17 November 2021 (Tabs G-72 to G-73 and AA-5). MSP had flown one other formation approach prior to the MS, from the #2 position (Tabs G-72 to G-73 and AA-5). The MS was MSP's fourth T-38C formation sortie (syllabus event F5204) (Tabs G-72 to G-73 and AA-5). There were no significant trends noted in the gradebook review (Tab AA-5). Overall, the gradebook review and interview with MSP's flight commander indicated MSP was progressing through the T-38C program with average performance (Tabs V-3.31 to V-3.32 and AA-5).

9. MEDICAL

a. Qualifications

MIP1 completed his most recent Periodic Health Assessment (PHA) and annual flight physical on 8 December 2020 (Tab X-2). Landstuhl RSN Base Operational Medicine Clinic issued a Medical Recommendation for Flying or Special Operational Duty (Department of Defense (DoD) Form 2992) on that date indicating medical clearance for pilot duties (Tab X-2). MIP1 did not require any aeromedical waivers (Tab X-2). There is no evidence to indicate MIP1's medical condition was relevant to the mishap.

MIP2 completed his most recent PHA and annual flight physical on 6 August 2021 (Tab X-2). Laughlin AFB Flight and Operational Medicine issued a DoD Form 2992 on 6 Aug 2021, indicating medical clearance for pilot duties (Tab X-2). There were no medical conditions requiring aeromedical waiver (Tab X-2). There is no evidence to indicate that MIP2's medical condition was relevant to the mishap.

MSP completed his most recent PHA and annual flight physical on 30 Oct 2020 (Tab X-2). Laughlin AFB Flight and Operational Medicine issued a Medical Recommendation for Flying or Special Operational Duty (DoD Form 2992) on that date indicating medical clearance for pilot duties (Tab X-3). There were no medical conditions requiring aeromedical waiver (Tab X-3). There is no evidence to indicate that MSP's medical condition was relevant to the mishap.

b. Health

The outpatient medical and dental records (paper and electronic) were reviewed for MIP1, MIP2, and MSP. MIP1, MIP2, and MSP had no significant health issues relevant to the mishap (Tab X-3).

MIP1 sustained minor injuries due to the mishap and was treated at a local hospital and released (Tab X-3). MIP2 sustained severe, life threatening injuries requiring helicopter transportation to BAMC from the scene (Tabs R-191, X-3, Y-13, and AA-28). MSP sustained fatal injuries (Tab X-3).

c. Pathology

The MSP was transported to BAMC, TX, where an Armed Forces Medical Examiner System (AFMES) Regional Medical Examiner performed an autopsy on 22 November 2021 (Tab X-3). The AFMES Forensic Toxicology Laboratory performed toxicology tests for alcohol, common drugs, and carbon monoxide (Tab X-3). All test results were negative (Tab X-3). The cause of death was multiple injuries due to aircraft mishap (Tab X-3). Based on the pattern of injuries and force involved, the MSP was fatally injured on impact with the ground.

Toxicology tests were also performed by the AFMES Forensic Toxicology Laboratory on MIP1 and MIP2. MIP1 toxicology testing resulted in negative findings (Tab X-3). Toxicology testing for MIP2 was positive only for a medication administered in the field (after the mishap) while awaiting transport before the blood sample was collected (Tabs R-191 and X-3).

d. Lifestyle

The medical records, toxicology reports, 72-hour and 7-day History Form for MIP1 were reviewed, and no unusual habits, behavior or stressors were noted (Tab X-3).

There was no evidence to suggest MIP2's lifestyle contributed to the mishap. MIP2 also had no history of being late, but on the day of the mishap he arrived 4 minutes late to the flight planning brief (19 minutes late overall, as 87 FTS standards require arrival 15 minutes prior to brief time) (Tabs O-5, R-21, V-1.21 and V-1.46).

Interviews with the roommates of MSP did not identify any significant life stressors, unusual habits or behavior (Tab V-4.12 to V-4.17 and V-9.2 to V-9.7).

There is no evidence to suggest lifestyle factors contributed to the mishap.

e. Crew Rest and Crew Duty Time

AFMAN 11-202, Volume 3 states crew rest is compulsory for aircrew members and is a minimum of 12 non-duty hours before the flight duty period (BB-37). The AETC Supplement to AFMAN11-203V3 (BB-39) additionally specifies that aircrew members must have a minimum of 24 hours of crew rest following three consecutive flight duty periods of 16 hours or more with minimum crew rest between flights. The AIB determined there was no evidence to suggest that

MSP, MIP1, and MIP2 were not afforded adequate crew rest in the days leading up to the mishap.

The AETC Supplement also addresses maximum flying times, including simulator time (Tab BB-40 to BB-41). For T-38Cs, the maximum flying time is 6.5 hours during one flight duty period, 30 hours in 7 consecutive days, and 75 hours in 30 consecutive days (Tab BB-40 to BB-41). Neither MSP, MIP1 nor MIP2 had flight time totals exceeding these maximums (Tab G-11, G-17, G-18, and G-48 to G-71).

	Flying Hours in Current Flight Duty Period	Flying Hours per 7 Consecutive Days	Flying Hours per 30 Consecutive Days
11-202 Max. Limits	6.5	30	75
MSP	1	4.7	14.2
MIP1	1	0	4.5
MIP2	1	6.9	25.5

The AIB determined that there was no evidence to indicate crew rest and crew duty time were factors in the mishap.

