UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

C-17A, T/N 10-000215

16TH AIRLIFT SQUADRON
437TH AIRLIFT WING
JOINT BASE CHARLESTON, SOUTH CAROLINA

LOCATION: JOINT BASE ELMENDORF-RICHARDSON, ALASKA

DATE OF ACCIDENT: 21 AUGUST 2023

BOARD PRESIDENT: BRIGADIER GENERAL DEREK M. SALMI

Conducted in Accordance with Air Force Instruction 51-307

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR MOBILITY COMMAND

FEB 27 2024

ACTION OF THE CONVENING AUTHORITY

The report of the Accident Investigation Board, conducted under the provisions of AFI 51-307, *Aerospace and Ground Accident Investigations*, current as of 6 April 2023, that investigated the 21 August 2023 mishap near Joint Base Elmendorf-Richardson, involving a C-17A, T/N 10-000215, assigned to the 16th Airlift Squadron, 437th Airlift Wing, Joint Base Charleston, South Carolina, substantially complies with the applicable regulatory and statutory guidance and on that basis is approved.

RANDALL REED
Lieutenant General, USAF
Deputy Commander (Convening Authority)

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGAITON

C-17A, T/N 10-000215
JOINT BASE ELMENDORF-RICHARDSON, ALASKA
21 AUGUST 2023

On 22 August 2023, at 0806 local time (L), the Mishap Member (MM), a General Schedule (GS) civilian assigned to the Missile Defense Agency (MDA), Redstone Arsenal, Alabama, suffered cardiac arrest and passed away while under treatment for decompression sickness (DCS)-related symptoms at the Joint Base Elmendorf-Richardson (JBER), Alaska, Emergency Room (ER).

On the previous day, 21 August 2023, the MM participated in a high-altitude simulated airdrop mission on the Mishap Aircraft (MA), a C-17 (Tail Number (T/N) 10-000215) from the 437th Airlift Wing, Joint Base Charleston, South Carolina. The MA departed JBER at 1008L on a planned seven-hour mission to test ranges off the Alaskan coast. Following uneventful takeoff, departure, and cruise portions of the flight, at approximately 1400L and with the MA fully depressurized to 24,900 feet mean sea level (MSL) and all personnel on oxygen, the Mishap Crew (MC) opened the cargo doors and executed the test pass of the medium range ballistic missile payload. Upon test completion and shortly following cargo door closure, the MM signaled distress to nearby mission essential personnel (MEP). The MM, who was sweating profusely, complaining of shortness of breath and pain in his right arm, was attended to by High Altitude Airdrop Mission Support (HAAMS) physiological technicians. Following the MA's arrival at 1700L, JBER Emergency Medical Services (EMS) transported the MM via ambulance to the JBER ER at 1749L.

Upon hospital arrival the attending physicians immediately began treating the MM for DCS and coordinating follow on treatment in a hyperbaric chamber. At 0806L the following day, 22 August 2023, as the MM was being transported to higher care at a local hospital, he entered cardiac arrest. ER personnel were unable to resuscitate the MM and he was pronounced deceased at 0832L on 22 August 2023.

The Medical Examiner (ME) determined the cause of death as decompression sickness with contributing factors of obesity, hypertension, and atherosclerotic cardiovascular disease, with an unknown role for SARS-CoV-2 infection. The manner of death was declared as accidental.

The Accident Investigation Board (AIB) President found, by the preponderance of the evidence, that this mishap was the result of decompression sickness induced by the high altitude, unpressurized portion of the military test mission. The AIB President found, by the preponderance of the evidence, the following factor substantially contributed to the mishap: the pre-existing and underlying medical conditions of the MM.

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.

SUMMARY OF FACTS AND STATEMENT OF OPINION

C-17A, T/N 10-000215
JOINT BASE ELMENDORF-RICHARDSON, ALASKA
21 AUGUST 2023

TABLE OF CONTENTS

*The following sections prescribed by AFI 51-307 are not applicable: Impact, Egress and Aircrew Flight Equipment, Search and Rescue, Recovery of Remains, and Crew Rest and Crew Duty Time.

