UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

C-130H3, T/N 94-6706

779TH EXPEDITIONARY AIRLIFT SQUADRON
386TH AIR EXPEDITIONARY WING
ALI AL SALEM AIR BASE, IRAQ

LOCATION: AL TAJI ARMY AIRFIELD, IRAQ

DATE OF ACCIDENT: 8 JUNE 2020

BOARD PRESIDENT: COLONEL ADAM B. THOMAS

Conducted IAW Air Force Instruction 51-307

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

C-130H3, T/N 94-6706
Al TAJI ARMY AIRFIELD
8 JUNE 2020

On 8 June 2020, at approximately 2205 hours local time (L), the mishap aircraft (MA), a C-130H (tail number (T/N) 94-6706), was involved in a mishap during a routine mobility airlift mission from Ali Al Salem Air Base, Kuwait, into Al Taji (Camp Taji), Iraq, when it failed to come to a stop during landing, overran the runway, and impacted a concrete barrier. All 26 mishap crew (MC) members and passengers survived the mishap, with relatively minor injuries to two of the individuals. The MA was damaged beyond repair, and was valued at $35,900,000. The MA was from the 165th Airlift Wing (165 AW), Georgia Air National Guard (ANG), was manned with Wyoming ANG crew members deployed from the 153d Airlift Wing (153 AW), in Cheyenne, Wyoming, and assigned to the 386th Air Expeditionary Wing (386 AEW) at Ali Al Salem Air Base, Kuwait.

The mishap occurred at the end of the first planned leg of the MC's mission on 8 June 2020. The MC departed Ali Al Salem Air Base, Kuwait, at approximately 2053L, with an uneventful start, taxi, takeoff, and cruise to Camp Taji. During descent into Camp Taji, the MC prepared the MA for a nighttime landing, using night vision devices. During this time, the MC turned the MA earlier than their planned turn point, did not descend to lower altitudes in accordance with their planned descent, and allowed the airspeed to exceed recommended maximum speeds for the configuration the plane was in. During the landing, the MA continued to be above the planned glideslope and maintained excessive airspeed, with a nose-down attitude until touchdown. The MA proceeded to "porpoise" or oscillate down the runway from the point of touchdown until the MA was slowed sufficiently by use of reverse thrust from the engines to allow the MA to settle onto the wheels, which in turn allowed for the brakes to engage. The MA, despite slowing somewhat, had less than 1,000 feet of runway remaining by that point, and thus overran the runway and did not come to a complete stop until it impacted a 12-foot-high concrete barrier, approximately 600 feet past the runway.

The Accident Investigation Board (AIB) President found by a preponderance of the evidence that the causes of the mishap were the MA's excess airspeed above recommended landing velocity, which caused the MA to maintain lift (flight) and did not provide sufficient weight on wheels (WOW) to allow braking action to occur. Additionally, the AIB President found, by a preponderance of the evidence, the MC's failure to adequately assess risk, failure to follow proper procedures, and their poor communication were all substantially contributing factors to the mishap.

SUMMARY OF FACTS AND STATEMENT OF OPINION
C-130H3, T/N 94-6706
AL TAJI ARMY AIRFIELD, IRAQ
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ACRONYMS AND ABBREVIATIONS

1st Lt	First Lieutenant
2nd Lt	Second Lieutenant
ACV	Antiskid Control Valve
ADCON	Administrative Control
AEW	Air Expeditionary Wing
AFB	Air Force Base
AFCENT	Air Forces Central
AFI	Air Force Instruction
AFD	Airfield Directory
AFMAN	Air Force Manual
AFTO	Air Force Technical Order
ADO	Assistant Director of Operations
ADO (Pseudonym)	779 EAS Assistant Director of Operations
AGL	Above Ground Level
AHLTA	Armed Forces Health Longitudinal Technology Application
AIB	Accident Investigation Board
AM	Al Taji Army Airfield Manager
AMC	Air Mobility Command
AMD	Air Mobility Division
AMWG	Air Mobility Working Group
AMP	Airfield Marking Pattern
AMXS	Aircraft Maintenance Squadron
ANG	Air National Guard
AOC	Air Operations Center
AOR	Area of Responsibility
ARA	Airborne Radar Approach
AS	Airlift Squadron
ASIMS	Aeromedical Services Information Management System
ASRR	Airfield Suitability and Restrictions Report
ATO	Air Tasking Order
AW	Airlift Wing
AWACS	Airborne Warning and Control System
BICU	Bus Integration Computer Unit
BPO	Basic Post Flight
Capt	Captain
CAVOK	Ceiling and Visibility Okay
CC1	779 EAS Commander
CC2	187 AS Commander
CC3	153 OSS Commander
Col	Colonel
COVID-19	Novel Coronavirus Disease 2019
CRM	Crew Resource Management
CT	779 EAS Chief of Tactics
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DIRMOBFOR	Director of Mobility Forces
DO	Director of Operations
DoD	Department of Defense
FDC	Flight Data Computer
FDU	Fault Display Unit
FU	Smoke
FPM	Feet Per Minute
EAS	Expeditionary Airlift Squadron
GCAS	Ground Collision Avoidance System
GDSS	Global Decision Support System
GPS	Global Positioning System
HFACS	Human Factors Analysis and Classification System
HPCON	Health Protection Condition
HSC	Home Station Check (Maintenance Inspection at Home Unit)
HZ	Haze
IDCU	Integrated Display Computer Unit
IMDS	Integrated Maintenance Data System
INU	Inertial Navigation Unit
IP	Instructor Pilot
ISO	Isochronal
KIAS	Knots Indicated Airspeed
L	Local Time
Lt Col	Lieutenant Colonel
LZ	Landing Zone
MA	Mishap Aircraft
MAFFS	Modular Airborne Fire-fighting System
Maj	Major
MAJCOM	Major Command
MC	Mishap Crew
MCP1	Mishap Copilot 1
MCP2	Mishap Copilot 2

METAR	Meteorological Terminal Aviation Routine
MFE	Mishap Flight Engineer
MLM1	Mishap Loadmaster 1
MLM2	Mishap Loadmaster 2
MN	Mishap Navigator
MP	Mishap Pilot
MS	Mishap Sortie
MSgt	Master Sergeant
MSL	Mean Sea Level
NM	Nautical Miles
NOGs	Night Operation Goggles
NOTAMs	Notices to Airmen
NTS	Negative Torque Signal
NVDs	Night Vision Devices
NVGs	Night Vision Goggles
OG	Operations Group
OKAS	Ali Al Salem Air Base, Kuwait Airport Designator
OPCON	Operational Control
ORBI	Baghdad International Airport Designator
ORM	Operational Risk Management
ORTI	Camp Taji Iraq Airport Designator
OSS	Operational Support Squadron
PDM	Programmed Depot Maintenance
P/N	Part Number
PR	Preflight
PUTSI	Navigation Waypoint Approximately 15 miles east of ORTI
SCNS	Self-contained Navigation System
SIB	Safety Investigation Board
SSgt	Staff Sergeant
ROM	Restriction of Movement
TACON	Tactical Control
TCTO	Time Compliance Technical Order
TH	Thru-Flight Inspection
TMDS	Theater Medical Data Store
T/N	Tail Number
TO	Technical Order
TOLD	Takeoff and Landing Distance
TP	Turn-Point
TSgt	Technical Sergeant
USCENTCOM	United States Central Command
VFR	Visual Flight Rules
VVI	Vertical Velocity Indication
WIC	Weapons Instructor Course
WOW	Weight on Wheels
WST	Wheel Speed Transducer
Z	Zulu

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 17 July 2020, Lieutenant General Jacqueline D. Van Ovost, Deputy Commander, Headquarters Air Mobility Command (AMC), appointed Colonel Adam B. Thomas to conduct an aircraft accident investigation of the 8 June 2020 crash of a C-130H, tail number (T/N) 94-6706, at Al Taji, Iraq (Tab Y-1 to Y-4). The investigation was conducted remotely from 22 July 2020 through 26 September 2020, with no travel by the Board members due to travel restrictions and operational considerations related to the novel coronavirus disease 2019 (COVID-19). To aid in the investigation, the Staff Judge Advocate, Headquarters Air Mobility Command, appointed members from the Air Force Regular, Reserve, and Guard components: a Colonel Medical Member; a Major Legal Advisor; a Captain Pilot Member; a Senior Master Sergeant Flight Engineer Member; a Master Sergeant Maintenance Member; and a Senior Airman Recorder (Tab Y-1 to 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 8 June 2020, the mishap aircraft (MA), a C-130H, with tail number (T/N) 94-6706, departed Ali Al Salem Air Base, Kuwait at approximately 2053 hours Local time (L) on the first scheduled leg of a contingency airlift mission to Camp Taji, Iraq (Tab K-49). The mishap crew (MC) was from the 153d Airlift Wing (153 AW), Wyoming Air National Guard, and consisted of the mishap pilot (MP), the mishap copilot (MCP1), the mishap copilot (MCP2), the mishap navigator (MN), the mishap flight engineer (MFE), and two mishap loadmasters (MLMs) (hereinafter mishap loadmaster 1 (MLM1) and mishap loadmaster 2 (MLM2)) (Tabs G-9 to G-264, K-49, K-50, K-52, V-1.2, V-2.2, V-3.1, V-4.1, V-5.1, V-6.1, V-7, and V-11.1). The MA was from the 165th Airlift Wing (165 AW), Georgia Air National Guard (Tab J-15). The MC and MA were deployed and assigned to the 779th Expeditionary Airlift Squadron (779 EAS), 386th Air Expeditionary Wing (386 AEW), at Ali Al Salem Air Base, Kuwait (Tabs K-50, J-3, V-3.1, V-4.2, V-8.1, and V-11.1). Additionally, onboard the MA at the time of the mishap sortie (MS) were 19 United States Army personnel traveling as passengers with their baggage (Tab K-56 and K-59). At approximately 2053L the MA departed Ali Al Salem, Kuwait, with nothing out of the ordinary noted during taxi, takeoff, climb, or the initial level off (Tabs K-49, and L-1 to L-2). After cruising for approximately 59 minutes, the MA began its descent into Camp Taji, Iraq. Thereafter, the MC began a turn, but did so prior to the pre-briefed plan for doing so (Tabs K-42, K-49, K-55, and L-1 to L-2). As the

MA approached the runway in anticipation of landing at Camp Taji, the MA was 1,000 feet higher than the planned glideslope (Tabs L-4 and N-6). The MC attempted to land the MA at higher than optimal speed with a nose-down attitude (Tabs L-4, N-7, and BB-267 to BB-272). The excessive air speed generated lift on the MA and caused it to "porpoise" or oscillate upon touchdown, which prevented the MA's braking system from engaging due to a lack of proper weight on wheels (WOW) (Tabs J-11, J-19, and J-21). The MA did eventually begin to slow once the engines were placed in reverse and as the wheels then received sufficient weight to engage the brakes; however, by that point there was insufficient runway remaining and the MA departed the prepared surface and came to a stop only when it struck a 12-feet-high concrete barrier approximately 600 feet past the end of the runway (Tabs J-19 and Q-89). All 26 individuals onboard the aircraft survived the mishap and egressed with relatively minor injuries to two individuals (Tabs Q-89, R-34 to R-35, R-73 to R-74, V-6.2, and V-7.2). The aircraft was damaged beyond repair and was valued at $35,900,000 (Tabs J-27 and P-1).

3. BACKGROUND

a. Air Mobility Command (AMC)

AMC is a major command headquartered at Scott AFB, Illinois. AMC provides global airlift, air refueling, and aeromedical evacuation services in support of various enterprises (Tab BB-1). Approximately 110,000 Regular, Reserve, and Guard members and Department of Defense (DoD) civilians comprise AMC's Total Force and make the command's rapid global mobility operations possible (Tab BB-2).

b. Air National Guard (ANG)

The ANG has two missions. The ANG's federal mission is to maintain well-trained, well-equipped units available for prompt mobilization during war and provide assistance during national emergencies (such as natural disasters or civil disturbances). During peacetime, the combat-ready units and support units are assigned to most Air Force major commands to carry out missions compatible with training, mobilization readiness, humanitarian, and contingency operations, such as Operation ENDURING FREEDOM in Afghanistan. ANG units may be activated in a number of ways as prescribed by public law. Most of the laws may be found in Title 10 of the United States Code. The ANG provides almost half of the Air Force's tactical airlift support, combat communications functions, aeromedical evacuations, and aerial refueling. In addition, the ANG has total responsibility for air defense of the entire United States (Tab BB-5).