10. OPERATIONS AND SUPERVISION

a. Operations

According to Air Force Manual (AFMAN) 13-204 volume 3, mandatory Air Traffic Control guidance, "Unless Safety of flight or necessity for the control of air traffic dictates otherwise, controllers should avoid transmitting to aircraft in the following critical phases of flight: short final, touchdown, landing roll, departure roll, and initial climb-out." (Tab BB-5). The AIB determined that the tower controllers would have initially seen the two aircraft, which were in formation, performing a relatively normal act (Tab V-12.3 and V-12.5). From the time the two aircraft were lower than 100 feet AGL, minimal time was available and there would be uncertainty of which aircraft belonged to which callsign (Tab V-12.3). Furthermore, tower controllers are unfamiliar with training rules of different aircraft communities (Tab V-12.5). Therefore, the AIB determined that Laughlin Tower controllers were not a factor in this mishap.

The AIB determined there was no evidence to suggest the operations tempo was a factor in this mishap (Tabs R-173 to R-174, V-2.7, V-3.8, V-4.3, V-5.2 to V-5.3, V-11.5 to V-11.6, V-14.10, V-16.2, and V-17.3).

Based on interviews about the 87 FTS ORM culture, in addition to lifestyle evidence, the AIB determined that ORM was not a contributing factor in this mishap (Tabs R-173 to R-174, V-2.6, V-2.15, V-3.7, V-5.2, V-10.5, V-11.10, V-13.2, V-14.2, V-14.9, V-16.2, and V-17.3).

b. Supervision

The 87 FTS Operations Supervisor (Ops Sup) authorized the MS, and the 87 FTS scheduled the MS in accordance with the T-38C syllabus (Tabs K-3, K-4, R-83 and AA-12).

According to the Ops Sup, the MF left from the operations desk to go out to the aircraft approximately five minutes late, but did not seem to be rushed (Tab R-84). At the operations desk, the Ops Sup reviewed the MF's ORM and authorized the MF to step to their aircraft after giving them a step briefing (Tab R-83 to R-84). The step briefing consisted of takeoff and landing data (TOLD), an ORM review, flying and ground currency check for crew members, and discussion of any applicable threats or weather conditions that could affect flying (Tab R-81 to R-83).

According to the majority of interviews, squadron leadership fostered an environment in which students and instructor pilots felt empowered to be honest with the ORM assessment, and not fly if the individual thought that was the correct decision (Tab V-2.6, V-2.9, V-3.7, V-4.2, V-13.2, V-15.4 and V-16.2). The AIB determined supervision was not a factor in this mishap.

11. HUMAN FACTORS ANALYSIS

a. Introduction

The Department of Defense Human Factors Analysis and Classification System 7.0 lists potential human factors that can play a role in aircraft mishaps and identifies potential areas of assessment during an accident investigation (Tab BB-11 to BB-33). The human factors identified as relevant to the mishap are listed below.

b. Failure of Crew/Team Leadership

PP101 Failure of Crew/Team Leadership: is a factor when the crew/team leadership techniques failed to facilitate a proper crew/team climate, to include establishing and maintaining an accurate and shared understanding of the evolving task and plan on the part of all crew/team members. (Tab BB-25)

c. Critical Information Not Communicated

PP105 Critical Information Not Communicated: is a factor when known critical information was not provided to appropriate individuals in an accurate or timely manner. (Tab BB-25)

d. Complacency

PC208 Complacency: is a factor when the individual has a false sense of security, is unaware of, or ignores hazards and is inattentive to risks. (Tab BB-22)

e. Inadequate Real-Time Risk Assessment

AE201 Inadequate Real-Time Risk Assessment: is a factor when an individual fails to adequately evaluate the risks associated with a particular course of action and this faulty evaluation leads to inappropriate decision-making and subsequent unsafe situations. (Tab BB-17)

f. Breakdown in Visual Scan

AE105 Breakdown in Visual Scan: is a factor when the individual fails to effectively execute visual scan patterns. (Tab BB-16)

g. Provided Inadequate Procedural Guidance or Publications

OP003 Provided Inadequate Procedural Guidance or Publications: is a factor when written direction, checklists, graphic depictions, tables, charts or other published guidance is inadequate, misleading or inappropriate. (Tab BB-30)

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publicly Available Directives and Publications Relevant to the Mishap

(1) AETCMAN 11-251, T-38C Flying Fundamentals, 12 October 2020
(2) AFI 11-2T-38V1_AETCSUP, Flight Operations, 29 January 2018
(3) AFI 11-2T-38V3_AETCSUP, T-38 Operations Procedures, 14 May 2020
(4) AFI 51-307, Aerospace and Ground Accident Investigations, 17 March 2019
(5) AFMAN 11-202V3, Flight Operations, 9 September 2020
(6) AFMAN 11-2T-38V3, T-38 Operations Procedures, 13 May 2020
(7) DAFMAN11-401, Aviation Management, 14 July 2021
(8) AFI 91-203, Safety Investigation and Hazard Reporting, 27 April 2018
(9) LaughlinAFBI13-204, Laughlin AFB Instruction, Airfield Operations, 8 August 2016
(10) DoD Human Factors Analysis and Classification System, Version 7
(11) AFI 11-290_AETCSUP, Cockpit/Crew Resource Management, 9 February 2021
(12) AFMAN 13-204 Vol3, Nuclear, Missile, Command and Control Operations, Air Traffic Control, 22 July 2020