ACRONYMS AND ABBREVIATIONS

AFEM	Aircrew Flight Equipment Member
AIB	Accident Investigation Board
AERO I	Aeronautical Intermediate
AF	Air Force
AFB	Air Force Base
AFFORGEN	Air Force Force Generation
AFMAN	Air Force Manual
AFME	Air Force Medical Examiner
AFTO	Air Force Technical Order
AFI	Air Force Instruction
ALE	Airborne Launch Equipment
AMC	Air Mobility Command
AOC	Air Operations Center
AS	Airlift Squadron
AvORM	Aviation Operational Risk Management
AW	Airlift Wing
BMI	Body Mass Index
BP	Board President
C	Celsius
C3	Command, Control, and Communications
Capt	Captain
Col	Colonel
COVID-19	Coronavirus Disease 2019
CPAP	Continuous Positive Airway Pressure
DAFMAN	Department of the Air Force Manual
DCS	Decompression Sickness
DoD	Department of Defense
DR1	Emergency Room Doctor 1
DR2	Emergency Room Doctor 2
EMS	Emergency Medical Services
EMT1	Emergency Medical Technician 1
EMT2	Emergency Medical Technician 2
ER	Emergency Room
FAA	Federal Aviation Administration
FSOC	Flight Surgeon On Call
GS	General Schedule
HAAMS	High-Altitude Airdrop Mission Support
HALO	High Altitude Low Opening
HF	High Frequency
ICU	Intensive Care Unit
IV	Intravenous
JB	Joint Base
JBER	Joint Base Elmendorf-Richardson
KCHS	Charleston AFB/International Airport
KXMR	Cape Canaveral Space Force Station Skid Strip
LA	Legal Advisor
LA1	Legal Advisor 1
Lt Col	Lieutenant Colonel
LMM	Loadmaster Member
LOX	Liquid Oxygen
MA	Mishap Aircraft
MC	Mishap Crew
MCP1	Mishap Copilot 1
MCP2	Mishap Copilot 2
MDA	Missile Defense Agency
MDG	Medical Group
ME	Medical Examiner
MEDM	Medical Member
MEDM1	Medical Member 1
MEP	Mission Essential Personnel
MEPP	MEP Pilot
MH1	Mishap HAAMS 1
MH2	Mishap HAAMS 2
MH3	Mishap HAAMS 3
MIL	Mishap Instructor Loadmaster
MIP	Mishap Instructor Pilot
MIS	Maintenance Information Systems
MLM	Mishap Loadmaster
MM	Mishap Member
MRBM	Medium Range Ballistic Missile
MS	Mishap Sortie

MSgt	Master Sergeant
MSL	Mean Sea Level
MXM	Maintenance Member
OG	Operations Group
OSA	Obstructive Sleep Apnea
PAED	Elmendorf AFB Airport
PM	Pilot Member
RCH465	Mishap Sortie Call Sign
REC	Recorder
RTC	Redstone Test Center
SAAM	Special Airlift Assigned Mission
SAFE	Safety Aircrew Flight Equipment
SATCOM	Satellite Communication
SBP	Safety Board President
SCR	Safety Center Representative
SIO	Safety Investigating Officer
SME	Subject Matter Expert
SMM	Safety Maintenance Member
SOLL	Special Operations Low Level
SOM	Safety Other Member
SO1	Safety Officer 1
SO2	Safety Officer 2
SOP	Standard Operating Procedures
SOS	Safety Other Support
SP1	Safety Physiologist 1
SP2	Safety Physiologist 2
SPM	Safety Pilot Member
SRM	Safety Recorder Member
STE	Safety Technical Expert
T/N	Tail Number
TOT	Time On Target
T.O.	Technical Order
TSgt	Technical Sergeant
UHF	Ultra High Frequency
VA	Veterans Affair
VHF	Very High Frequency

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 18 September 2023, Lieutenant General Randall Reed, Deputy Commander, Air Mobility Command (AMC), appointed then-Colonel Derek M. Salmi to conduct an aircraft accident investigation board (AIB) for the 21 August 2023 mishap involving a C-17 aircraft, tail number (T/N) 10-000215, which occurred in the vicinity of Joint Base Elmendorf-Richardson (JBER), Alaska (Tab A-3, Tab Y-3 to Y-4). Additional board members were a Colonel (Col) Medical Member (MEDM), Lieutenant Colonel (Lt Col) Legal Advisor (LA), Captain (Capt) Pilot Member (PM), Master Sergeant (MSgt) Loadmaster Member (LMM), MSgt Aircrew Flight Equipment (AFE) Member (AFEM), Technical Sergeant (TSgt) Maintenance Member (MXM), and TSgt Recorder (REC) (Tab Y-3, Y-5). A Lt Col High Altitude Airdrop Pilot Subject Matter Expert (SME), a MSgt High Altitude Airdrop Mission Support (HAAMS) Physiology SME, and a Civilian HGU 56/P Helmet SME were also appointed to advise the AIB (Tab Y-7, Y-9, Y-11). On 8 November 2023, LA1 was relieved and LA2 was appointed (Tab Y-15). On 14 2023, MEDM1 was relieved and MEDM2 appointed (Tab Y-13).

b. Purpose

In accordance with Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations*, dated 18 May 2019 (administrative change 6 April 2023), this AIB 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 21 August 2023, during a high-altitude test mission off the coast of Alaska, the Mishap Member (MM), a General Schedule (GS) 13 civilian assigned to the Missile Defense Agency (MDA), experienced decompression sickness (DCS) symptoms shortly after the unpressurized simulated airdrop portion of the mission (Tab K-3, Tab K-26, Tabs V-18.1 to V-18.2, Tab V-9.3). HAAMS physiological technicians aboard the C-17 aircraft (T/N 10-000215) rendered initial assistance for hyperventilation (Tab V-9.3, Tab V-17.1, Tab V-4.3, Tab Y-3). Mission essential personnel (MEP) attempted to assist the MM for the return portion of the flight (Tab V-12.10, Tab V-9.3 to V-9.8). The aircraft was met by emergency medical services (EMS) upon landing at Joint Base Elmendorf-Richardson (JBER), Alaska where the MM was taken to the JBER Emergency Room (ER) for additional treatment for DCS-related symptoms (Tab V-16.1, Tab V-3.3 to V-3.4). The MM subsequently entered cardiac arrest upon preparatory transfer to higher-level care and was pronounced deceased on 22 August 2023 (Tab X-29).