When ANG units are not mobilized or under federal control, they report to the governor of their respective state, territory (Puerto Rico, Guam, or Virgin Islands), or the commanding general of the District of Columbia National Guard. Each of the 54 National Guard organizations is supervised by the adjutant general of the state or territory. Under state law, the ANG provides

protection of life, property, and preserves peace, order, and public safety. These missions are accomplished through emergency relief support during natural disasters (such as floods, earthquakes, and forest fires), search and rescue operations, support to civil defense authorities, maintenance of vital public services, and counterdrug operations (Tab BB-5).

c. 153d Airlift Wing (153 AW), ANG

The 153 AW is located in Cheyenne, Wyoming, and is an ANG unit (Tab BB-48). The Wyoming ANG's history dates back to World War II, and has included various missions over the years (Tab BB-48 to BB-49). From the 1970s onward, its current mission set has included using the C-130 Hercules for firefighting in the United States, through Modular Airborne Fire Fighting Systems (MAFFS), as well as other humanitarian and operational support (Tab BB-48). Beginning in April 1997, the 153 AW was reorganized under Air Mobility Command for purposes of federal missions under Title 10 (Tab BB-49). At present, the 153 AW continues to fulfill its dual commitment to both state and federal authorities. Deployments throughout the CENTCOM AOR continue on an almost constant basis for its personnel (Tab BB-50).

d. 165th Airlift Wing (165 AW), ANG

The 165 AW is an ANG unit, and when activated on federal orders, it falls under Air Mobility Command (Tab BB-18). The 165 AW is located at Savannah/Hilton Head International Airport, Georgia. The 165 AW, which currently flies the C-130 Hercules, was created after World War II in 1946. The unit was officially mobilized first for the Korean War and then again for Operation Iraqi Freedom. The 165th provides air transport for airborne forces, their equipment and supplies with delivery by airdrop or airland, and to provide strategic airlift of personnel, equipment and supplies (Tab BB-18).

e. United States Air Forces Central Command (AFCENT)

Air Forces Central (AFCENT), or Ninth Air Force (9 AF), is the air component of United States Central Command, a regional unified command. AFCENT is responsible for air operations, either unilaterally or in concert with coalition partners, and developing contingency plans in support of national objectives for United States Central Operations Command (USCENTCOM) 20-nation area of responsibility (AOR) in southwest Asia. Additionally, AFCENT manages an extensive supply and equipment prepositioning program at several sites within the USCENTCOM AOR (Tab BB-45).

f. 386th Air Expeditionary Wing (386 AEW)

The 386 Air Expeditionary Wing (AEW), headquartered at Ali Al Salem Air Base, Kuwait, serves as the primary airlift hub and gateway for delivering combat power to joint and coalition forces in the U.S. Central Command Area of Responsibility (AOR) (Tab BB-9). The 386 AEW flies several aircraft including the C-130 Hercules, which is capable of operating from rough, dirt strips and is the prime transport for airdropping troops and equipment into hostile areas (Tab BB-12). Ali Al Salem and its "Cargo City" are the busiest aerial ports in the AOR, with a yearly average of 600 monthly missions, delivering approximately 54,000 tons of cargo and 180,000 personnel. The wing also supports more than 4,000 joint and 8,500 coalition forces (Tab BB-9). These Airmen fill and support requirements for more than 60 different specialties and unique skillsets operating at locations throughout Southwest Asia (Tab BB-9).

g. 779th Expeditionary Airlift Squadron

The 779th Expeditionary Airlift Squadron (779 EAS) is a provisional unit constituted by AMC and under the operation control of USAFCENT. It is a subordinate unit of the 386 AEW. The squadron operates the C-130 Hercules in support of combat, contingency, and humanitarian aid operations throughout the AOR. (Tab BB-277).

h. Al Taji Army Airfield, Iraq (Camp Taji)

Located approximately 20 kilometers north of Baghdad in Central Iraq, the Al Taji Army Airfield (also known as Camp Taji) is approximately 121 feet above sea level and can be found at latitude 33.31 degrees north, longitude 44 15.4 degress east (Tab O-6 and O-15).

i. C-130 Hercules

The C-130 Hercules primarily performs the tactical portion of the airlift mission (Tab BB-12). The C-130 operates throughout the U.S. Air Force, serving with Air Mobility Command, Air Force Special Operations Command, Air Combat Command, U.S. Air Forces in Europe, Pacific Air Forces, Air National Guard and the Air Force Reserve Command, fullfilling a wide range of operational missions in both peace and war situations. Basic and specialized versions of the aircraft airframe perform a diverse number of roles, including airlift support, Antarctic ice resupply, aeromedical missions, weather reconnaissance, aerial spray missions, firefighting duties for the U.S. Forest Service, and natural disaster relief missions (Tab BB-12). The Air Force issued its original design specification in 1951, yet the remarkable C-130 remains in production. The initial production model was the C-130A,

with four Allison T56-A-11 or -9 turboprop engines. A total of 219 were ordered and deliveries began in December 1956. The C-130B introduced Allison T56-A-7 turboprop engines and the first of 134 entered Air Force service in May 1959. Introduced in August of 1962, the 389 C-130Es were ordered using the same Allison T56-A-7 engine, but added two 1,290 gallon external fuel tanks and an increased maximum takeoff weight capability. June 1974 introduced the first of 308 C-130Hs with the more powerful Allison T56-A-15 turboprop engine. Nearly identical to the C-130E externally, the new engine brought major performance improvements to the aircraft. The latest C-130 to be produced, the C-130J, entered the inventory in February 1999. With the noticeable difference of a six-bladed composite propeller coupled to a Rolls-Royce AE2100D3 turboprop engine, the C-130J brings substantial performance improvements over all previous models. The C-130J-30, a stretch version with a 15-foot fuselage extension, increases the capabilities even more (Tab BB-13).

j. C-130 Hercules, T/N 94-6706

The Mishap Aircraft was accepted into the Air Force's fleet of aircraft in August of 1995 by the 167th Airlift Wing (167 AW) (Tab U-1). By November of 2005, the Mishap Aircraft had been reassigned to the 130th Airlift Wing (130 AW) where it was operated until it transferred to the 165 AW in April of 2016 (Tabs U-21 and U-48).

4. SEQUENCE OF EVENTS

a. Mission

The planned mission for 8 June 2020 consisted of a round trip to Camp Taji, (airport designator ORTI) Iraq, from Ali Al Salem Air Base (airport designator OKAS), Kuwait, broken up with five segments, or legs, along the journey (Tab K-49). Based on the operational risk management (ORM) and sign-in sheet, the flight duty period was scheduled at 12 hours 45 minutes (Tab K-52). The MS occurred on the first scheduled leg (segment) of the planned five-leg mission. The 609th Air Operations Center (AOC) Air Mobility Division (AMD) authorized the MS (Tab K-49).

(1) Crew Composition

The MP was the Aircraft Commander during the MS and was positioned in the left seat as the pilot monitoring the copilot (Tabs K-50, R-62, and V-5.2). The MCP1 was the pilot flying during the MS and was positioned in the right seat (Tabs K-50, R-62 and V-5.2). The MCP2 was acting as an additional crew member and was standing on the aircraft left (just behind the MP) during a portion of the descent and was later seated on the crew bunk during the final stages of the approach and landing (Tabs K-50, R-73, and V-3.3). The MN was standing on the aircraft right (just behind the MCP1) during the descent and was seated for the final stages of the approach and landing (Tabs K-50 and V-4.5). The MFE was seated behind and between the MP and MCP1 at the flight

engineer's station (Tabs K-50 and R-63). The MLM1 and MLM2 were seated in their respective crash worthy seats in the cargo compartment. (Tabs K-50, R-5 to R-6, and R-14 to R-15).

(2) Airfield Considerations

The data pulled from the Global Decision Support System (GDSS) listed ORTI as being restricted to visual flight rules (VFR) Only and Day Only operations (Tabs O-6 to O-16). "VFR Only" due to the lack of instrument approaches into ORTI (Tab O-7). "Day Only" means operations at this airfield were limited to the hours between sunrise and sunset due to the inadequate runway lighting (Tab O-7). The relevant Airfield Suitability Restrictions Report (ASRR) states that prior to night vision device (NVD) operations at a Day Only airfield or runway, the Operations Group Commander (OG/CC) or deployed OG/CC equivalent (may be delegated to Squadron Commander (SQ/CC) or deployed SQ/CC equivalent) will ensure that the airfield possesses lighting adequate for NVD operations (Tab BB-56). The Director of Mobility Forces (DIRMOBFOR) may accept this responsibility for assets temporarily on loan from another command (i.e., where there is a change in operational control, or OPCON) as required (Tab BB-56). DIRMOBFOR approval is based on AMD scheduling of aircraft (Tab V-9). According to the AFCENT (United States Air Forces Central Command) Operational Guidance, an airfield assessment is provided to the AFCENT/CC by the Air Mobility Working Group (AMWG) and approval authority would have been delegated to the DIRMOBFOR for approval (Tabs V-2.3 to V-2.4, and BB-56). The AFCENT Operational Guidance also notes that mobility aircrew will adhere to guidance published in the ASRR and GDSS Airfield Directory (AFD) regarding suitability for prepared (i.e., paved) runways (Tabs O-6 to O-16 and BB-55 to BB-57).

b. Planning

The mission was planned by the 779 EAS in conjunction with the 609 AOC, AMD (Tabs K-49 to K-51). It was planned and briefed as a nighttime contingency mission involving one C-130H aircraft operating out of OKAS, callsign "CROME60" (Tab K-49). The MC followed the standard planning process involving a review of the cargo load report, airfield analysis, and weather analysis (Tabs F-1, K-56 to K-61, and O-6 to O-16). The crew briefing was conducted at the 779 EAS and included classified briefings, with nothing unusual noted during the briefing. The MCP1 was a guest flyer on this crew (Tab R-64). It appears he was a last minute write-in change on the orders, since his name and other information are written by hand, instead of being typed like the other MC members (Tab K-50).

c. Preflight

On 8 June 2020, the MC arrived at the 779 EAS at 1845 L and completed an Operational Risk Management (ORM) sheet for that day's mission (Tab K-52). Of the seven crewmembers, none noted any personal factors or fatigue, and all were listed as current and proficient (Tab K-52). The MP indicated greater than 1,000 hours in current flight qualification (Tab K-52). The MP was penciled-in (i.e., hand written, as opposed to being typed in) as an instructor pilot (IP) on the flight authorization (Tab K-50). The MP had 48.9 hours as an IP in the C-130H (Tab G-72). Of note, if the MP had indicated less than 200 hours on the ORM sheet, this would have added 4 points to the overall ORM total and would have required approval by a Director of Operations (DO) or Assistant DO (Tab K-52). Instead, the ORM was assessed as "LOW" and the MP acting as the Aircraft

Commander signed off on the ORM sheet (Tab K-52). The MCP1 was written in on the flight authorization that day as a last minute add-on (Tab K-50). During the preflight preparations (e.g., crew assembly, review of Notices to Airmen (NOTAMS), flight plans, aircraft configuration, preflight action, and engine start procedures), nothing else of significance or relevance to the mishap was noted or observed.

d. Summary of Accident

At approximately 2053L, the aircraft departed OKAS (Tab K-49). Nothing unusual or of significance to the later mishap occurred between aircraft start, taxi, takeoff, climb, or the initial level off (Tab L-1 to L-2).