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

b. Other Directives and Publications Relevant to the Mishap

(1) 87 FTS Red Bull Flying Standards, 18 August 2020
(2) 87 FTS Theater Indoctrination Training Syllabus, 28 July 2020
(3) AETC Syllabus F-V5A-B T-38C Pilot Instructor Training with Change 1, December 2017
(4) AETC Syllabus P-V4A-A T-38C Specialized Undergraduate Pilot Training, October

2019

(4) Other AETC Unit T-38C Flying Standards Combined, 21 June 2021

(5) T.O. 1T-38C-1, USAF Series T-38C Aircraft Flight Manual, with Change 1, dated 1 October 2020

(6) T.O. 1T-38C-1CL-1 CHG 1, USAF Series T-38C Aircraft Flight Manual, with Change 1, dated 1 October 2020

(7) T.O. 1T-38C-2-6, USAF Series T-38C Technical Manual, Organizational Maintenance, dated 9 July 2018, with Change 10, dated 28 October 2021

c. Known or Suspected Deviations from Directives or Publications

All known or suspected deviations from directives or publications were previously discussed.

Digitally signed by
KREUDER.GREG[redacted]
ORY[redacted]

7 APRIL 2022

GREGORY KREUDER
Brigadier General, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

T-38C, T/N 68-8121 & T/N 70-1586
LAUGHLIN AIR FORCE BASE, TEXAS
19 NOVEMBER 2021

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

1. OPINION SUMMARY

At 10:14:02L (10:14:02 a.m. Local Time [L]) on 19 November 2021, two T-38C Talon aircraft, Tail Numbers 68-8121 and 70-1586, collided during the landing phase to Runway (RWY) 13 Center (13C) following a formation approach at Laughlin Air Force Base (AFB), Texas (TX). Both aircraft were assigned to the 47th Flying Training Wing (FTW) at Laughlin AFB, TX.

The Mishap Sortie (MS) was a local formation flight and was the Mishap Student Pilot's (MSP) fourth formation event in the T-38C Specialized Undergraduate Pilot Training program. The Mishap Formation (MF) consisted of Mishap Instructor Pilot (MIP1) occupying the front cockpit (FCP) of Mishap Aircraft 1 (MA1), Mishap Instructor Pilot (MIP2) occupying the rear cockpit of Mishap Aircraft 2 (MA2), and the MSP occupying the FCP of MA2.

The MF planned for MA1 to lead the first half of the MS, perform a lead swap in the military operations area, then have MA2 lead the flight for the return to Laughlin AFB. The primary plan was for MA2 to lead the formation approach to RWY 13C, clear off MA1 to land, and perform a low approach to the T-38 pattern, with the caveat that a difference in fuel levels could change who landed. On final approach after MA2 "cleared off" MA1, both aircraft attempted to land and neither performed a low approach. MA1, originally on the right side of the formation in the wingman position, ended up below MA2 on final approach in a position where neither aircraft could see the other. MA1 landed first at 10:14:01L. One second later, at 10:14:02L, MA2's nose landing gear impacted MA1's left horizontal stabilizer. Both aircraft were rendered uncontrollable and subsequently destroyed. MIP1 egressed MA1 on the ground after the mishap with minor injuries. MIP2 and MSP experienced an interrupted ejection sequence due to the inversion of MA2, causing multiple life threatening injuries for MIP2 and fatal injuries for MSP.

I find, by a preponderance of the evidence, there are two causes of the mishap: as the MF returned to base and conducted a formation approach, where one aircraft would land and the other would perform a low approach, (1) MIP2 failed to communicate and MIP1 failed to verify which aircraft would land, resulting in MA1 and MA2 simultaneously attempting to land on RWY 13C; and (2) MIP2 failed to recognize a precarious situation developing after the "cleared off" call and failed

to intervene and prevent MA2 from impacting MA1 on landing. Further, I find by a preponderance of the evidence there are two factors that substantially contributed to the mishap: (1) MIP1 and MIP2 used conflicting techniques to perform the 1-up/1-down maneuver and (2) MSP's callsign usage, affected by the "administrative lead" change and various techniques for referencing position number, was improper and confusing.

2. CAUSES

a. MIP2 failed to communicate and MIP1 failed to verify which aircraft would land, resulting in MA1 and MA2 simultaneously attempting to land on RWY 13C.

Following the flight brief, MIP1 and MSP understood the formation approach would terminate with MA1 landing and MA2 conducting a low approach unless there was a difference in fuel states, however it is unclear whether MIP2 understood this. Prior to the formal flight brief, MIP1 met with MSP and conducted a pre-brief. MSP outlined his requested student profile, which included the sequence of events he intended to accomplish during the flight. MSP intended to lead the recovery, conduct a formation approach, and have MA1 land and MA2 low approach, i.e., fly parallel to the runway then climb into the T-38C pattern. MIP1 concurred with MSP's plan. MIP2 arrived to the briefing area late, approximately four minutes after the coordinated formal brief time. As a result, MIP2 missed the pre-briefing and discussion between MIP1 and MSP. MIP1 began the formal brief shortly after MIP2 arrived.