3. BACKGROUND

a. Air Mobility Command (AMC)

Air Mobility Command is a Major Command headquartered at Scott Air Force Base (AFB), Illinois (Tab CC-18). AMC provides unrivaled airlift, air refueling, aeromedical evacuation, global air mobility support and Global Mobility Mission Command to project, connect, maneuver and sustain the Joint Force to achieve national objectives (Tab CC-18). The command is composed of more than 110,000 Active Duty, Air Force Reserve, Air National Guard, and civilian employees, and 13 different airframes (Tab CC-18).

b. 437th Airlift Wing (437 AW)

The 437th Airlift Wing is headquartered at Joint Base (JB) Charleston in Charleston, South Carolina (Tab CC-10). Its mission is to provide safe, precise, reliable airlift worldwide, anytime and anywhere (Tab CC-7). The Wing commands airlift and supporting units to maintain 41 assigned C-17A aircraft executing a wide range of missions to include passenger movement, out-sized equipment delivery, bulk cargo transport and aeromedical evacuation (Tab CC-8). The Wing delivers passengers, equipment and supplies whenever and wherever required via airland or airdrop missions (Tab CC-8). The 437 AW trains and executes the only C-17A special operations mission capability in the Air Force (Tab CC-8).

c. 437th Operations Group (437 OG)

The 437th Operations Group is responsible for operating a fleet of 41 C-17 aircraft valued at $9.2 billion dollars through four flying squadrons and one flight comprised of 1,300 military and civilian personnel supporting Department of Defense tactical airdrop, worldwide airlift, and aeromedical evacuation support (Tab CC-10).

d. 16th Airlift Squadron (16 AS)

The 16th Airlift Squadron is one of four C-17 flying squadrons under the 437 AW (Tab CC-5). Unit members fly strategic, tactical, and Special Operations Low Level II (SOLL II) airlift missions in support of contingency and humanitarian operations worldwide (Tabs CC-5 and CC-10).

e. Joint Base Elmendorf-Richardson (JBER)

Joint Base Elmendorf-Richardson is a joint Air Force/Army installation located near Anchorage, Alaska (Tab V3.9, Tab CC-12). The combined force is comprised of three Air Force (AF) Total Force wings, one Army Brigade, and 55 other tenant units to include United States Alaskan Command, 11th Air Force, the Alaskan North American Aerospace Defense Command Region, and the 3rd Wing, as well as U.S. Army Alaska, the 4/25 Brigade Combat Team (Airborne), and various subordinate units (Tab CC-25). JBER is a key strategic location due to its unique mix of air and ground military capabilities that provide air sovereignty, combat training, force staging, and logistics support for the Pacific, Arctic, and worldwide contingencies (Tab CC-25). It is also home to several Alaska training facilities, to include the Joint Pacific Alaska Range Complex (Tab CC-25).

f. 673d Medical Group (673 MDG)

The 673d Medical Group, located at JBER, is a 65-bed, 8 operating room military treatment facility providing primary and subspecialty, outpatient, and inpatient care to 159,000 Department of Defense (DoD) and Veterans Affairs beneficiaries (Tab CC-14). This Joint Venture hospital is a primary referral center for Alaska (Tab CC-14). It supports global engagement through multiple Expeditionary Medical Support elements, Critical Care Air Transport Teams, and casualty reception with the mission capability to expand to 150 beds and a 100-bed En Route Patient Staging System (Tab CC-14).

g. Missile Defense Agency (MDA)

The Missile Defense Agency is a DoD research, development, and acquisition agency whose mission is to develop and deploy a layered Missile Defense System to defend the United States and its deployed forces and allies from missile attacks in all phases of flight (Tab CC-26).

h. C-17A Globemaster III

The C-17A Globemaster III is capable of the rapid strategic delivery of troops and cargo of all types to main operating bases or directly to forward bases in the deployment area (Tab CC-23). The aircraft can perform tactical airlift and airdrop missions as well as transport litters and ambulatory patients during aeromedical evacuations (Tab CC-23). The inherent flexibility and performance of the C-17 force improves the ability of the total airlift system to fulfill the worldwide air mobility requirements of the United States (Tab CC-23). It can fly up to 45,000 feet at cruising speed (Tab CC-24).

i. High-Altitude Airdrop

Airdrop missions conducted 3,000 feet above ground level and higher are considered part of the high-altitude drop mission set (Tab BB-94). These airdrops are normally used for threat avoidance, military deception, standoff delivery, or personnel insertions (Tab BB-94). Additionally, high-altitude airdrops can be used to gain the element of surprise by dropping specially trained jumpers several miles from their drop zone as well as in delivering critical supplies to remote areas (Tab BB-95). Due to its unique and specialized mission set, there are special requirements and training required to execute these missions (Tab BB-95). Some examples of these requirements include additional physiological training for aircrew members and the requirement for onboard physiological technicians to monitor mission personnel (Tab BB-95).