As captured on the cockpit voice recorder, at approximately 20 minutes en route, the MCP1 started to ask questions about the descent into ORTI and what the rest of the crew had experienced in previous sorties to the airfield (Tab AA-08). The MCP1 asked if they could expect to descend from PUTSI (PUTSI is an area navigation waypoint approximately 15 miles east of ORTI) at 11,000 feet straight to a 5-mile TP (turn point for final approach as identified on the Self-Contained Navigation System (SCNS)). Some discussion was had about possible restrictions after descent from PUTSI from a bottom clearance altitude of 3,000 feet. The MCP1 stated that they would "ride the pole down" (Tab AA-08). Referring to the NOTAM that the first 600 feet on runway 34 was degraded concrete, the MCP1 asked the MP for clarification on where the MP usually planned on landing at ORTI (Tab AA-8). The MP stated that under NOGS (Night Operation Goggles) they are aiming for the "box"--i.e., the 500-foot marked landing zone via runway edge lighting provided by the AMP-1 lighting available at ORTI (Tab O-8 and AA-08). Approximately 12 minutes later, the MP asked the MCP1 about the descent profile, with further discussion revealing MCP1 believed the distance from PUTSI to the TP was 18 nautical miles (NM) (Tabs AA-13 to AA-14). The MP corrected the MCP1 by identifying the shorter distance of 16.2 NM (Tab AA-14). The MCP1 then stated they would need to lose 8,000 feet from the initial altitude of 11,000 feet to the bottom altitude of 3,000 feet, and MCP1 added "right on a 3-degree [glideslope]" (Tab AA-14). If using the calculations for the briefed parameters, the MCP1 should have come to the conclusion of a 4.9-degree glideslope (Tab V-1.6 and V-2.8). The MP suggested the point where the MCP1 should start the descent was at or before PUTSI (Tab AA-13). The MP reminded the MPC1 that with the 3.5 motors there may be some flight idle torque. The MP suggested to add 2 miles to their calculated descent point (Tab AA-14).

According to the transcript of the cockpit voice recorder (CVR), the MP queried the Baghdad Controller for the current weather at ORTI but instead received the current weather at Baghdad International (airport designator ORBI) (Tab AA-15). During this time, the MCP1 was off headset and was putting on his helmet and NVDs (Tab AA-16 to AA-17). The Baghdad Controller stated CAVOK (ceiling and visibility okay), 170/2, Temperature 31 degrees (sky condition and visibility better than 5,000 feet and 5 statute miles, wind 170-degrees at 2 knots temperature 31-degrees Celsius) at ORBI (Tab AA-14). Upon returning to crew communication, it appears that the MCP1 was not briefed on the weather observation provided by Baghdad control. At approximately 43 minutes into the flight (while the MP was donning his helmet and NVDs, and off interplane communications) the MFE asked the MCP1 if they wanted assault speeds posted on the pilot TOLD (Take Off and Landing Distances) card (Tabs K-48 and AA-17). The MCP1 then responded "Ah, sure that sounds good" (Tab AA-17). When the MP came back up on interplane

communications, he was briefed about the assault speeds provided on the landing card (Tab AA-17).

At approximately 46 minutes into the MS, the MCP1 began to brief the approach (Tab AA-17). The MCP1 briefed a normal right seat landing at 100 percent flaps, for a calculated 120-thousand-pound aircraft weight (Tabs K-48 and AA-17). The MCP1 briefed that they would be aiming for the AMP-1 "box" of runway 34 (Tab AA-17 to AA-18). AMP-1 lighting box starts at 415 feet past the approach end of runway 34 (Tab O-8). The "box" was 500 feet in length (Tab O-178), ending at 915 feet past the approach end of runway 34 (Tab O-10). MCP1 stated to call their "go" (go-around) if they were not on the ground before the "1,000 foot markers" (Tab AA 17 to AA-18). This appears to be in reference to visual aimpoint markers, often called "Captain's Bars," which actually began at 1,020 feet from the approach end of runway 34 and end at 1,520 feet from the approach end of runway 34 (Tab V-1.8). From the CVR, it appears that no vertical velocity indication (VVI) was briefed by the MCP1. (Tab AA-17 to AA-18). A desired glidepath of 3.0-degrees was briefed; however, the briefed 3.0-degree glidepath would provide 20 feet of clearance from the high-tension power lines located off the approach end of runway 34 (Tab V-1.5). The MCP1 briefed three separate altitudes for the 5 nautical mile final, as, at most 3,000 feet, but desired 2,000-1,500 feet, or words to that effect, and these briefed altitudes range from a 6-degree glideslope to a 3-degree glideslope (Tab AA-18). It appears this approach briefing was not questioned or scrutinized further by any mishap crewmember. During the continuation of the *Descent Checklist*, the MCP1 asked the MP if they should select "TAC" (Tactical Mode) on the Ground Collision Avoidance System (GCAS) for that approach (Tab AA-19). The MP responded in the affirmative (Tab AA-19). The rest of the *Descent Checklist* was completed without incident (Tab AA-19).

At approximately 52 minutes into the MS, the MP contacted the ORTI tower controller to establish communications (Tab AA-22). In reply, the ORTI tower controller provided a current weather observation of:

> winds estimated three zero zero degrees at zero five knots (wind 300-degrees magnetic heading at five knots), visibility three-thousand meters (1.86 statute miles), sky clear, temperature 36 (+36-degrees Celsius), altimeter two niner six zero (29.60 inHg), runway 34 in use, Report two zero miles for runway three four (report 20 NM from the airfield for runway 34)

(Tab AA-22).

The MP reported all necessary information back to the tower (Tab AA-22). The MP noted the tower's observation of a temperature of three six (+36 degrees Celsius) and asked the MFE if this would affect the take-off and landing distance (TOLD) (Tab AA-22). (Of note, a new Pilot TOLD card is required anytime gross weight changes +/-5,000 pounds, outside temperature changes +/-5-degrees C (Celsius), or pressure altitude changes +/-1,000 feet (Tab BB-269)). The MP stated "I'm ok with that but let's run it to see if there is a difference" (Tab AA-22 to AA-23). The MFE apparently calculated the new TOLD, and then stated that it did not make much difference and it is within a knot of everything posted (Tab AA-22 to AA-23). The MP accepted these differences

on the posted landing card and conferred with the MCP1 to ensure that they were ok with the difference, and no objection was noted (Tab AA-23).

At approximately 59 minutes into the MS, the MCP1 began the descent into ORTI from the en route cruise altitude of 16,500 feet to 11,000 feet (Tab N-1). The MP confirmed that the *Descents Checklist* was called complete and the MFE confirmed that the checklist was previously called complete (Tab N-1). The MP requested descent, pilot discretion, down to 3,000 feet--but the Baghdad controller denied the request and stated they will advise when cleared down to 3,000 feet (Tab N-1). The MP contacted Taji tower to report 20 miles out from the airfield (Tab N-2). This was the straight line distance and not representative of the flight plan route of more than 30 miles (Tab K-42). The MA reached 11,000 feet prior to the pre-briefed point of PUTSI (Tabs K-42, K-55, and L-1). The MCP1 stated they will slow the MA down to 210 knots indicated air speed (KIAS) (Tab N-2). This was 6 miles from PUTSI as stated by the MP (Tab N-2). Shortly thereafter, Baghdad control cleared CROME60 to descend 3,000 feet (Tab N-2). The MCP1 began a descent prior to PUTSI, which was ahead of the prebriefed profile for the descent (Tabs K-42 and L-1). The MCP1 began a turn prior to reaching PUTSI to the TP on the final approach segment (Tab K-42 and K-55). This turn cut off some distance and reduced the MA's time for further descent (Tab K-55). During the descent, the MCP1 stated that "we want to be about 2,000 [feet] by 5 miles so we're at 9 [thousand feet] we gotta [*sic*] lose 7 [thousand feet]" and "we're looking good" (Tab N-2). The MP acknowledged "that checks" (Tab N-3). The MP then stated "3 minutes from the TP" followed by "3,000 feet per minute, yeah you'll be good" (Tab N-3). The MCP1 then stated they wanted to stay high as long as possible without getting "jammed up" with threats (Tab N-3). It appears no other comment on the descent was made by any other crew member en route to the TP (Tab N-3 to N-4).

At approximately 1 hour 6 minutes into the MS, the MP reported 10 miles out for runway 34 (Tab N-4). The ORTI tower controller instructed the MA to continue and report a 5-mile final for runway 34 (Tab N-4). Shortly thereafter, the MP stated in the event of a go-around that it would be a right turn into the traffic pattern (Tab N-5). This maneuver would be required due to an aerostat located on ORTI (Tab O-14). Just prior to final intercept, the MCP1 started to call for configuration of the aircraft for landing (Tab N-5). At the same time, the MP calls "4,000 for 3,000" (identifying the aircraft was passing 4,000 feet mean sea level (MSL) for 3,000 feet MSL) (Tab N-5). The MFE initiated the *Before Landing Checklist*, and during this checklist the MP reports a 5-mile final (Tab N-5). GPS data shows the aircraft intercepting final approach course prior to 5-miles (Tab K-55). The ORTI tower cleared CROME60 for landing on runway 34 (Tab N-6). The MCP1 called for flaps 100 on speed (Tab N-5). Based on relevant guidance, the MP would be responsible for manipulating the flaps to 100 percent (Tab BB-272). The MA was configured with gear down and flaps 100 percent, within all aircraft limitations at this time, and the *Before Landing Checklist* was completed (Tabs L-7 to L-8 and N-6).

Shortly after the completion of the *Before Landing Checklist*, the MP stated the MCP1 was 1,000 feet above glideslope (Tab N-6). When the MP stated that the aircraft was 1,000 feet above glideslope, the aircraft was 1.6 Nautical Miles from the approach end of the runway at 1,764 feet Above Ground Level (AGL) (Tabs K-44 and L-7). "Airspeed" was announced by the MP and acknowledged by the MCP1 (Tab N-6). During this time, DFDR data indicated that the aircraft accelerated from an original configuration speed of 136 KIAS, to a speed of 150-156 KIAS while

the MC attempted to intercept the glideslope (Tab L-7). The flap limitation speed as identified in relevant guidance for 100% flaps is 145 KIAS (Tab BB-272). The aircraft continued to maintain a speed above flap limitation speed on final until after initial touchdown (Tab L-7). In order to intercept the glideslope from their current position, the MCP1 maneuvered from -8 to -11 degrees pitch, in an apparent attempt to achieve the desired glideslope (Tab L-7). The MA was unable to maintain an approach speed with the excessive pitch-down attitude, even with the throttle levers at Flight Idle and the aircraft fully configured for landing (Tab L-7 to L-8). The MN stated "two right drift, and we have a tailwind," and followed up with "got about a ten knot tailwind at this altitude, two right drift" (Tab N-6). At 500 feet the GCAS system provided an aural alert of "SINKRATE" (Tab N-6). Based on relevant guidance, this alert would have only occurred if the vertical velocity was between 2,500 and 3,750 feet per minute (FPM) (Tab BB-268). The MCP1 responded to the aural alert with "I've got it" (Tab N-6). At 300 feet the GCAS system again provided the aural alert of "SINKRATE" (Tab N-7). At that altitude, the alert would be triggered by a vertical velocity of 2,200 to 2,450 FPM (Tab BB-268). According to the CVR, no "Stabilized Approach Criteria" call out was observed at 300 feet or 150 feet (Tabs N-6 to N-7, and O-120 to O-121). By regulation, at 100 ft AGL the MN begins the night vision goggle (NVG) callouts (Tab O-374). The MN announced "100 feet'" and an additional "SINKRATE" aural alert sounded (Tab N-7). This alert would only be triggered by a vertical velocity of 1,700 to 2,100 FPM (Tab BB-268). During the final 50 feet, the MP was instructing the MCP1 to "pick the nose up" and arrest the descent, while the GCAS was still providing the aural alert of "SINKRATE" (Tab N-7). This final alert would have required a vertical velocity of 1,680 to 1,900 FPM (Tab BB-268). The MN continued to announce the suggested NVG callouts (Tabs N-7 and O-374).