During the formal brief, MIP1 covered the flight profile, which included MIP1 leading the first half of the sortie, an "administrative lead" change, then MSP, with MIP2 in the back seat, leading the second half of the sortie. MIP1 recalls briefing the formation approach to include the primary plan for MA1 to land and MA2 to perform a low approach with the caveat that, in the case of a fuel difference, the aircraft lower on fuel would land. MIP1 does not recall if he used the word "significant" when referencing fuel differences. In his interview, MIP1 stated he viewed a significant fuel difference to be 100-200 pounds, however many IPs interviewed viewed a significant difference to be anywhere from 10-200 pounds. Following standard practice, MIP1 concluded his portion of the brief after 10-15 minutes and turned the remaining approximately 20 minutes over to MIP2, who finished his portion of the brief with MSP. MIP1 was present and does not recall MIP2 further discussing the formation approach. As MIP2 could not be interviewed due to his medical condition, I am unable to determine if he fully understood the formation approach plan to be primarily MA1 landing with MA2 performing a low approach, with the opposite being a contingency due to fuel differences.

As briefed, MIP1 performed an "administrative lead" change at the halfway point. This meant MSP/MIP2 would now lead all aspects of the flight to include navigating, managing the radios, and making "changes to the profile if external conditions dictate." With an administrative lead change, aircraft within a formation refer to each other by position number, regardless of flight authorization callsign. This means the aircraft now leading refers to the previous lead as "2." Callsign usage when speaking to air traffic control (ATC) would still reflect the original assigned callsigns per the flight authorization, since callsigns never actually change. Therefore, "STEER 1" and "STEER 2" should still refer to MA1 and MA2, respectively. Although MIP1 retained ultimate authority for the formation as the scheduled flight lead, the "administrative lead change" also

meant MSP/MIP2 could modify the profile, specifically the events being accomplished, without asking MIP1 for permission. It is incumbent on the "administrative lead," however, to avoid potential confusion by communicating any profile changes to the rest of the flight.

After leading the remainder of the profile in the airspace, MSP, with direction from MIP2, initiated recovery to the base. This is likely when a divergence of expectations began regarding who would land following the formation approach. MSP's first radio call to ATC at 09:57:04L was "*Ski, STEER 0-1, … 1 and 2, request vectors ILS 1-3 Center, 1 will be option Lariat, 2 will be full stop.*" MSP was probably communicating the primary plan for MA2 to low approach and MA1 to land, but was incorrectly using the position each aircraft was currently flying in this radio call instead of full callsigns to ATC. This is also the first time where MIP1 or MIP2 could have intervened, corrected the radio call, and clarified landing roles.

MSP performed a fuel check, with both aircraft having the same fuel level of "1.3," meaning 1,300 pounds of fuel remaining. MSP then told MIP2 on intercom that they will "*drop him off then we'll pull into Lariat*," confirming the primary plan for MA1 to land and MA2 to conduct a low approach then proceed to the Lariat/T-38C pattern. MIP2 was not directive, but instead indicated what he "*would do is wait until we get closer … get on frequency* [intra-flight radio] *like 12-70 or like 12-50, whatever it happens to be. Does that make sense*?" This indicates MIP2 likely intended to use exact fuels to determine landing order as the MSP's fuel check, which was "1.3," is a rounding off on the fuel reading to the nearest 100 pounds, and not as precise as reading the exact level on the fuel gauge, for example 1,270 pounds or 1,250 pounds.

With a vector to base leg of the radar pattern at 10:08:08L, MIP2 prompted MSP to conduct a fuel check. This exact fuel check is normally used during a formation approach to ensure the lead aircraft calculates the final approach speed based on the heavier of the two aircraft. During the fuel check, MA1 had 1,070 pounds and MA2 had 1,040 pounds remaining. During an interview, MIP1 indicated he considered a 30-pound difference as negligible and not sufficient to alter the primary plan. However, it appears MIP2 interpreted any fuel difference as sufficient to alter the plan.

Following this last fuel check, MSP states to MIP2 on intercom, "*Alright, so he'll be the full stop*." Although it is possible MSP did not process the different fuel states, it is equally likely that he perceived the fuel difference to be less than "significant" and intended to proceed with the primary plan. Rather than be directive, MIP2 responds with, "*Well, he's heavier, right*?," implying that, since MA2 was 30 pounds lighter on fuel, MSP arrived at the wrong conclusion and in fact MA2 should land and MA1 should low approach. MSP responds with "*oh, 1070, yup*." Although not stated nor confirmed by either MSP or MIP2, it appears MSP interpreted MIP2's question as an IP prompt to swap to the contingency plan, and now MA2 would land and MA1 would conduct a low approach.

As the administrative flight lead, MA2 was responsible for communicating the change in profile to MA1. The two discussions on intercom in MA2 regarding who would land out of the approach should have highlighted the potential for confusion within the flight. This was MSP's fourth formation flight in the T-38C and his first time leading a formation approach; therefore, as an instructor MIP2 had responsibility for ensuring flight lead actions were performed correctly. MSP and MIP2 may have assumed MIP1 processed the difference during the final fuel check and figured

out who was landing, however this would be an unreasonable expectation. To avoid confusion, lead is responsible for communicating changes from the primary to contingency plan.