j. High Altitude Airdrop Mission Support (HAAMS) Capability Program

The High Altitude Airdrop Mission Support capability program ensures in-flight physiological support to aircrews, MEP, and parachuting operations performed in un-pressurized flights at or above FL180 Mean Sea Level (MSL) or as requested for additional missions (Tab BB-83). The physiological technicians on board are trained to advise the aircraft commander and crew on the use of oxygen equipment, depressurization schedules, and to identify and mitigate potential physiological issues that can occur in flight (Tab BB-100). During flight, HAAMS technicians monitor personnel onboard the aircraft and are responsible for addressing and reporting any physiological incidents (Tab BB-100).

k. Hyperventilation

Hyperventilation is an increase in ventilation beyond that normally driven by the body's blood carbon dioxide levels, the normal driver for rate and depth of breathing (Tab X-45). It may be caused by emotional, psychological, physical, physiological, or environmental stress as well as by improperly sized or fit equipment (Tab X-45). Its observable symptoms are decreased reaction time, impaired judgement, euphoria, pale appearance, muscle spasms, and drowsiness (Tab X-45). Since many of the symptoms of hyperventilation and hypoxia are the same, in-flight hyperventilation is difficult to distinguish from hypoxia using symptoms alone, although its onset is typically gradual and slower than hypoxia (Tab X-46). For these reasons, the procedure to treat hyperventilation is identical to that for hypoxia, which consists of: 1) ensuring all switches from the oxygen regulator panel are placed on to deliver 100% oxygen 2) the oxygen mask is on the member and correctly connected to the regulator 3) the member controls their rate and depth of breathing 4) the aircraft commander is notified of the situation and 5) the aircraft descends below 10,000 feet MSL (Tab X-47).

l. Decompression Sickness (DCS)

Decompression sickness, also known as "the bends," results when pressure is reduced on body fluids, to include blood, that are normally saturated with an inert gas such as nitrogen (Tab X-11). In aircraft, this occurs at higher altitudes when the air pressure is lower than that experienced on the ground (Tab X-11). When exposed to lower pressures, nitrogen may not be absorbed into the capillaries and can instead form nitrogen “bubbles" (Tab X-11). These bubbles can interact with the surrounding tissue, putting pressure on nerves, causing tissue damage, and/or blocking the flow of blood (Tab X-11 to X-12).

DCS can present with a diverse set of symptoms but is typically broken down into four categories:

- **Limb Pain** – Typically joint or muscle pain
- **Skin** – Mottling, pins and needles, tingling, prickling
- **Neurologic** – Cold sweats, dizziness, swelling, inappropriate or sudden onset of fatigue, headache, light headedness, loss of consciousness, motor and/or sensory loss, nausea, the “shakes”
- **Respiratory** (pulmonary) – Dyspnea (difficult or labored breathing), substernal distress (tightness and/or pain in chest, especially during inspiration (Tab X-12)

If DCS is suspected, the appropriate procedures are as follows: 1) place the patient on 100% oxygen 2) descend as soon as practical 3) declare an in-flight emergency and 4) land at the nearest airfield where qualified medical assistance (military flight surgeon or civil aeromedical physician) is available (Tab X-15). If symptoms are not resolved with the above conservative treatments and interventions, then the patient will need to undergo Hyperbaric Oxygen therapy (Tab X-15).

In the case of DCS that occurs at high altitudes, symptoms are typically resolved during descent while breathing 100% oxygen (Tab X-14). Continued breathing of 100% oxygen on the ground for two hours is usually an effective treatment for mild cases of DCS that do not resolve completely during descent (Tab X-14). The continued breathing of 100% oxygen partially removes nitrogen from blood and tissues, reducing the potential for bubble growth and also shrinking existing bubbles in tissues next to capillaries (Tab X-14).

There are several risk factors that can contribute to the development of DCS to include higher body mass index (BMI), lower physical fitness levels, and overall weight (Tab X-22 to X-23). Individuals with these characteristics generally have lower maximal oxygen absorption, lower level of vascularization (the ability to grow blood vessels into a tissue to improve oxygen and nutrient supply), and a slower pace of removing nitrogen from the body (Tab X-23).

Since World War II, the military has recognized the potentially dangerous effects of DCS (Tab X-27). Prevention of DCS is achieved mainly from pre-breathing 100% oxygen before entering high altitudes and limiting time and activity at high altitudes (Tab X-20 and Tab X-24). Despite pre-breathing, there is still a 30% risk of developing some level of DCS when flying at altitudes between 18,000 feet and 30,000 feet MSL (Tab X-4).