The DFDR data shows the MA touched down on the runway surface at 146 KIAS, approximately 3,889 feet from the departure end of the runway, at -1.75 degrees pitch (Tabs J-19 and L-7). This touchdown speed was 38 knots above the posted and briefed Pilot TOLD card 100% flap landing speed (Tab K-48). A mild pitch oscillation occurred over the next 10 seconds (Tabs J-21, L-7, and R-52). There was no weight on wheels (WOW) indication to the DFDR, and no brake application indication switch installed on the aircraft to indicate when brakes are applied (Tab J-5). By using the data provided for pitch information, airspeed indications, technical data, and mishap crew testimony, it can be determined that in the first 10 seconds upon touchdown at ORTI the aircraft began a pitch oscillation which was not fully identified by the MC (Tabs J-6 and L-7). During this time, no positive WOW signal would have been received by the Mark IV anti-skid system and, therefore, the anti-skid system would by-pass the brakes no matter how much brake pressure was applied by either pilot (Tab J-11). According to testimony from the MC members, the MCP1 attempted maximum brake pressure after touchdown with no perceived effect (Tab V-2.9). It was not until 5 seconds after touchdown that the pitch oscillations had some amplitude and varied from 0 to -2 degrees (Tab L-7). On the initial 0-degree pitch point identified on the DFDR, the aircraft WOW indication would have been provided; however, with the speed of the aircraft and the frequency of the oscillations, the brakes were not on the ground long enough to be effective (Tab J-12 and J-21). On the second 0-degree pitch point, the WOW indication would not have been needed, as touchdown protection after the first satisfaction of the WOW indication (Tabs J-11, J-21, and BB-66). It is at this point, with 2,300 feet remaining on the runway, that skid-marks are found on the runway surface (Tab K-22 to K-23). It is also at this time the MP stated "pull it back" followed by the MFE stating "brakes" (Tab N-7). MC interviews all described a "different" feeling or sensation to the time immediately after touchdown (Tabs V-1.8, V-3.7, V-4.2, V-6.1, and V-

7.1). Descriptions ranged to being on a "hilly road" to "an odd floating that definitely was not a bounce" (Tabs R-6, V-1.8, and V-3.7). Ten seconds after the first observed touchdown, the aircraft was no longer observed to be oscillating (Tab L-7). For a further three seconds, the aircraft only minimally slowed prior to the throttles being placed in REVERSE (Tab L-7). The MA traveled for a total of 13 seconds with no appreciable deceleration, covering 2,936 feet (Tab J-19). At 953 feet remaining to the end of the runway and 122 KIAS, after the MCP1 moved the throttles into REVERSE, the MP took control of the aircraft (Tabs J-19 and V-1.8). After the aircraft's throttles were placed in REVERSE, the MA decelerated at a rate that met or exceeded predicted or charted data for normal brakes and propellers in REVERSE (Tab J-21). Based on information set forth in the technical reports, it appears that the brakes were fully operational, but, due to the excessive speed of the aircraft and weight partially supported by the wing, along with the pitch oscillations, there was insufficient positive weight on the wheels for the anti-skid to provide braking application (Tab J-11 and J-20). Shortly after going into REVERSE, it appears the MC realized they would depart the prepared surface (Tabs N-7 and V-1.8). At 60 KIAS, the MA departed the prepared surface off the end of runway 34 and traveled another 594 feet to impact a concrete barrier at 23.5 knots (Tab J-19).

e. Impact

The MA impacted the 12-foot concrete barrier, located 594 feet past the end of the prepared surface of runway 34, at a speed of 23.5 knots (Tab J-19). At that time, the front of the aircraft sustained substantial damage, buckling the airframe (Tab J-22). Upon MA impact with the concrete barrier, all four propellers, which were still in reverse, and the front of their reduction gear boxes were liberated from their respective engines (Tab J-22). The two external tanks contacted the concrete barrier (Tab J-22). Debris from the propellers and other aircraft parts that impacted the barrier scattered across the MA and the immediate area surrounding the MA (Tabs J-22, S-5, and S-7 to S-12).

f. Egress and Aircrew Flight Equipment (AFE)

Egress occurred when both MLM1 and MLM2 attempted to open the paratroop doors with the armor still in place (Tabs V-6.2 and V-7.1). MLM1 signaled for MLM2 to move to the right paratroop door and help MLM1 remove the armor and open the door (Tabs R-36 and V-7.1). Upon opening the door, MLM1 and MLM2 started egressing the MA passengers and crew through the right paratroop door (Tabs R-36 and V-6.2). The MCP2 opened the top escape hatch on the flight deck, but was told to instead egress out of the paratroop door (Tabs R-47, R-63, and V-6.2). MLM2 assisted the MP who was limping to exit out the right paratroop door (Tabs R-36, R-63, and V-7.2). After the MC assembled outside of the MA, MCP2, the MFE, and MLM1 reentered the MA to turn off power and collect the classified material (Tab R-25, R-47, and R-57). Egress of the aircraft was accomplished in accordance with relevant guidance (Tab BB-270 to BB-271)

g. Search and Rescue (SAR)

At approximately 2205 L, the Iraqi Air Traffic Controller in the Camp Taji Tower, after observing the MA overrunning the runway and colliding with the concrete barrier, notified fire and rescue/ambulance operations (Tabs Q-88 to Q-89, and V-13.2). Firetrucks and rescue crews were sent to the crash site, where they worked until approximately 0300 L (on 9 June 2020) to control

fires, contain the spread of leaking fuel, power down and secure the aircraft, and also attend to/evacuate the MC members (Tabs Q-10, Q33, Q-43, Q-57, Q-81, Q-89, Q-99, Q-103, Q-139, Q-153, Q-157, Q-163, Q-165, Q-173, Q-177, Q-181, R-25, R-36, R-51, R-63, R-74, and R-76.) All 26 individuals onboard the MA survived the mishap, with only minor injuries to two individuals (Tabs Q-89, R-34, R-73 to R-74, V-6.2, and V-7.2).

h. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

The 165th Aircraft Maintenance Squadron (165 AMXS), Georgia Air National Guard (ANG), maintained the MA maintenance forms while in the United States, and the 386 AEW at Ali Al Salem Air Base, Kuwait, maintained the MA's forms while deployed (Tab J-3). The purpose of the Integrated Maintenance Data System (IMDS) is to provide an automated maintenance information system for space vehicle, engine, trainer, support equipment, missile, and communications-electronic maintenance data (Tab BB-73). IMDS provides support for home base, deployed operations, and depot level maintenance data (Tab BB-73). The purpose of the Air Force Technical Order (AFTO) 781 series forms is to document maintenance discrepancies (Tab BB-72). The active AFTO 781 series forms were on the MA and were recovered after the mishap (Tab U-62 to U-99). A comprehensive review of the MA's IMDS history, the AFTO 781 forms, and Time Compliance Technical Orders (TCTOs) were accomplished (Tab D-1 to D-30). There is no evidence of non-compliance with maintenance actions, TCTO's, or forms documentation.

b. Inspections

The preflight inspection (PR) is a flight preparedness inspection that is accomplished prior to the first flight of the flying period (Tab BB-70). The preflight validity period is 72 hours (Tab BB-70). The thru-flight inspection (TH) is accomplished between flights when scheduled ground time exceeds six hours but does not exceed the 72-hour preflight validity period (Tab BB-70). The combined preflight/basic postflight (PR/BPO) inspection is accomplished after the last flight of the flying period (Tab BB-70). The home station check (HSC) is a 270-day-interval inspection (Tab BB-274). The isochronal (ISO) is a 540-day interval inspection consisting of three minor, and one major inspection (Tab BB-274). TCTOs are inspections or maintenance procedures required before specific dates or flights (Tab BB-276).

For T/N 94-6706, the most recent BPO/PR was annotated as being performed on 7 June 2020 at 1700 hours (Tab D-29). The most recent HSC was completed on 24 January 2020 (Tab D-15). The next HSC was due on 20 October 2020 (Tab D-15). The most recent ISO was completed on 24 January 2020 (Tab D-15). The next ISO was due on 17 July 2021 (Tab D-15). The most recent Programmed Depot Maintenance (PDM) was completed on 12 May 2016 (Tab D-15). The next PDM was due on 12 February 2022 (Tab D-15). No TCTOs restricted the MA from flying, and all required TCTOs were accomplished in accordance with applicable guidance (Tab D-25 to D-27).

c. Maintenance Procedures

All four engines were modified to the T56-A-15A configuration and installed per aircraft TCTO 1C-130-2211 (Tab J-15). This modification was intended to improve the reliability and fuel efficiency of the propulsion system on the aircraft (Tab J-15). Aircraft TCTO 1C-130-2266 was intended to adjust the fuel schedule to mimic the T56-A-15 engine performance in flight idle and was accomplished in conjunction with TCTO 1C-130-2211 (Tab J-15). The brake system has been modified by TCTOs 1C-130-2095 "Replacement of MARK II Antiskid System with MARK IV Antiskid System on select C-130 Aircraft" and 1C-130-2098, "Replacement of Carbon Brakes (P/N 2-1744) and replacement wheels (P/N 3-1660) on select C-130H aircraft" (Tab J-15). Based on information from the DFDR during the mishap flight and landing, there is no evidence of engine or propeller failures or malfunctions (Tab J-10). Additionally, normal brake system performance was achieved after the MA slowed to a velocity where the antiskid/brake system could be effectively applied (Tab J-11). There was no evidence to indicate maintenance procedures were a factor in the mishap.

d. Maintenance Personnel and Supervision

A thorough review of training and qualification records (AF Form 623s and AF Form 797s) revealed all involved personnel from the 165 AMX and 386 AEW were properly trained, qualified, and supervised (Tab T-4 to T-054). All maintenance related activities prior to the mishap were normal.

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

No fuel, engine oil, or hydraulic fluid samples were obtained from the MA after the mishap. However, there is no evidence to indicate the MA's fuel, hydraulic fluid, engine oil, or oxygen were a factor in this mishap.

f. Unscheduled Maintenance

Since the last inspection, the following unscheduled maintenance was performed: The #4 engine bleed air regulator shut off valve was replaced on 3 February 2020 (Tab U-94). The #2 engine speed sensitive control was replaced on 5 February 2020 (Tab U-94). The #2 engine propeller was changed on 8 February 2020, and again on 4 June 2020 (Tab U-93 and U-119). On 3 March 2020 the pilots vertical velocity indicator (VVI), the #1 integrated display computer unit (IDCU), and the #2 inertial navigation unit (INU) were replaced (Tab U-112). On 12 May 2020 the bus integration computer unit (BICU) was replaced (Tab U-113). The #2 engine valve housing was replaced on 13 May 2020. On 23 May 2020, the flight station flow control shutoff valve was replaced (Tab U-122). The left and right ramp actuators were replaced on 4 June 2020. On 6 June 2020 the receiver-transmitter-processor (RTP) was replaced (Tab U-133 to U-134). On 6 June 2020 the Copilots #2 flight director computer (FDC) was replaced (Tab U-134). There is no evidence to suggest unscheduled maintenance was a factor in this mishap.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

The aircraft was determined to be unrepairable due to the significant damage to the fuselage and wings (Tab J-15). Most of the damage occurred during either initial contact of the front of the aircraft (flight deck and nose landing gear) with the concrete barrier, or subsequent contact of the four propellers and external fuel tanks with the concrete barrier. All four propellers contacted the concrete barriers in REVERSE and were instantaneously destroyed (Tab J-22). The aircraft was deemed not repairable and the engines/propellers were destroyed (Tab J-27). Both brake metering valves (P/N 23410-3 or 697395-1), both anti-skid control valves (P/N 39-941), the fault display unit (P/N 142-15520), the anti-skid control box (P/N 142-151), four brake fuses, Quick Disconnect brake lines and shuttle valve (P/N 211-164), and fluid bolt (P/N 45-1523) were sent to Ogden Air Logistics Complex for tear down and analysis (Tab J-10 to J-11). All DFDR indications reflect that the aircraft, including all four engines, all four propellers, the flight controls, the landing gear, and the brakes all performed normally throughout the mishap mission (Tab J-27). Analysis of the DFDR data shows that nominal brake system performance was achieved after the mishap aircraft (MA) slowed to a velocity where the anti-skid/brake system could be effectively applied (J-27).

b. Evaluation and Analysis

(1) Hydraulic Systems Performance

The MA used three independent hydraulic systems: utility, booster, and auxiliary. The utility system powered half of the ailerons, rudder, and elevators. It also powered the flaps, main landing gear, nose landing gear, steering, and the normal brakes (Tab J-11). The booster system powered half of the ailerons, rudder, and elevators (Tab J-11). The auxiliary system powered the ramp and door, emergency nose landing gear extension, emergency brakes, and ground operation of the utility hydraulic system (Tab J-11). Hydraulic power was supplied to the utility and booster systems through four engine driven pumps, one mounted on the reduction gearbox of each engine. The DFDR system recorded no indications of low hydraulic pressure throughout the MS (Tab J-16).