Additionally, MA2 kept MA1 on the right side of the formation, away from Lariat's pattern, during the entire recovery and formation approach to RWY 13C. MIP1, in addition to the majority of other IPs interviewed, said his technique was to place the low approach aircraft on the side of Lariat's pattern. At 10:10:07L, MSP informed MIP2 on intercom that, "*I need to put him on the left side, he's going to Lariat*." This initiated a discussion where MIP2 indicated he is comfortable leaving the low approach aircraft on the side opposite of Lariat in case "*we have to go around*." MIP1 was not aware of this intercom discussion in MA2 and considered the fact he was kept on the right side as nonverbal confirmation of the primary plan where MA1 would land and MA2 would conduct a low approach. Although guidance at the time did not specify which side the low approach aircraft will be on during this maneuver, based on the intercom conversation, MIP2 should have again realized this could cause confusion. Therefore MIP2 missed another opportunity to ensure the plan was communicated to MA1.

During the formation approach, MSP made two radio calls to tower that conflicted with each other. At 10:11:12L, MSP transmitted, "*Tower, STEER 0-1, 9 and a half* [miles] *out ILS 1-3 Center, STEER 2 will be full stop, STEER 1 will be option Lariat.*" This radio call correctly indicated, based on using flight authorization callsigns when talking to ATC, MSP's updated plan that MA1 would conduct a low approach and MA2 would land. However, based on the next radio call MSP makes, it is unclear if MSP was referring to MA2 as "STEER 1" or "STEER 2" in this call. MIP1 does not recall hearing this transmission due to task saturation and frequency congestion as tower was controlling aircraft operations on both RWY 13C and RWY 13 Left (L). If MIP1 had heard this radio call, he should have queried MA2 as to the landing plan, as it would have differed from the primary plan and his expectations.

MSP made his last radio call to tower at 10:12:41L, "*STEER 0-1 flight, cleared for the option 1-3 Center, and STEER 1 will be full stop.*" This call is in conflict with MSP's previous radio call at 10:11:12L as it now technically indicated MA1 would land. It is unclear why MSP said "*STEER 1 will be full stop,*" however, it appears MSP occasionally transposed callsigns after the "administrative lead" change. It is likely MSP intended to clarify to tower that MA2 would land and incorrectly used intra-flight callsigns rather than the flight authorization callsigns. However, MIP1 heard this radio call and interpreted it, along with his position on the right side, as confirmation that MA1 would land and MA2 would perform a low approach then turn left into Lariat's pattern.

At 10:13:27L, MIP2 prompted MSP to ask MIP1, "*STEER 2, do you have the runway in sight?*" MIP1 replies, "*Affirm*." Lead normally ensures the wingman has the runway in sight prior to splitting up the formation at the end of a formation approach. At 10:13:33L, MIP2 prompts MSP over intercom again saying, "*STEER 2, cleared off*". MSP echoes this prompt, making a final radio call to MIP1, "*STEER 2, cleared off*," thus severing the formation flight. At this point, after ensuring initial safe separation, both aircraft are expected to maneuver independent of each other. After the "administrative lead" change, MIP2 should have prompted MSP to refer to MA1 as either "2" or "STEER 1," but not "STEER 2," as callsigns do not change. Neither MIP1 nor MIP2 corrected any of these calls.

At any point during the recovery, either MIP1 or MIP2 could have clarified who was landing and who was performing a low approach, thus alleviating any potential confusion. The radio calls MIP1 recalls hearing along with MA2 keeping him on the right side confirmed in MIP1's mind they were performing the primary plan of MA1 landing. MIP1 saw the fuel difference of 30 pounds as negligible and everything else matched his expectation, however MSP's improper use of callsigns warranted clarification. Although MIP2 could not be interviewed, it is assumed he understood the briefed plan. On the final fuel check, MIP2 saw a fuel difference and perceived that as sufficient to alter the landing plan. Although fuel differences were briefed as a caveat, MIP2 should have communicated this to MA1 when changing who was landing.

I find, by a preponderance of evidence, as the aircraft returned to base and conducted a formation approach, MIP2 failed to communicate and MIP1 failed to verify which aircraft would land, resulting in MA1 and MA2 simultaneously attempting to land on RWY 13C.

b. MIP2 failed to recognize a precarious situation developing after the "cleared off" call and failed to intervene and prevent MA2 from impacting MA1 on landing.

At 10:13:33L (380' above ground level [AGL]) and approximately 27 seconds prior to impact, MSP told MIP1 he was "*cleared off*." MIP1 took initial actions to deconflict from MA2 then began a 6 degree descent to intercept a normal 2.5-3 degree final. As confirmed by interviews, simulated formation approaches in the T-38C simulator, and a local T-38C sortie, pilots landing from a 2-ship formation can often keep the aircraft performing a low approach in their peripheral vision through touchdown. The aircraft conducting a low approach would initially rise in the landing aircraft's upper left or right peripheral vision, depending on which side they were on. The low approach aircraft, after retracting landing gear and accelerating, would have then moved slowly forward on the landing aircraft's canopy. This often happens as the landing aircraft approaches the runway threshold. The pilot landing must place nearly all of their concentration on ensuring a safe touchdown, however, and it is understandable if at some point on final they lose the ability to simultaneously monitor the low approach aircraft.