4. SEQUENCE OF EVENTS

a. Mission Background

The Mishap Aircraft (MA), assigned to the 16 AS, 437 AW, departed JB Charleston (KCHS) on 26 July 2023 for Cape Canaveral Space Force Skid Strip (KXMR) in support of MDA testing at both Cape Canaveral and JBER (Tab K-6, Tab K-16, Tab K-26). At Cape Canaveral, a Command, Control, and Communication (C3) pallet and Airborne Launch Equipment (ALE) pallet, employed in medium range ballistic missile (MRBM) testing, was loaded onto the MA and test engineers carried out initial operational testing on a local training mission to ensure safe operations and equipment validity (Tab K-21 to K-22). After initial testing, the MA proceeded to JBER (PAED) on 14 August 2023, loaded with MEP from the MDA and Aerojet Rocketdyne Coleman Aerospace (Tab K-16, Tab V-11.3). As recently as 20 August 2023, the MA received routine maintenance, to include fuel and liquid oxygen (LOX) servicing, from the assigned maintenance personnel (Tab D-27, Tab U-6).

b. Mission Planning

Mission planning for the test sorties was carried out by aircrew members under strict MDA test parameters (Tab V-5.3, V-7.2). Identifying possible alternate landing locations in case of engine or aircraft systems failure proved a key element of the mission planning process (Tab V-5.3). Because much of the mission would be over water, this included assessing the viability of recovery locations in the Aleutian Islands, off the coast of Alaska (Tab V-5.11). The aircrew met with the HAAMS technicians to discuss contingency plans for possible physiological events, to include hypoxia and DCS (Tab V-5.3, V-4.11). With mission test requirements limiting the allowable fuel load, the aircrew concluded JBER was the only viable recovery base and any distressed members would require follow on care via chartered medical flights to Seattle and the nearest hyperbaric chamber per the JBER DCS plan (Tab V-5.4, V-4.11, and Tab X-39). Of note, the HAAMS personnel had previously coordinated with JBER flight surgeons per their pre-flight requirements; however, JBER Flight Medicine was not aware that this specific flight was occurring on 21 August 2023 (Tab V-10.7 to V-10.8).

c. Pre-Flight

On the morning of 21 August 2023, at approximately 0615L, the Mishap Crew (MC) began preparations for that day’s flight (Tab R-74). The MEP arrived at the MA between 0615L and 0645L (Tab R-286, R-296). Ground maintenance members were waiting at the MA with power running and visual inspections completed (Tab R-271). The MEP conducted preflight tests of their specialized equipment and checked oxygen equipment on the MA while the aircrew carried out standard preflight checklists (Tab R-26, Tab R-266, and Tab V-1.3 to V-1.4).

At approximately 0900L, all mission personnel gathered on the ramp near the aircraft for mission and safety briefs from the HAAMS technicians and Misson Instructor Pilot (MIP), who was also the Aircraft Commander (Tab R-296, Tab V5.2 and Tab V-5.5). The MIP briefed the overview of the mission and what MEP could expect for the pressurization schedule while operating in the high-altitude scenario (Tab V-5.5). Using a written guide, the HAAMS technicians briefed pre-breathing procedures, physiological incident symptoms and corresponding treatment, as well as distress signals to use in case of emergency and what assistance MEP could expect in those scenarios (Tabs V-1.4, V-4.13, and V-5.5). At the end of the brief, the HAAMS technicians asked the mission personnel if anyone had any health concerns that would inhibit their ability to fly, with no concerns expressed by the Mishap Member (MM) or others (Tab V-8.3 to V-8.4). Upon completion of the briefing, the HAAMS technicians checked the passengers' equipment for positive oxygen flow with no discrepancies noted (Tab R-51, Tab R-286, Tab V-4.17, and Tab V-31.1).

d. Summary of Accident

Takeoff occurred at 1008L after which the Mishap Sortie (MS) followed the planned route and timeline to the south and west of Alaska past the Aleutian Islands (Tab K-16). Approximately two hours into the MS, the MEP assigned to monitor the test from the palletized positions moved to their prescribed seats to prepare for the simulated airdrop and initiate equipment power-on checks (Tab R-266 and Tab R-296). The MM moved to the C3 pallet, the forward-most pallet, at the left-most seat position which is closest to the forward loadmaster station (Tab V-32.1, Tab BB-132).