(2) Brake System Performance

A hydraulically operated, disk-type brake is installed on each of the four main landing gear wheels (Tab J-10). The nose landing gear wheels do not have brakes (Tab J-10). The brakes normally operate from utility hydraulic system pressure, with an alternate supply available through the auxiliary hydraulic system (Tab J-10). If electrical power is off, the system with the highest pressure will supply pressure to operate the brakes (Tab J-10). Fluid for the normal brake system flows through a brake pressure selector valve to the right-hand and left-hand brake control valves (Tab J-10). When the fluid leaves the brake control valves, it flows through the dual anti-skid valves, brake fuse, and shuttle valves to the brakes (Tab J-10). Each brake is controlled by a brake control valve, an anti-skid valve, and a brake shuttle valve (TabJ-10). The auxiliary system supply flows through the emergency brake pressure selector valve. (Tab J-10). The brake system on T/N 94-6706 was modified by TCTOs 1C-130-2095 *Replacement to MARK II Antiskid System with MARK IV Antiskid System on select C-130 Aircraft*, and 1C-130-2098 *Replacement of Carbon*

Brakes (P/N 2-1744) and Replacement Wheels (P/N 3-1660) on select C-130H Aircraft (Tab J-15 to J-16).

The brake system was initially focused on because during the CVR replay from the MA, the MCP1 and MP were struggling to get adequate braking (Tabs J-19 and N-7). Evaluation of the deceleration of the aircraft revealed that the aircraft slowed down at two significantly different rates with deceleration between touchdown (5482.00 seconds) and application of REVERSE (5495.00) a much slower rate than between application of REVERSE and the end of the runway (5500 seconds) (Tab J-19). Between 5482 seconds (aircraft touchdown per the CVR and DFDR data) and 5495 seconds (REVERSE) the pitch angle oscillates between 0 degrees and -2 degrees while the aircraft decelerates from 146 KIAS to 122 KIAS (Tab J-19). When the aircraft throttles are brought into REVERSE at 5495 seconds, the aircraft decelerates from 122 KIAS to 60.7 KIAS at the end of the runway at 5502 seconds (Tab J-19). As the MA travels the 594 feet from the end of the runway to the concrete barrier, it decelerates to 23.5 KIAS and then impacts the concrete barrier at 5511 seconds (Tab J-19). Figure 5 is a depiction of the typical deceleration of an aircraft from the wheel brake system improvement (WBSI) flight testing with throttles in REVERSE and full braking applied. Typical deceleration during this flight test was 7.28 KIAS/s. (Tab J-20).

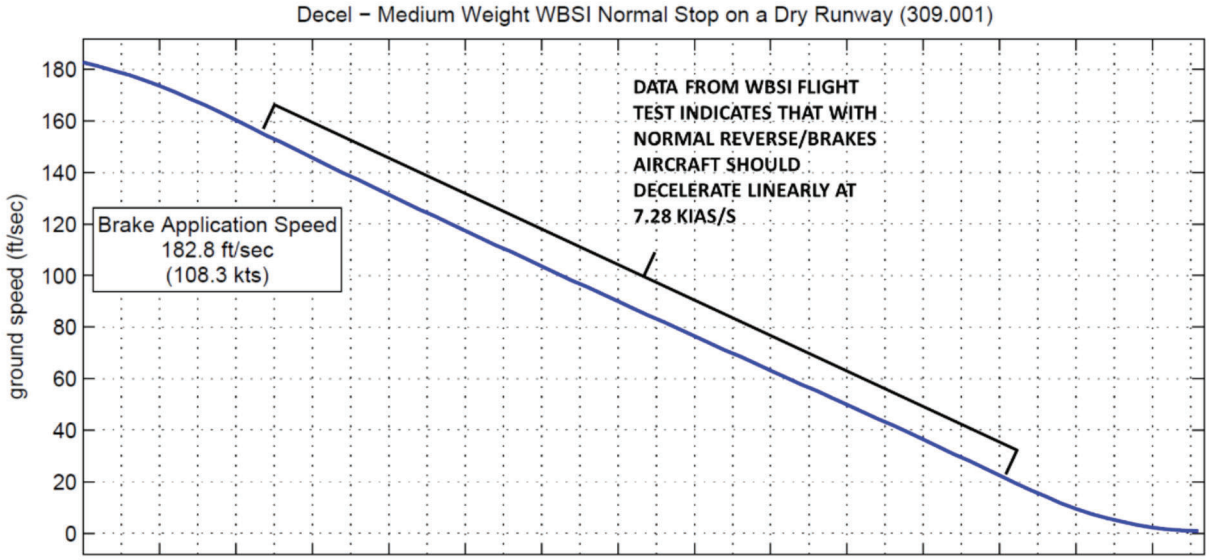
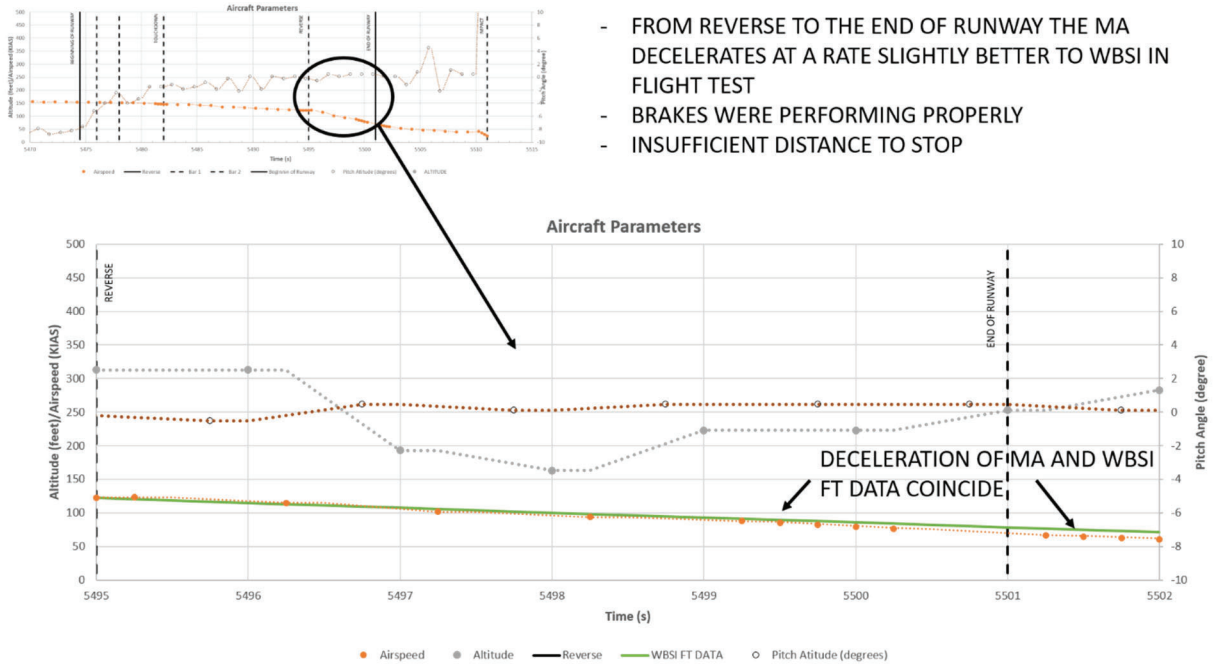


Figure 5. WBSI Flight Test Data (Tab J-20)

REVERSE to End of Runway. When this flight test data (in green) is plotted against the deceleration that the MA experienced (in orange) between REVERSE and the end of the runway in Figure 6a, the MA slows down at rate comparable to flight test data. Conclusion from this assessment of brake performance is that the brake system was working normally. MA experiences abnormal pitch oscillations while decelerating between touch down and REVERSE which is also an indication that the weight of the aircraft was not fully on the wheels (Tab J-21).

Figure 6a (Tab J-21)



(3) Engine Performance

Power is supplied by four Allison T56-A-15A, turboprop, constant-speed engines. Each engine drives a four-blade Hamilton Standard hydromatic, constant-speed propeller with full feathering and reversible pitch (Tab J-8). All engines and propellers started and performed normally throughout the mission (Tab J-18). The T56-A-15A did exhibit slightly higher torque than T56-A-15 engines would in flight idle (Tab J-18). The DFDR data indicates that the propellers responded quickly to the change to REVERSE throttles with torque rising from FLIGHT IDLE torque to reverse torque within 2 seconds on all four propellers (there is no data point in the DFDR where any throttle is at GROUND IDLE) (Tab J-18). No engine, propeller or performance anomalies were noted during a review of the takeoff, climb, cruise, approach for landing and landing (Tab J-8). The landing was performed with all engines at FLIGHT IDLE. At approximately DFDR time 5495, the throttles were moved from FLIGHT IDLE into REVERSE. It does not appear that throttles were left at GROUND IDLE for any period of time during this transition (Tab J-8).

(4) Ground Collision Avoidance System (GCAS)

GCAS is used to detect and warn the pilots of hazardous flight conditions related to proximity of terrain (Tab BB-68). GCAS detects airspeed, altitude, flap position, landing gear orientation, cycling of the landing gear, weight on wheels, radar altitude decision height, pitch, roll, glideslope deviation, and glideslope valid or inhibit signals (Tab BB-68). Eight modes of operation provide visual and aural (audible) alerts and warnings when the airplane is too low or not configured properly for takeoff or landing (Tab BB-68). Sink rate alerts are provided when the sink rate (the rate at which the aircraft is descending) exceeds acceptable rates with respect to terrain clearance (Tab BB-68). “Tactical mode” was used during the approach of the MS (Tab R-23). The MCP1 slowed the MA and configured the MA for approach-landing with flaps set to 100 percent (Tab J-3). The MA’s highest recorded airspeed during the final approach to landing was 157 KIAS (Tab

J-3). Maximum recommended airspeed with the wing flaps set to 100 percent is 145 KIAS (Tab J-3). At approximately two NM from the airfield, the MA was 1,000 feet above the recommended glideslope for runway 34 and at 150 KIAS (Tab J-3). At 500 feet AGL, an audible GCAS sink rate alert began and continued until approximately 50 feet AGL (Tab J-3). The global positioning system (GPS) recorded data indicated the MA crossed the runway 34 threshold at a ground speed of 161 knots (151 KIAS) (Tab J-3). The recommended calculated landing velocity for the MA at 122,000 pounds was 105 KIAS (Tab J-3).

(5) Digital Flight Data Recorder (DFDR)

All DFDR indications reflect that the aircraft, including all four engines, all four propellers, the flight controls, the landing gear, and the brakes all performed normally throughout the mishap mission (Tab J-27). The four engine structures that house each engine are called nacelles. There were no indications of nacelle overheat. There were no indications of low propeller oil. There are four discrete signals recorded in the DFDR for the hydraulics pump (one for each engine) (Tab J-16). There were no indications of low hydraulic pressure. All throttle lever positions were consistent with the normal start, takeoff, climb, cruise, and approach sequence. There were no indications of an engine fire. There were no indications of low engine oil (Tab J-17).