If MSP or MIP2 were monitoring MA1 after the "*cleared off*" call, they would have seen MA1 descend relative to their aircraft. This would have been alarming and prompted immediate action as MA1, if conducting a low approach, should never descend below MA2 after being cleared off. MSP may not have seen MA1 descend as it was his first formation approach as lead in the T-38C and he was likely focused on flying as smooth a platform as possible. MIP2's primary responsibility, however, was to monitor MSP and act as safety observer. MIP2 was in the best position to ensure MA1 was initiating a low approach as expected. If MIP2 had been monitoring MA1 as the flight separated, he would have seen MA1 descend instead of climb. At 10:13:39L (250 feet AGL), only 3 seconds after the "cleared off" call was acknowledged by MIP1, MIP2 began a series of prompts for MSP to watch his glide path and adjust his airspeed in preparation for landing, as MA2 had decelerated to 6 knots slower than the required final approach airspeed. It is unlikely anyone in MA2 was visually monitoring MA1 during or immediately following the cleared off call, or they would have perceived a dangerous situation developing.

After being "cleared off," MA1 initiated a steeper descent than MA2, as MIP1 was shifting his aim point to land closer to the runway threshold. From MIP1's perspective, it appeared MA2 was initiating a level off. Although MA2 did not actually level off, the steeper descent of MA1 caused a visual illusion in which MIP1's perception matched the expectations of MA2 leveling off. At approximately 200' AGL and as MA1 continued to land, however, MA2 would have disappeared from view above and behind MA1's aircraft instead of slowly accelerating forward. Although MIP1 could have noticed MA2 had disappeared, at this point he was focused on the critical landing phase.

At 10:13:45L (180 feet AGL), 11 seconds after the "cleared off" call, and simultaneous with another aircraft communicating with tower, MSP said to MIP2 in a concerned tone of voice, "*I don't have sight of him*." Although this was MSP's first formation approach as lead, it is clear he was now looking for MA1 and could not locate him. At this point MA1 was approximately 60 feet below and slightly in front of MA2. Neither aircraft would have been visible to the other. Five seconds later, at 10:13:50L (150 feet AGL), MSP asked MIP2, "*Do you have sight of him?*" MSP temporarily raised the nose of MA2, which shifted his aim point approximately halfway down the runway. Although I am unable to determine if MSP initially saw MA1 descend after the cleared off call, at this point MSP was likely focused on finding MA1. Based on the flight path of both aircraft to touchdown, MA1 would not have been visible to either MSP or MIP2 until 1 second prior to impact.

MIP2 may not have heard MSP's comment, "*I don't have sight of him,"* as another aircraft was speaking with tower at the same time. However, MIP2 did respond to MSP's follow-on question on intercom, "*Do you have sight of him?*" At 10:13:51L (150 feet AGL) MIP2 told MSP in a confident and reassuring tone, "*Yeah, he's…he's gone*." MA1 was not visible to either MSP or MIP2. In fact, at this time MA2's radar altimeter showed 60 feet AGL for two seconds due to MA1 being 60 feet under MA2. MIP2 had approximately 10 seconds to intervene before MA2 impacted MA1 at 10:14:02L and could have directed MSP to go around, queried MIP1 for his position, or taken control of MA2.

Receiving no direction from MIP2, MSP likely trusted MIP2's experience and assumed there was no conflict. At 10:13:52L (130 feet AGL), MSP said to MIP2, "*OK, so he's…*" and shifted his aim point from halfway down the runway to about 500 feet from the threshold to avoid landing significantly long. As MA2 began to flare approximately 500 feet down the runway, MA1 became visible for the first time at 10:14:02L, less than 1 second prior to impact and with insufficient time for either MSP or MIP2 to avoid a collision. MA2's nose landing gear impacted MA1's left horizontal stabilizer at 148 knots and 11 knots faster than MA1, which was in the beginning stages of an aero brake. Both aircraft were rendered uncontrollable from this point forward.

I find by a preponderance of the evidence MIP2 failed to recognize a precarious situation developing after the "*cleared off*" call and failed to intervene and prevent MA2 from impacting MA1 on landing.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

a. MIP1 and MIP2 used conflicting techniques to perform the 1-up/1-down maneuver.

Practice formation approaches could terminate in one of several ways: 1) with both aircraft performing a low approach; 2) a "Split to Land" where both aircraft land on separate runways; 3) a "Visual Meteorological Condition (VMC) Drag" where the wingman will assume a position 3,000 feet minimum behind lead to ensure separation; 4) or with one aircraft landing and the other performing a low approach. There is rarely confusion when the formation approach terminates with a low approach for both aircraft as there is no role swap or intra-flight communication required; the wingman continues to fly in formation off of lead as they perform the low approach together. Sufficient guidance exists for both the "Split to Land" and "VMC Drag" maneuvers such that there is little potential for confusion as to roles when performing either maneuver.

The last option where one aircraft lands and the other performs a low approach, however, is not defined in guidance or standards at Laughlin AFB or Pilot Instructor Training (PIT) at Randolph AFB, TX. Instructors at PIT often refer to this as the "1-up/1-down," which exposes this maneuver and terminology to upgrading instructors who have follow-on assignments to teach students at various SUPT bases. In most emergency scenarios it is clear which aircraft will be landing out of the approach: the aircraft with the malfunctioning system. However, the "1-up/1-down" maneuver is being used during training when neither aircraft has an actual or simulated malfunction and both aircraft are above normal recovery fuel. Unless this maneuver is briefed prior to flight and communicated in flight when there is a change, it can be less clear which aircraft will land and which will perform the low approach.