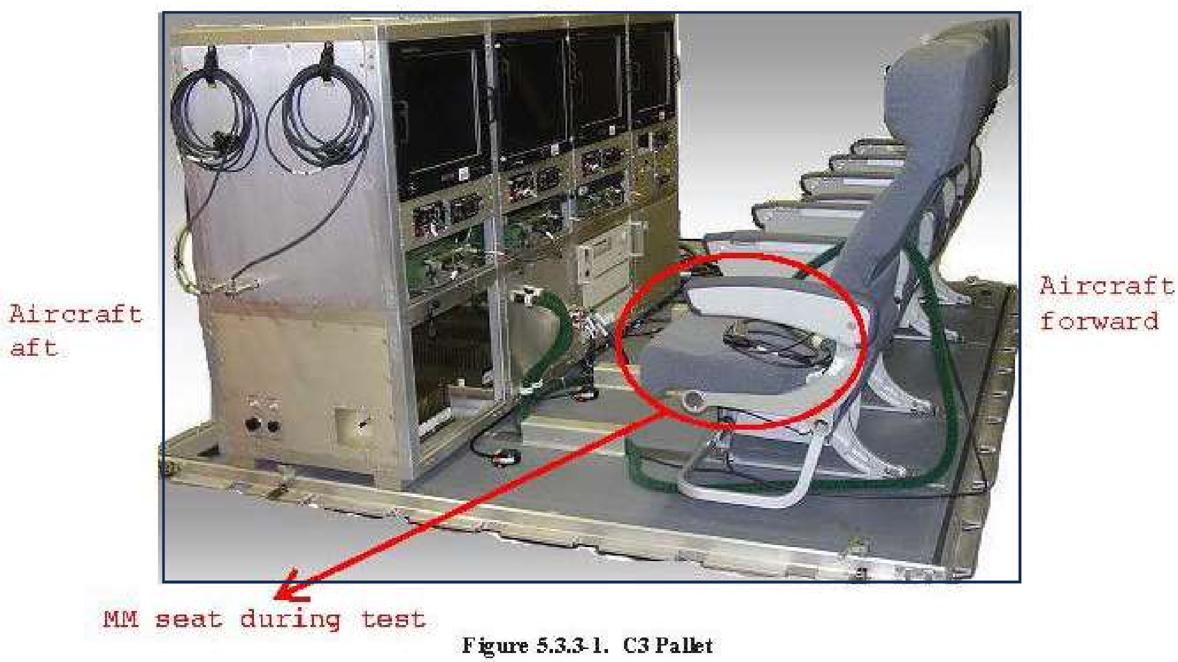

Figure 1 Tab BB-132

At 1257L, all personnel donned their helmets and oxygen masks to prepare for the 30 minutes of pre-breathing at 15,900 feet MSL required before high-altitude depressurized operations (Tab BB-85, Tab K-14, and Tab R-75). The purpose of pre-breathing is "to breathe oxygen to purge the nitrogen content [of the blood] in preparation for an activity that involves exposure to a significant change in pressure which might otherwise cause decompression sickness" (Tab BB-86). The MM wore an HGU-56/P helmet, commonly purposed for rotary aircraft, and an MBU-12/P mask that permitted oxygen flow from the oxygen regulator (Tab Z-3, Tab BB-4 and BB-157). The MM had used both pieces of equipment on previous missions (Tab V-13.11, Tab Z-3, and Tab T-23).

Figure 2 Tab Z-3

The MM's issued helmet and oxygen mask combination differed from other team members' helmets due to a previous fitting issue with the standard HGU-55/P helmet primarily used on the C-17 (Tab V-23.3 to V-23.5, Tab Z-3). The HGU-56/P helmet does not currently have a Safe-to-Fly certification for the C-17, which means it is not a qualified/certified helmet option for use on C-17 missions (Tab BB-4).

During pre-breathing, the HAAMS technicians checked on the aircrew and passengers one to two times for any adverse reactions or physiological symptoms (Tab R-47 to R-48, Tab R-291, Tab V-31.1, and Tab V-11.8). After pre-breathing was accomplished, the aircrew ran checklists for further cabin depressurization and followed standard operating procedures (SOPs) for the depressurization schedule to 24,900 feet MSL (Tab R-75, Tab BB-101, and Tab AA-5). Full depressurization occurred at 24,900 feet MSL when the cargo door and ramp were opened two to four minutes prior to the simulated drop time of 1400L (Tab R-75, Tab R-297). The cargo door and ramp were open for approximately 5 minutes for the simulated airdrop and then closed with no noted issues (Tab K-14, Tab R-297).

While climbing to 33,000 feet MSL, the planned flight altitude for the return flight, the MA began repressurizing the cabin to a pressure equivalent to below 10,000 MSL (Tab K-14, Tab AA-5). As the door and ramp closed and the aircraft repressurized, the MM began showing signs of distress (Tab R-57, Tab V-9.3, and Tab V-12.6). MEP located near the C3 pallet noticed excessive sweating and apparent motions of distress from the MM, causing them to immediately notify HAAMS personnel (Tab V-11.10, Tab R-67). MEP1 noted a distant and disoriented look in the MM's eyes causing immediate concern in his mind (Tab V-12.6). Both MEP1 and MEP2 began giving the distress signal to HAAMS technicians to alert them that the MM needed attention (Tab V-11.10, Tab V-12.7, and Tab R-26). MH1 and MH2 responded to the MM following the simulated airdrop when the ramp closed around 1400L (Tab V-11.10, Tab V-9.3 to V-9.4, Tab R-26, and Tab R-57). MH1 and MH2 checked the MM's oxygen levels using a pulse oxygen meter on his finger and attempted to communicate with him via written messages on a white board (Tab R-64, Tab V-31.1, and Tab V-9.3). MEP noted the MM could barely write on the whiteboard and was only capable of scribbling illegibly (Tab V-11.11, Tab R-42). The MS members recalled the MM complaining of not being able to breathe and a lack of mobility in his right arm, all while pointing to his right arm and sweating profusely as he was being checked by MH1 and MH2 (Tab V-9.3 to V-9.7, Tab R-42).