The time line of events as identified by the DFDR are as follows:

Seconds	Event
101.25 – 376.25	Engine #3, #4, #1, and #2 started
1173.00 – 1215.00	Taxi
1215.00 – 2166.00	Takeoff and Climb out
2166.00 – 4755.00	Cruise
4755.00	Begin descent, approach
5390.75	100% flaps. (airspeed 136.1 KIAS)
5390 – 5419.25	Aircraft accelerates to 150 KIAS–156 KIAS (no change in torque, pitch angle between -8 and -11 degrees (nose down))
5420 – 5479.25	Airspeed maintained between 150 KIAS and 156 KIAS
5480 – 5482	Aircraft decelerates to touchdown speed
5482.00	MA touchdown at 146 KIAS
5495.00	Throttles to REVERSE
5500.00	MA departs Runway
5511.00	MA impacts concrete barrier

(Tab J-17)

7. WEATHER

a. Forecast Weather

The forecasted weather for the mission was compiled on a DD form 175-1 weather brief, and was briefed to the MC at 1500 Z (Zulu time)/1800 L (Tab F-1). Forecasted weather for Al Taji, Iraq, was briefed during the time falling between 1825 Z/2125 L and 2025 Z/2325 L, as surface winds variable at 6 knots, visibility 9000 feet restricted by Haze (HZ), sky condition clear, altimeter setting 29.54 inHg (inches of mercury), runway temperature +31 degrees Celsius, pressure altitude +475 feet (Tab F-1).

b. Observed Weather

Observed weather, obtained by CVR data, was reported to the MC by Camp Taji tower controller approximately 20 minutes prior to touchdown. The weather relayed to the MC was: winds estimated at 300 degrees 05 knots, visibility 3000 meters (approximately 1.86 statute miles), sky condition clear, temperature +36 degrees Celsius, altimeter setting 29.60 (Tab AA-22). There were no automated weather observations at Camp Taji available to the MC (Tab O-12). Crewmembers did not note any obscuration to visibility and were able to see Camp Taji airfield beyond the required 3 statute miles visibility to operate at the visual flight rules (VFR) only airfield (Tabs O-12 to O-13, and AA-28). METAR (Meteorological Terminal Aviation Routine) data for Camp Taji at 1855 Z/2155 L (approximately ten minutes prior to the mishap) stated winds 210 at 03 knots, visibility 5000 meters (3.11 statute miles) restricted by smoke (FU), sky condition clear, temperature +34.4 degrees Celsius, dew point +05.9 degrees Celsius, altimeter 29.59 inHg, remarks were that wind data was estimated (Tab F-2). METAR data was not available to the MC prior to the mishap (Tab O-6 to O-16).

c. Space Environment

Not applicable.

d. Operations

Based on the forecasted and actual observations of the crew, the weather was within operational limits for the crew, aircraft, and the airfield (Tab F-1).

8. CREW QUALIFICATIONS

a. Mishap Pilot (MP)

The MP was a current and qualified instructor pilot with 1700.7 total C-130 hours, including 204.9 combat hours, and 150.9 NVG hours (Tab G-78). The MP had 48.9 hours instructing on the C-130 (Tab G-78). Of those hours, 42.0 were logged within the last 90 days (Tab G-71). The MP flew 20.7 hours at night over the last 90 days (Tab G-71). The MP was initially qualified for C-130's on 10 December 2012, qualified for instructor on 18 November 2019 (Tab G-80). The MP completed a recent flight evaluation on 18 December 2019 (Tab G-79). The MP was qualified

with 3.5 engines on 7 September 2018 (Tab G-100). The MP was a Senior Pilot assigned to the 187th Airlift Squadron (AS) (Tab G-74).

The MP's flight time during the 90 days before the mishap was as follows:

Last	Hours	Sorties
30 days	48.4	36
60 days	48.4	36
90 days	50.6	39

(Tab G-71)

b. Mishap Copilot 1 (MCP1)

The MCP1 was a current and qualified first pilot with 506.1 total C-130 hours, including 115.0 combat hours, and 58.7 NVG hours (Tab G-13). The MCP1 was initially qualified on 9 May 2018 and completed his most recent flight evaluation on 09 December 2019 (Tab G-18). The MCP1 flew 0.5 hours at night over the last 90 days (Tab G-09). No AF Form 4025 upgrading the MCP1 to 3.5 engine qualification was found within the MCP1's training record. The current letter of X's (Tab T-1) show him as qualified on 3.5 engines. The MCP1 was a C-130 Pilot assigned to the 187 AS (Tab G-12).

The MCP1's flight time during the 90 days before the mishap was as follows:

Last	Hours	Sorties
30 days	11.3	7
60 days	11.3	7
90 days	14.2	8

(Tab G-9)

c. Mishap Copilot 2 (MCP2)

The MCP2 was a current and qualified first pilot with 141.4 total C-130 hours, including 57.8 combat hours, and 23.7 NVG hours (Tab G-33). He was initially qualified on 14 February 2020 and this was the MCP2's most current evaluation (Tab G-36). The MCP2 flew 25.7 hours at night over the last 90 Days (Tab G-28). The MCP2 was on the bunk for the landing, but appears not to have had an AF form 4025 upgrading the MCP2 to 3.5 engine qualifications in his training folder (Tab R-73). The MCP2 was a C-130 Pilot assigned to the 187 AS (Tab G-31).

The MCP2's flight time during the 90 days before the mishap was as follows:

Last	Hours	Sorties
30 days	57.8	36
60 days	67.2	38
90 days	71.8	43

(Tab G-28)

d. Mishap Navigator (MN)

The MN was a current and qualified basic navigator with 2274.1 C-130 and 1843.4 E-3 hours, with a total of 4117.5 hours (Tab G-220). The MN was an instructor and evaluator on the E-3 for a total of 543.6 instructor hours and 23.6 evaluator hours (Tab G-220). The MN has 432.4 total combat hours (Tab G-220). The MN's last evaluation was 27 March 2019 (Tab G-223). The MN was initially qualified on 15 February 2002, and was qualified on the C-130 on 31 October 2008 (Tab G-241). The MN was MAFFS (modular airborne fire-fighting system) qualified as of 17 June 2008 (Tab G-264). The MN has logged 20.6 hours of night flying in the last 90 days (Tab G-214). The MN was a C-130 Master Navigator assigned to the 187 AS (Tab G-218).

The MN's flight time during the 90 days before the mishap was as follows:

Last	Hours	Sorties
30 days	57.8	36
60 days	57.8	36
90 days	58	37

(Tab G-214)

e. Mishap Flight Engineer (MFE)

The MFE was a current and qualified basic Flight Engineer with 1747.5 total C-130H hours (Tab G-51). The MFE was qualified on the C-130H 3.5 -15A aircraft on 22 August 2018 (Tab G-66). The MFE has 449.2 total combat hours (Tab G-51). The MFE was initially qualified on 07 June 2012 (Tab G-60). The MFE's last flight evaluation was on 25 September 2018 (Tab G-55). The MFE was a MAFFS qualified FE as of 2 July 2015 (Tab G-68). The MFE has flown 20.3 hours at night over the last 90 days (Tab G-47). The MFE was a C-130 Senior Aircrew member assigned to the 187 AS (Tab G-50).

The MFE's flight time during the 90 days before the mishap was as follows:

Last	Hours	Sorties
30 days	57.8	36
60 days	57.8	36
90 days	60.1	40

(Tab G-47)

f. Mishap Loadmaster 1 (MLM1)

The MLM1 was a current and qualified Evaluator Load Master with 2754.2 total C-130H hours (Tab G-131). The MLM1 was MAFFS qualified as of 2 May 2006 (Tab G-162). The MLM1 completed instructor upgrade on 16 September 2014 (Tab G-139). The MLM1 was initially qualified on 21 February 2003 and the last flight evaluation was on 29 August 2018 (Tab G-134). During the past 90 days, the MLM1 has flown 20.3 hours at night (Tab G-128). The MLM1 was a C-130 Chief Aircrew member assigned to the 187 AS. (Tab G-130).

The MLM1's flight time during the 90 days before the mishap was as follows:

Last	Hours	Sorties
30 days	57.8	36
60 days	57.8	36
90 days	58.1	37

(Tab G-128)

g. Mishap Loadmaster 2 (MLM2)

The MLM2 was a current and qualified basic Load Master with 161.9 total C-130H hours (Tab G-174). The MLM2 was initially qualified on 11 September 2019 from the 154th Training Squadron, and this was his last evaluation (Tab G-178). The MLM2 has flown 24.6 hours at night over the last 90 days (Tab G-171). The MLM2 was a C-130 Basic Aircrew member assigned to the 187 AS (Tab G-173).

The MLM2's flight time during the 90 days before the mishap was as follows:

Last	Hours	Sorties
30 days	57.8	36
60 days	61.1	37
90 days	67.8	42

(Tab G-171)

9. MEDICAL

a. Qualifications

According to the Aeromedical Services Information Management System (ASIMS), at the time of the mishap, all members of the MC had current annual physical flight examinations, and were

medically qualified for worldwide flight duty without restrictions (Tab T-2). The MCP2 and MFE had current and valid medical waivers (Tab T-2).

b. Health

The medical records of each member of the MC were reviewed in the Armed Forces Health Longitudinal Technology Application (AHLTA). Additionally, the Theater Medical Data System (TMDS) was accessed for review of the MP to assess the findings within the toxicology report (Tab T-2). No acute illnesses or medications which could have affected the MC were found in the medical records (Tab T-2).

c. Toxicology

The results of the toxicology blood and urine samples drawn on 9 June 2020 at Camp Taji, Iraq, were negative for all MC members, with the exception of the MP who tested positive for midazolam (Versed). This medication was appropriately indicated and appropriately dosed by the trauma team at Camp Taji (Tab T-2).

d. Lifestyle

The 72-hour/7-day histories of the MC were reviewed. The MCP2, MFE, MLM1, MLM2 submitted these on 10 June 2020 (Tab T-2). The 72-hour/7day histories of the MP and the MCP1 were submitted on 20 August 2020 (Tab T-2). The MN submitted his history on 21 August 2020 (Tab T-2). Each crewmember recorded low stress levels and minimal activities in the days prior to the mishap. Each crewmember recorded no alcohol use in the 24 hours prior to the accident (Tab T-2). Each crewmember recorded only minimal to no caffeine intake (Tab T-2). Only the MP admitted to the use of zolpidem (Ambien) on the night prior to the Mishap (Tab T-2). This was taken appropriately and the MP had greater than the 6-hour DNIF (duties-not-to-include-flying) period required for safe flight (Tab T-2). The remaining crew admitted to no medications or supplements prior to flight (Tab T-2). Both the MP and MN recorded stressors in the past three months (Tab T-2). The MP denied that there were any stressors affecting him on the day of the mishap (Tab T-2). The MN denied that there were any stressors affecting him on the day of the mishap (Tab T-2).

e. Crew Rest and Crew Duty Time

The 72-hour/7-day histories of the MC were reviewed (Tab T-2). Each crewmember recorded sufficient amounts of rest and met crew rest guidelines per Air Force Instruction (AFI) 11-202 volume 3, *General Flight Rules* (Tab T-2).

10. OPERATIONS AND SUPERVISION

a. Operations

At the time of the mishap, the mishap unit, the 779 EAS, consisted of ANG personnel and assets from the 130 AW, 153 AW, and 165 AW, provided by the AMD at Air Forces Central (AFCENT) (Tabs V-8.1, V-9.1, V-10.1, V-11.1, V-12.1, and J-3). Members of the MC and unit leadership

were confused as to the command relationships between AMC and AFCENT; specifically, deployed AMC units/personnel remained under AFCENT administrative control, while deployed AMC aircraft were under AFCENT tactical control, but AMC retained operational control of those assets (Tab V-2.3, V-3.5., V-4.1, and V-8.1). Some witnesses from the deployed mishap unit noted that scheduling difficulties in the deployed environment were also noteworthy, because, during the deployment cycle for the mishap crew, their deployed unit, and two other sister units were consolidated (Tab V-8.2). The consolidation of these three units to one location created a "mixed fleet" of aircraft consisting of eight C-130 H3s with standard -15 engines, and four C-130 H3's with -15A engines (Tab V-8.2). Personnel operating the -15A engines require additional training, as those engines maintain slightly higher torque which must be accounted for on approach and landings (Tabs O-519 to O-533, V-1.2, V-3.3 to V-3.4, and V-8.2). The MC was trained on -15A engines prior to this incident (Tab G-100).