In the absence of guidance, there are various techniques instructors at PIT and Laughlin AFB use to determine whether the lead aircraft or wingman would land, as well as on which side lead would place the wingman during the "1-up/1-down." Many said the aircraft flying on the wing would land, as this matches the most likely outcome of the contingency where an aircraft with a system failure is being led home, then "dropped off" to land. Several others, however, said the aircraft that happened to be lower on fuel would land first even though neither was in a low fuel state. Some briefed that a particular aircraft would land unless the fuel difference was "significant," however what "significant" meant varied anywhere between 10-200 pounds. Techniques also varied as to which side the landing aircraft would be placed when on final. While the majority of those interviewed said they would have the full stop aircraft on the side away from the adjacent T-38C landing pattern, many said this did not matter and they would not swap sides to make this happen. This could easily create a divergence of expectations; for example, when a pilot who expects to be placed on a particular side when they are the landing is flying on the wing of another who does not share this technique.

Additionally, the phrase "cleared off" is not defined in guidance. It only has one reference in the 87 FTS standards, where it describes a flight split in the MOA. Flight splits in the MOA typically occur in a less task-intensive phase of flight compared to on final when an aircraft is about to land. Although not specified in SUPT guidance or standards for use during formation approaches, "cleared off" is used by most IPs interviewed during the "1-up/1-down" to allow the wingman to stop flying formation off of lead, ensure deconfliction, then proceed with either a landing or low

approach. Most IPs interviewed used "cleared off" with nothing further added. Only a few pilots interviewed would say "cleared off to land" or "cleared off to low approach" depending on the plan. On the MS, if MA2 had informed MA1 he was "cleared off to low approach," this would have alleviated any potential confusion between the two aircraft. This clarity is crucial, since "cleared off" is being used at the end of a formation approach where there is limited time to recover from any misunderstanding due to the near-total concentration required to safely land an aircraft.

This investigation revealed a multitude of techniques among IPs that are potentially in conflict with one another. The mitigation of risk, therefore, relies on the flight lead to brief a clear plan that is fully understood by all flight members and verified in flight. In this case, MIP1 briefed a solid plan except for quantifying the amount of fuel difference necessary to override the primary plan of MA1 landing and MA2 performing a low approach. MIP1 viewed the 30-pound difference as negligible, however MIP2 either determined 30 pounds was sufficient to alter the plan or did not fully understand the primary plan as outlined during the flight brief.

I find by a preponderance of evidence MIP1 and MIP2 used conflicting techniques to perform the 1-up/1-down maneuver.

b. MSP's callsign usage, affected by the "administrative lead" change and various techniques for referencing position number, was improper and confusing.

AETCMAN 11-251 defines three types of lead change options: "Navigation Lead," "Administrative Lead," and "Tactical Lead." The "Administrative Lead" change is often used during UPT formation sorties to enable the student to fly in either the lead or wing position for the first half of the sortie, then swap places and practice the other position for the remainder of the flight. With both an "Administrative Lead" and "Tactical Lead" change, the new lead aircraft manages the radios. However, of the three types of lead changes, the "Administrative Lead" is the only one that renumbers the flight: "…aircraft within the flight are administratively renumbered to match the position being flown (for example, Sling 11 is now "2" for intraflight communication purposes but retains Sling 11 as his or her callsign)." Renumbering the flight during a sortie increases the potential for incorrect callsign usage.

When MIP1 (callsign STEER 01) passed MSP (callsign STEER 02) the "administrative lead" at 09:44:10L, the aircraft within the flight were administratively renumbered, which means MSP would now refer to his aircraft, MA2, as "1" and MA1 as "2" when communicating only between MA2 an MA1. When communicating with ATC about individual aircraft, however, MSP would still use STEER 01 (or STEER 1) when referring to MA1 and STEER 02 (or STEER 2) when referring to MA2. Those are their original callsigns and they do not swap, even with an "Administrative Lead" change. Additionally, since MSP now manages the radio on behalf of the flight, as lead he would use the STEER 01 callsign with ATC when transmitting on behalf of the entire formation.

This renumbering within the flight, while retaining original callsigns, increases the potential for improper callsign usage, i.e., referring to "1" when meaning "2," and vice versa, as it requires additional effort to ensure the correct callsign is being used depending on to whom the radio call is being directed. It also requires additional effort by another flight member listening to the radio

call, in this case MIP1, to figure out whom MSP was referring to as "1" or "2" in his radio calls to ATC.

Of note, the assigned callsigns on the Flight Authorization (FA) were "STEER 1" and "STEER 2", yet the flight plan was filed as "STEER 01." Interviews of MIP1, multiple 87 FTS instructor pilots and student pilots, and tower personnel indicate that in the majority of opinions "STEER 01" holds the same meaning as "STEER 1." Therefore, for purposes of this investigation, there is no substantive difference between "STEER 01" and "STEER 1," as they would both refer to MA1. Likewise, "STEER 02" and "STEER 2" would refer to MA2.

There are three radio calls MSP makes during recovery where he intended to convey who is landing and who is performing a low approach that highlight MSP's potential confusion as they are all different:
In the first call to ATC, at 09:57:04L, MSP said, "*Ski, STEER 01, er, 1 and 2, request vectors ILS 1-3 Center, 1 will be option Lariat, 2 will be full stop*." Based on intercom discussions, MSP was likely communicating his primary plan for MA2 to low approach and MA1 to land with this call, however assuming that was the case, MSP should have said, "*STEER 01 will be a full stop, STEER 02 will be option Lariat*."