MH1 and MH2 initially assessed the MM as experiencing hyperventilation, based on statements they both made to the Mishap Instructor Loadmaster (MIL), MH3, and MEP3 (Tab V-9.3, Tab V-17.1, Tab V-4.3). MH1 and MH2 switched the MM's oxygen supply to the emergency setting and checked his mask and oxygen hose connections (Tab V-32.1, Tab V-27.1). Following those checks, several MEP reported that MH1 and MH2 removed the MM's helmet and mask and placed him on an emergency oxygen mask connected to an MA-1 emergency walk-around bottle (Tab V-11.12, Tab V-12.6). Of note, the MIL stated that after a short discussion with MH1 and MH2, the technicians opted to not use an MA-1 emergency walk-around bottle due to the bottle's limited oxygen supply and instead connected the emergency oxygen mask to the regulator on the C3 pallet (Tab V-9.3 and Tab V-9.5). MH1 then returned to his seat about halfway down the right sidewall seats while MH2 monitored the MM (Tab V-9.8, V-31.1, and V-4.7).

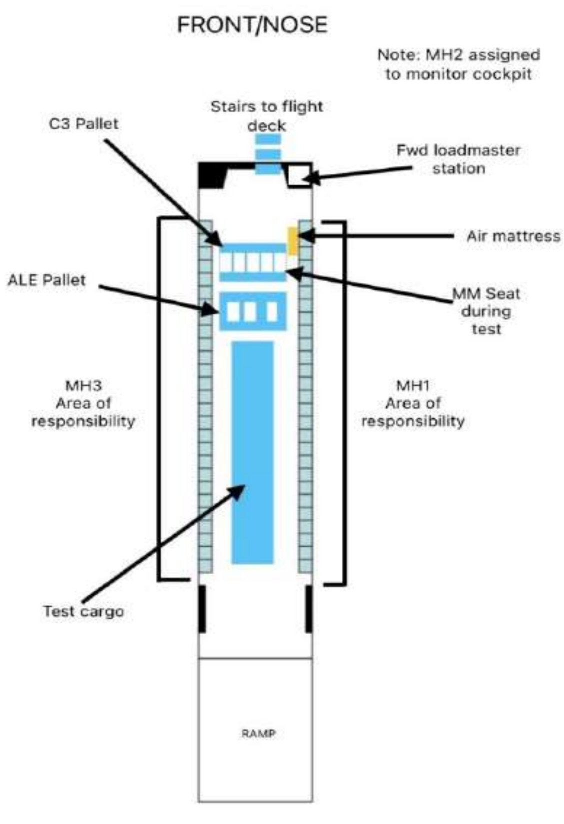

Figure 3 Tab Z-4

As the aircraft cabin altitude decreased below 10,000 feet MSL and all MEP were able to remove their oxygen masks, MH2 removed the MM's emergency oxygen mask after deeming him stable (Tab V-31.1, Tab V-9.3). The MM was on oxygen for a short time following the initial response and continued the rest of the flight without any sort of supplemental oxygen (Tab V-12.10, Tab V-9.3 to V-9.4, Tab V-14.9, and Tab V-11.14). The MM was moved to the right sidewall seats with assistance from MH2 (Tab V-31.1). The MIL stated the MM's "right arm was droopy" when his oxygen mask was removed (Tab V-9.7). MEP1 stated that the MM was "having difficulty even standing up" and "looked like a guy that had been drinking all night" (Tab V-12.6).

The MIL talked with MH2 regarding the MM's condition and recommended notification of the MIP as the next course of action, in alignment with AF directives (Tab V-9.3, Tab BB-88). MH2 stated that pilot notification of the MM's condition could wait until landing at which point the MIL urged the need to immediately notify the MIP of the situation (Tab V-9.3). MH2 agreed and huddled with MH1 to discuss the notification (Tab V-9.3 to V-9.4, Tabs BB-77 to BB-78). The MIL subsequently informed the MIP over intercom that the MM was suffering from hyperventilation and not looking good (Tab V-9.4, Tab V-5.5). Moments later MH1 informed the MIP over intercom that the MM had hyperventilated but was in a stable condition and recommended requesting a flight doctor upon landing (Tab V-5.5). The MIP continued the flight to JBER at 33,000 feet and cabin pressure below 10,000 feet MSL with the understanding the MM was stable pending any updates from HAAMS technicians (Tab K-4, Tab V-5.5 to 5.8).

After the MM sat on the right sidewall for a brief time, MEP3 checked on the MM and retrieved a mattress for him to lay on (Tab V-17.1). Then MEP moved the MM to the floor of the front right side of the aircraft (Tab V-12.6, Tab V-11.13, Tab Z-4). Several MEP reported that MH2 returned to his seat near MH1, approximately halfway down the right side of the aircraft cargo compartment, sometime shortly after the MM's movement to the sidewall and MH2 remained there for the rest of the flight, with little to no checks on the MM from either member (Tab V-11.14 to V-11.15, V-24.1, V-14.6, and V-31.1).