In the days before the mishap, the MC flew a mission on 6 June 2020 (Tab G-85). The MCP1, who was not part of the hard crew, last flew on 1 June 2020 (Tab G-24). These missions were not complex and there was sufficient time for crew rest and recovery (Tabs G-24, G-85, and R-56).

b. Supervision

Unit leadership attested to a well understood safety culture in the 153d Operations Group (153 OG) and the 779 EAS (Tab V-8.2). Crews are trained to use their best judgment when faced with safety related issues on aircraft, and are vigorously supported by leadership if a crew feels unsafe to fly (Tab V-8.2). With regard to flight safety, aircrew use the "whole crew" concept, crew resource management (CRM), and Operational Risk Management (ORM) to mitigate any risks (Tab V-5.2 and V-7.2). Supervision was fully aware of the mission plans and appear to have had no concerns with the MC flying the MA to Camp Taji, and the mission was considered routine (Tab V-8.2 and V-11.2). The MCP1 in this incident was a tactics officer who was flying with a fixed or "hard crew" in order to maintain currency (Tab V-1.2 and V-2.3). All 779 EAS supervision who were interviewed believed the MA was in good flying condition with a well-qualified crew to conduct that mission assigned that evening (Tab V-8.2 and V-11.2).

11. HUMAN FACTORS ANALYSIS

a. Introduction

The DoD Human Factors Analysis and Classification System (HFACS) lists potential human factors that can play a role in mishaps and is designed for an investigation board to accurately record all aspects of human performance associated with individuals and the mishap or event (Tab BB-74). The discussion below lists the human factors directly involved in this mishap.

b. Performed Inadequate Risk Assessment – Formal

Performed Inadequate Risk Assessment – Formal: is a factor when supervision does not adequately evaluate the risks associated with a task or when pre-mission risk assessment tools/programs are inadequate (Tab BB-89).

c. Lack of Supervisory Responses to Critical Information

Lack of Supervisory Responses to Critical Information is a factor when information critical to a potential safety issue was provided but supervisory/management personnel failed to act upon it (failure to close the loop) (Tab BB-90).

d. Failed to Identify/Correct Risky or Unsafe Practices

Failed to Identify/Correct Risky or Unsafe Practices is a factor when a supervisor fails to identify or correct risky behaviors or unsafe tendencies and/or fails to institute remedial actions. This includes hazardous practices, conditions or guidance (Tab BB-90).

e. Selected Individual with Lack of Proficiency

Selected Individual with Lack of Proficiency is a factor when a supervisor selects an individual that is not proficient in a task, mission or event (Tab BB-90).

f. Overconfidence

Overconfidence: is a factor when the individual overvalues or overestimates personal capability, the capability of others or the capability of aircraft/vehicles or equipment (Tab BB-84).

g. Failure of Crew/Team Leadership

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-87).

h. Lack of Assertiveness

Lack of Assertiveness: is a factor when an individual failed to state critical information or solutions with appropriate persistence and/or confidence (Tab BB-87).

i. Failed to Effectively Communicate

Failed to effectively communicate is a factor when communication is not understood or is misinterpreted as the result of behavior of either sender or receiver, including a failure to provide backing, supportive feedback or acknowledgement to ensure that personnel correctly understood announcements or directives (Tab BB-87).

j. Fixation

Fixation is a factor when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others (Tab BB-86).

k. Procedure Not Followed Correctly

Procedure not followed correctly is a factor when a procedure is performed incorrectly or accomplished in the wrong sequence (Tab BB-78).

l. Over-Controlled/Under-Controlled Aircraft/Vehicle System

Over-controlled/under-controlled aircraft/vehicle/system is a factor when an individual responds inappropriately to conditions by either over- or under-controlling the aircraft/vehicle/system. The error may be a result of preconditions or a temporary failure of coordination (Tab BB-78).

m. Breakdown of Visual Scan

Breakdown in visual scan is a factor when the individual fails to effectively execute visual scan patterns (Tab BB-78).

n. Inadequate Real-Time Risk Assessment

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-79).

o. Ignored a Caution/Warning

Ignored a caution/warning is a factor when a caution or warning is perceived and understood by the individual but is ignored by the individual (Tab BB-79).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publicly Available Directives and Publications Relevant to the Mishap

(1) AFI 51-307, *Aerospace and Ground Accident Investigations*, 18 March 2019
(2) AFI 13-217, *Drop Zone and Landing Zone Operations*, 10 May 2007
(3) AFMAN 11-2C-130HV3, *C-130H Operations Procedures*, 12 December 2019
(4) AFMAN 11-2C-130HV3ADDA, *C-130 Operations Configurations/Mission Planning*, 8 August 2018, Corrective Actions Applied on 13 September 2018
(5) AFMAN 11-202V1, *Flying Operations*, 27 September 2019
(6) AFI 11-202V3, *General Flight Rules*, 10 August 2016
(7) AFI 11-202V3_AMCSUP, General Flight Rules, 14 February 2019

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.

b. Other Directives and Publications Relevant to the Mishap

(1) MAF Syllabus – T56-A-15A (Series 3.5), 14 June 2019
(2) AFTTP_3-3.C-130H, *Air Force Tactics, Techniques, and Procedures 3-3.C-130H*, 27 July 2018

(3) AMC Project 19-001-15, *C-130H with T-56-A-15A 3.5-Series Engines, NP2000 Propellers, and Electronic Propeller Control System Force Development Evaluation Final Report*, December 2019
(4) TO 1C-130H-1-1, *Flight Manual USAF Series C-130 Airplanes Equipped with T56-A-15 Engines*, 1 June 2014
(5) PTO 1C-130H-1-1, *Flight Manual USAF Series C-130 Airplanes Equipped with T56-A-15 Engines/T56-A-15A*, 1 June 2014
(6) TO 1C-130(K)H-1, *Flight Manual USAF Series C-130H Aircraft AF92-0547 through AF92-3281 and Up*, 15 January 2008 (Incorporating change 24, 5 May 2020)
(7) FCIF 20-05-07, *Release of AFMAN 11-202V3, Flight Operations*, 29 May 2020
(8) TO 4BA4-129-3, *Technical Manual Overhaul Instructions with Illustrated Parts Breakdown, Antiskid Control Valve (ACV)*, 14 April 2011 (Incorporating change 2, 24 March 2016)
(9) TO 4BA11-12-3, *Technical Manual Overhaul Instructions with Illustrated Parts Breakdown, Wheel Speed Transducer (WST) C-130H Aircraft*, 16 March 2020
(10) TO 8D15-11-3, *Technical Manual Overhaul Instructions with Illustrated Parts Breakdown, Fault Display Unit (FDU), Flat Mounting Plate Assembly, Shelf Mounting Plate Assembly, Adapter Cable Assembly C-130H Aircraft*, 1 May 2019
(11) TO 00-20-1, *Technical Manual, Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures*
(12) TO 1C-130A-6WC-10, *Technical Manual Work Cards Preflight/Thruflight/ Combined Pre/Postflight Inspection USAF Series ALL C-130 Aircraft Except C-130J Aircraft*, 1 March 2019 (Incorporating change 1, 15 August 2019)
(13) DOD HFACS 7.0, *Human Factors Analysis and Classification System Version 7.0*
(14) AC 150-5340-1M, *Standards for Airport Markings,* 10 May 2019
(15) TO 1C-130A-6WC-14, *Technical Manual Work Cards Home Station Check/Minor and Major Isochronal Inspection USAF Series All C-130 Aircraft Except C-130J Aircraft,* 15 October 2019
(16) TO 00-5-15, *Air Force Time Compliance Technical Order Process*, 22 Sep 2014
(17) *FCIC 20-05-07 Release of AFMAN 11-202V3, Flight Operations,* 29 May 2020

c. Known or Suspected Deviations from Directives or Publications

(1) TO 1C-130(K)H-1, *Flight Manual USAF Series C-130H Aircraft AF92-0547 through AF92-3281 and Up*, 15 January 2008 (Incorporating change 24, 5 May 2020) pages 1M-2, 1M-43, 3A-13, 2-79, 2-84, 2-87 – 2-88, 2-90, 5-10
(2) AFI 11-202v3 AMCSUP, *General Flight Rules*, 14 February 2019, paras. 18.8.1., and 18.8.4.1. – 18.8.4.11.

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ADAM B. THOMAS, Colonel, ANG
President, Accident Investigation Board

STATEMENT OF OPINION
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

C-130H3, T/N 94-6706
Al TAJI ARMY AIRFIELD
8 June 2020

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

1. OPINION SUMMARY

On 8 June 2020, the mishap aircraft (MA), a C-130H, with tail number (T/N) 94-6706, departed Ali Al Salem Air Base, Kuwait at approximately 2053 hours local time (L) on the first scheduled leg of a contingency airlift mission into Al Taji (Camp Taji), Iraq. The mishap crew (MC) was from the 153d Airlift Wing (153 AW), Wyoming Air National Guard (ANG), and consisted of the mishap pilot (MP), the mishap copilot (MCP1), the mishap copilot (MCP2), the mishap navigator (MN), the mishap flight engineer (MFE), and two mishap loadmasters (MLM1 and MLM2). The MA was from the 165th Airlift Wing (165 AW), Georgia Air National Guard. The MC and MA were deployed and assigned to the 779th Expeditionary Airlift Squadron (779 EAS), 386th Air Expeditionary Wing (386 AEW), at Ali Al Salem Air Base, Kuwait. Additionally, onboard the MA at the time of the mishap sortie (MS) were 19 United States Army personnel traveling as passengers with their baggage.

At approximately 2053L the MA departed Ali Al Salem, Kuwait, with nothing out of the ordinary noted during taxi, takeoff, climb, or the initial level off. After cruising for approximately 59 minutes, the MA began its descent into Camp Taji, Iraq. During descent, the MC leveled off at 3,700 feet mean sea level (MSL) and reduced throttles to flight idle. The MCP1 slowed and configured the MA for a night vision device (NVD) approach and landing with flaps set to 100 percent. The MA's highest recorded airspeed during this approach was 157 Knots Indicated Air Speed (KIAS), although the maximum recommended airspeed with the wing flaps set to 100 percent is 145 KIAS. At approximately two nautical miles (NM) from the airfield, the MA was 1,000 feet above the recommended glideslope for runway 34 and at 150 KIAS, and remained above glideslope until landing. The reported tailwind for runway 34 at Camp Taji was 10 knots, with a temperature of 34 degrees Celsius. The global positioning system (GPS) recorded data indicated the MA crossed the runway 34 threshold at a ground speed of 161 knots (151 KIAS); the recommended calculated landing velocity for the MA at its weight (122,000 pounds) was 105 KIAS.

The MC attempted to land the MA at higher than optimal speed with a nose-down attitude. The MA's excessive air speed continued to generate lift on the MA and caused it to "porpoise" or oscillate upon touchdown (similar to the movement of a porpoise through water, alternating up

and down), which prevented the MA's braking system from engaging due to a lack of proper weight on the wheels. Thirteen seconds after touchdown--eight seconds of which were spent "porpoising"-- the MA began to slow as expected, once the engines were placed in reverse and when the wheels then received adequate weight to engage the anti-skid brakes. However, by that point there was insufficient runway remaining (less than 1,000 feet) and the MA departed the prepared surface, whereupon it came to a stop only when it struck a 12-foot-high concrete barrier approximately 600 feet past the end of the runway, at approximately 2205L. All 26 individuals onboard the aircraft survived the mishap and egressed, with only relatively minor injuries to two individuals. The aircraft was damaged beyond repair and was valued at $35,900,000.

I find, by a preponderance of the evidence, that the cause of the mishap was the MA's excess airspeed of 38 knots above calculated landing velocity, combined with its excess descent angle. This excess airspeed caused the MA to maintain lift (flight) and did not provide sufficient weight on wheels (WOW) to allow for braking action to occur until the aircraft slowed enough to settle onto the runway.