In the second call to ATC, 10:11:12L, MSP said, "*Tower, STEER 01, 9 and a half [miles] out ILS 1-3 Center, STEER 2 will be full stop, STEER 1 will be option Lariat***.**" This call happened after the plan had changed to MA2 landing, and MSP would be correctly indicating MA2 would now land and MA1 would perform a low approach. Although this radio call uses full callsigns and correctly identified the roles of each aircraft, MSP's next radio call indicates potential confusion and/or improper callsign usage.

In the third and final call to ATC, at 10:12:41L, MSP said: "*STEER 01 flight, cleared for the option 1-3 Center, and STEER 1 will be full stop.*" Since MSP had already relayed which aircraft was landing in his previous call to tower, it is likely MSP perceived his previous radio call as incorrect. MSP was almost certainly referring to himself as STEER 1 in this call as he later attempts to land MA2. However, this radio call to ATC would indicate to MIP1 that MA1, whose callsign is STEER 1, would be the full stop.

At 10:13:27L, with MIP2 prompting him to make the following radio call and including exact verbiage, MSP said on inter-flight radio to MA1, "*STEER 2 do you have the runway in sight*?" Since callsigns do not swap, even with an "administrative lead" change, MIP2 should have prompted MSP to either use "2" based on formation position or "STEER 1" in this call to MA1.

At 10:13:33L, again with MIP2 prompting him to make the following radio call and including exact verbiage, MSP said on inter-flight radio to MA1, "*STEER 2's cleared off.*" Again, MIP2 should have prompted MSP to use "2" based on formation position or "STEER 1" in this call to MA1. MIP1 parrots the radio call and replies with "*STEER 2's cleared off."*

Since neither MIP2 nor MSP made a radio call directly to MA1 to indicate who was landing and who was conducting a low approach, MIP1 would have had to listen to the radio calls MSP made to ATC agencies to figure out whether the plan changed. As highlighted earlier in this report, MIP1

does not recall the first radio call MSP made to Ski, and missed the second radio call to tower due to a combination of frequency congestion and task saturation. MIP1 only heard the final call MSP made to tower, that indicated STEER 1, which is MA1's callsign, was performing the full stop.

Furthermore, interviews with several IPs and tower personnel at Laughlin AFB indicated various techniques in using callsigns when communicating with ATC while operating as an intact formation. Many IPs indicated, during a formation approach that terminates with a "1-up/1-down," they would use other than flight authorization callsigns when communicating who would land and who would perform the low approach. Some would use "[Callsign] 1" when referring to whoever was in the lead regardless of the flight authorization callsign. Others would use the correct flight authorization callsign regardless of the formation position they were currently in. Several IPs said that "tower didn't care" who was "1" and who was "2" in these radio calls until after the formation split up. Tower personnel also stated this did not really matter, as it is the responsibility of the formation itself to know who was doing which maneuver. All IPs and tower agreed that flight authorization callsigns would be used by each aircraft after they split, for example when the low approach aircraft made another call to tower to request a follow on pattern to land or when the full stop aircraft contacted ground control to taxi back.

Since MIP2 was prompting MSP to make several radio calls during the formation approach that used "STEER 2" rather than "2" or "STEER 1" when referencing MA1, it appears he may not have been aware that an "administrative lead" change only renumbers the flight internally, or perhaps he shared one of the various techniques as other IPs interviewed. MIP1, however, stated "STEER 1" always should have referred to MA1. Therefore he interpreted the final call from MSP to tower that, "…STEER 1 will be full stop," indicated MA1 would land. As previously discussed, it was still incumbent on MIP2, in the lead position, to communicate to MA1 the change to the landing plan and MIP1, as the overall flight lead, to verify the plan when the communication to ATC did not match. However, the variety of techniques among IPs as to the usage of "1" and "2" on both intra-flight communication and when speaking with ATC during a formation approach further increases the potential for confusion.

I find, by a preponderance of the evidence, MSP's callsign usage, affected by the "administrative lead" change and various techniques for referencing position number, was improper and confusing.

4. CONCLUSION

In addition to review of the evidence described in the Summary of Facts, which included HUD video from both aircraft, a reconstructive animation of the mishap, and interviews with relevant personnel, I also replicated the mishap sequence in a T-38C Weapon System Trainer (simulator) and flew a local T-38C sortie that terminated in a formation approach to land for one aircraft and low approach for the other.

I find, by a preponderance of the evidence, there are two causes of the mishap: as the MF returned to base and conducted a formation approach, where one aircraft would land and the other would perform a low approach, (1) MIP2 failed to communicate and MIP1 failed to verify which aircraft would land, resulting in MA1 and MA2 simultaneously attempting to land on RWY 13C; and (2)

MIP2 failed to recognize a precarious situation developing after the "cleared off" call and failed to intervene and prevent MA2 from impacting MA1 on landing. Further, I find by a preponderance of the evidence there are two factors that substantially contributed to the mishap: (1) MIP1 and MIP2 used conflicting techniques to perform the 1-up/1-down maneuver and (2) MSP's callsign usage, affected by the "administrative lead" change and various techniques for referencing position number, was improper and confusing.

KREUDER.GRE[redacted] Digitally signed by
GORY.[redacted]

7 APRIL 2022

GREGORY KREUDER
Brigadier General, USAF
President, Accident Investigation Board

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