Additionally, I find, by a preponderance of the evidence, that the MC's failure to adequately assess risk, failure to follow proper procedures, and poor communication were all substantially contributing factors to this mishap. The MC failed to recognize, and appropriately respond to or correct the MA's excess airspeed on the approach, or to take control of the aircraft and call for/conduct a go-around once the approach and landing was deemed untenable.

2. CAUSE

The primary cause of the mishap was the MCP1's improper excess airspeed of 38 KIAS above calculated landing velocity (i.e., based on Take Off and Landing Distance (TOLD) Card speed of 108 KIAS) upon touchdown, which resulted in the aircraft floating and "porpoising" while the crew continued to attempt to apply brakes. The aircraft, with the nose gear on the runway and the main landing gear touching intermittently, was still generating enough lift, such that the landing gear did not have sufficient weight on wheels (WOW) to allow the anti-skid braking system to activate until, eventually, the aircraft slowed enough to settle on the runway and provide the requisite WOW for brakes to be effective.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

I find, by a preponderance of evidence, that several additional factors substantially contributed to the mishap. Broadly stated, I categorize these factors under the overarching themes of inadequate risk assessment, failure to follow established procedures, and poor communication.

a. Risk was not adequately assessed in the events leading up to the mishap. Initially, the MC was selected and approved based on inaccurate information. Specifically, the 779 EAS Mission Set-Up & Risk Analysis Sheet, commonly referred to an operational risk management (ORM) sheet, was inadequate to properly evaluate the risks of this particular mission; under the section marked "flight crew experience (hours in current flight qualification), the MP marked "greater than 1,000 [hours]" on the form, which correlated to a risk of zero on the scoring sheet. However, even though the MP had greater than 1,000 hours in a C-130, the ORM sheet should have been

annotated to accurately capture the fact that for this mission he was not flying as the Pilot, but rather was in the role of Instructor Pilot (IP) – which was written in on the mission orders. This distinction matters chiefly because, as an IP, the MP has less than 50 hours of time instructing, meaning that on the ORM sheet, the phrase "hours in current flight qualification" should have been interpreted as hours in the role for the mission given. As such, the proper risk number associated would be 4 giving a grand total of 16 points--and this greater risk value would have required the Director of Operations or Assistant Director of Operations (DO or ADO) to approve the composition of this crew.

Furthermore, this inadequate assessment of risk allowed an individual--the MP--who lacked the necessary proficiency as an IP to be selected to fill that role for this aircrew. This substantially contributed to the mishap, in that the MP was faced with extraordinary challenges such as providing instruction in an environment where the airfield had poor or inadequate lighting, diverting attention to perceived threats, and a copilot with limited recency/proficiency in the aircraft on night vision goggles (NVGs) --i.e., 0.5 hours in the past 90 days. While recognition of this greater risk alone might not have prevented the mishap, per se, it was nonetheless a substantial contributor.

Related to the inadequate assessment of risk was the sense of overconfidence evident in the MC members. In particular, it seems the MC were overly confident in the perceived knowledge, skills, and abilities of the MCP1. Stated differently, due to MCP1's previous experience as a check-pilot with a civilian airline, the MP and other members of the MC likely treated the MCP1 with greater deference than his military experience or rank called for. As such, it is more likely than not that the MC members believed that any deviations to the MA's approach glidepath or airspeed would eventually be corrected by the MCP1. For example, even after the MP stated "start picking the nose up," and the MCP1 responded "I got it," the MCP1 briefly flared, but then resumed a nose-down attitude in order to reacquire the glideslope, without any further corrections or statements by the MP. If the MC had regarded the MCP1 with less deference, it is more likely than not that they, and the MP in particular, would have intervened earlier.

Even more than this overconfidence in the MCP1, the MC had a collective overestimation in the capabilities of themselves and the MA, and this substantially contributed to the mishap. Specifically, the MC members appeared to have had a false sense of a safe landing; at 1.6 NM from the approach end of the runway, the aircraft was 1,000 feet above desired glideslope. The MP recognized this deviation and announced it to the crew, but, based on their behavior and communications, the MC overconfidently believed that the approach could still be salvaged prior to touchdown, since they did not call for a "go-around."

Lastly, this overconfidence was closely tied to, and exacerbated by, the MC's inadequate real-time assessment of risk in the moments leading up to the mishap. After the MA was on the ground, the MC failed to call for a "go-around" due to their overconfidence and their faulty assessment of risk. As proof of the faulty risk assessment, when interviewed by this Board, the MCP1 stated that a "go-around" was not attempted after touchdown due to the danger of obstacles. However, this was not actually a risk, as evidenced by the MC's prior "go-around" briefing, where they briefed to make right closed traffic (that is, to follow a right hand racetrack/pattern around the airfield and circle back to the runway) to avoid the only obstruction – the aerostat off the left side of the runway.

Stated differently, if the MC had correctly assessed the risks involved in executing a "go-around," they might have aborted the landing and the mishap could have been avoided. Thus, it is clear that the MC's failure to adequately assess risk in real-time substantially contributed to the mishap.

b. Established procedures were not consistently followed. As a general observation, several critical procedures were not adhered to, and this significantly contributed to the mishap. To consolidate overlapping factors and avoid unnecessary repetition of facts, I am using the term "established procedures" to also capture the MC's demonstrated fixation, breakdown of visual scans, ignoring caution/warnings, over-/under-controlling the mishap aircraft, as well as a lack of supervisory response to critical information. Each of these overlapping factors substantially contributed to the mishap.

As an example, stabilized approach criteria call-outs were not adhered to or followed at 300 and 150 feet above ground level (AGL), per Air Mobility Command (AMC) guidance. Further, upon the MCP1's failure to correct the MA being high and fast on approach, the MP should have taken control of the MA by 150 feet AGL. Alternately, at a minimum, at 150 feet AGL a "go-around" should have been called because the aircraft exceeded expected parameters for the approach.

Additionally, the MC's failure to place the aircraft on the approach at a desired altitude and airspeed, and then over-controlling the MA to pitch attitudes (forcing the MA to accelerate), was clearly a failure to follow proper procedures. Likewise, the MC failed to follow proper procedures when they under-controlled the MA's airspeed by allowing a deviation of 38 knots from the desired touchdown speed of 108 knots.

Despite the series of deviations from the planned turn point, planned glideslope, descent, and airspeed, as well as the many indicators (visual, instrumental, and aural) that the landing had become untenable, the MC remained fixated on landing the MA "in the box." Based on the transcription of the cockpit voice recorder (CVR), it is clear that both the MP and the MCP1 ignored (or were desensitized to), and failed to verbally address the "PULL UP" warning light on the instrument panel and the aural "SINKRATE" alert. Aural alerts and warnings produced by the Ground Collision Avoidance System (GCAS) are based on a set of parameters being met at multiple altitudes. The trigger points in which an alert or warning is produced based on these parameters is less restrictive in the "Tactical Mode" used at the time of the mishap. Where an aural alert was being produced on the approach to notify the MC of the increased descent rate, a warning would have been produced if the GCAS was in the "Normal Mode." No immediate action is required when presented with an alert. Immediate action is required when presented with a warning. If presented with an aural warning from the GCAS, the MC would have had to perform an immediate "go-around" (Escape Maneuver). In other words, the MC should have been even more mindful of aural alerts from the GCAS, because the system had been configured to accept greater risk. However, as is shown by their inattentiveness and failure to follow proper procedures, they were fixated on landing the aircraft.

This fixation--at the expense of following proper procedures--further led the MCP1 and the MP to neglect to prioritize an instrument cross check with a visual scan of the landing zone. This is evidenced by the lack of vocalized communication regarding the MA's excessive speed on touchdown. In turn, this substantially contributed to the mishap in that it led to gross deviations

of approach speeds and the MC exceeding aircraft limitations on flap speeds. Further still, the MC then failed to follow proper procedures when the MA landed past the previously briefed "go around" point of the runway's "captain's bars" and they did not call for a "go-around" as they should have.

Lastly, when the MA touched down, the MP and the MCP1 applied the brakes and became fixated on the lack of deceleration (which, based on their testimony, they attributed to failure of the normal braking system). The majority of the MC members reported an unusual sensation described as "bubbling," "hilliness," or "oscillation," that none of them had experienced before. By not recognizing the floating or "porpoising" sensation as continued flight, and thus, not maintaining adequate main landing gear ground contact with sufficient WOW required for braking action to be enabled, the crew failed to appropriately respond to the floating/flying condition by executing a "go-around." It appears this was due in part to the MC's inaccurate expectation that, despite multiple deviations from the planned turning point, glideslope, airspeed, touchdown, and failure to stop via normal braking action, that they would land and stop as expected. This fixation led to improper (in)action by the MC to correct the situation before the MA departed the prepared surface of the runway, and substantially contributed to the mishap.

c. Leading up to the mishap, communication among the MC members was imperfect at best and poor at worst. Failure to communicate effectively was demonstrated in several key instances, which ultimately was a substantial contributor to the mishap. For example, the MCP1 used ambiguous language to communicate when he stated "coming up on airspeed, here." The MP likewise was not precise when he twice told the MCP1 to "watch your airspeed." Another instance of noteworthy ineffective communication occurred when the MC did not ensure the MCP1 understood the comment that the MA was 1,000 feet off desired glideslope while on short final--which also appears not to have been acknowledged by the MCP1 – and the MC members further failed to communicate the need for the MCP1 to correct this deviation. Additionally, at least one MC member testified that he knew the plane was 20 knots fast prior to touchdown; however, transcription from the CVR shows he did not communicate this overspeed to the other MC members. Lastly, as a further example of the MC's failure to effectively communicate, multiple MC members testified they perceived a primary brake failure; yet, despite these apparent observations, no MC member vocalized any issues or concerns with the normal or emergency braking systems during the MA's touchdown or attempts to stop.

However, these examples of the MC's breakdown in communication, while substantially contributing to the mishap, were preceded by even more noteworthy instances. Specifically, during the descent, the MC failed to identify that the MCP1 had turned prior to PUTSI and were not descending at the planned rate (i.e., they had gotten behind the descent profile). Upon arriving on final, the aircraft was 1,000 feet above the desired altitude, and this deviation gave the crew less time to correct the issues of excessive speed and altitude. While the observation that the MA was 1,000 feet high was communicated to the MCP1, additional communication, follow-up, or instruction was not provided as it should have been. For example, prior to reaching the runway at Camp Taji, the MA exceeded the 100 percent flap extension speed of 145 KIAS by flying from 150-156 KIAS, and the MCP1 varied the MA's nose-down attitude anywhere from minus five to minus 11 degrees, with a large negative VVI (vertical velocity indication). In other words, poor communication substantially contributed to the mishap, as is clearly shown by the MC members

not assertively communicating or taking some other action to correct risky/unsafe practices, such as instructing the MCP1 to get safely onto the desired airspeed and glideslope (or the MP taking the controls sooner).

Perhaps the most glaring example of the MC's failure to communicate--as well as a lack of assertiveness and team leadership--is seen during the landing itself. Here, when the most critical phase of the flight was reached, there was a remarkable lack of communication regarding reactions or responses to landing past the intended touchdown point and in excess of recommended airspeed. In other words, the MC should have verbally identified the landing condition as above glideslope, landing long, and well above recommended airspeed by 38 KIAS. Continuing with that lack of communication, the MC failed to call a "go- around" or conduct the emergency procedure to apply emergency brakes--and the MP and the MCP1 failed to direct any crewmember actions for 13 seconds from initial landing to moving the throttles to REVERSE. This lack of effective communication clearly was a significant contributor to the mishap.

4. CONCLUSION

After a comprehensive investigation into this mishap, I find, by a preponderance of the evidence, the cause of the mishap was the MA's excess indicated airspeed on approach, which developed into the subsequent floating and "porpoising" of the aircraft after touchdown, further resulting in continued lift and insufficient WOW to apply braking action.

Additionally, I find, by a preponderance of the evidence, that the MC's failure to adequately assess risk, failure to follow proper procedures, and poor communication were all substantially contributing factors to this mishap. The MC failed to recognize, and appropriately respond to or correct the MA's excess airspeed on the approach, or to take control of the aircraft and call for/conduct a "go-around" once the approach and landing was deemed untenable.

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