It is unclear how often the MIP requested or received updates on the MM's status for the remainder of the flight. The MEP pilot (MEPP) member recalled receiving a report of hyperventilation and "nerve pain or numbness" in one of the MM's arms and that, upon requests from the MIP, he would look down from the flight deck for visual updates of the MM (Tab R-75, Tab V-8.7). MCP2 stated that the MIP asked "a few times" for the status of the MM but did not indicate the timing or results of those requests (Tab V-1.5). MCP1 stated that the crew was told by a HAAMS technician that the MM was hyperventilating and then later was told by MLM that the MM was lying down and taking a nap (Tab V-7.5). MIP stated that he received no update indicating the MM's condition was less than stable or would require a change in flight profile (Tab V-5.8). Multiple crewmembers expressed the belief and trust that HAAMS technicians would continue to provide care and updates on the MM's condition (Tab V-5.7 to V-5.8, Tab V-9.7, and Tab V-1.5).

During the return flight to JBER, MEP supplied the MM with blankets, water, and snacks to eat and helped lower his flight suit around his waist so he could attempt to cool down (Tab V-9.7, Tab V-11.13, Tab V-12.10). While continuing to lay down and drink water, the MM was unable to hold his own water bottle and needed assistance from other MEP; he also could not chew any food offered to him (Tab V-12.10). Multiple crewmembers and MEP described the MM as appearing to be asleep while laying down with the cabin lights dimmed (Tab V-31.1, V-14.6). While lying on the mattress, the MM was reported as slurring his words, breathing heavy, and appearing uncomfortable, in pain, and pale (Tab V-12.10, Tab V-24.1, and Tab R-292). There is a lack of evidence indicating the MEP verbalized concern to the HAAMS or the MC (Tab V-5.8, Tab V-7.5).

Approximately two hours prior to landing and as part of normal landing coordination, the aircrew called JBER Command Post to request transportation, aircraft servicing, and parking (Tab DD-14). The crew did not request medical support (Tab DD-14). At approximately 1615L and as the MA began its descent, the MM was roused from the mattress and assisted back to his original sidewall seat by MEP in accordance with the MA's operating restrictions (Tab BB-75, Tab V-11.13, and Tab V-12.8). After raising the cabin lights to prepare for arrival, the MLM alerted the MIP that the MM "[wasn't] doing so hot," referencing his pallor and apparent distress (Tab V-5.7, V-14.8). The MIP confirmed the earlier recommendation to request a flight doctor to assess the MM upon landing but did not declare an inflight emergency (Tab V-5.5 to V-5.6, and V-5.8).

Thirty minutes from landing, the aircrew attempted to contact JBER Command Post to confirm landing support (Tab R-75). The aircrew was unable to contact Command Post until approximately 15 minutes remaining in flight when they requested a flight doctor meet the aircraft at parking due to the MM having adverse effects from "high-altitude operations" (Tab R-75, Tab DD-18 to DD-19). The crew requested the flight doctor meet at the MA but did not declare an inflight emergency (Tab DD-16). Command Post subsequently initiated calls to Flight Medicine and JBER Emergency Medical Services (EMS) to coordinate emergency procedures to meet the MA upon landing (Tab DD-8 to DD-13, DD-3 to DD-7). EMS personnel responded to the flight line with the understanding there was an MEP with symptoms from altitude sickness (Tab R-20). The MA landed uneventfully and promptly taxied to the aircraft parking area where they were met by waiting emergency vehicles (Tab R-19). After running appropriate checklists, the aircrew shut down all four engines with 43,000 pounds of fuel in the fuel tanks and opened the crew entrance door at which point medical personnel entered the MA to administer care to the MM (Tab R-19 to R-20, Tab D-39). The MIP recalled seeing the MM's condition for the first time and expressed shock at his appearance, noting he "looked like he had a stroke" and did not appear stable (Tab V-5.6).

e. Summary of Medical Response and Treatment

At 1706L, EMT1 and EMT2 entered the MA and found the MM sitting on the right side of the aircraft in mild respiratory distress, sweaty, and very tired but able to respond to questions appropriately (Tab V-16.1, Tab X-28). EMS was informed the MM was placed on oxygen without improvement shortly after he started having symptoms and was not able to move his right arm in flight (Tab X-28, Tab V-16.1). EMT1's on-scene physical exam showed the MM could move all his extremities without difficulty but that he had weak pulses at both right and left wrists (Tab X-28). The MM was also able to speak in complete sentences (Tab X-28). EMT1, noting that the MM did not appear stable, attempted intravenous (IV) access on the aircraft without success (Tab X-28). The MM was then moved from his seat to a stair chair and taken down the MA stairs and placed onto the ambulance gurney (Tab X-28). Once in the ambulance, EMT1 successfully obtained IV access and placed the MM on a non-rebreather mask at 15 liters of oxygen per minute while administering a liter of IV fluid and medication for nausea (Tab X-28). The MM remained very sleepy during transport (Tab X-28). The ambulance arrived at the emergency department at 1749L and immediately placed the patient in Room 7 (Tab X-28). EMT1 provided his status report to the ER physician on duty (DR1), while both were at the patient's bedside (Tab X-28).

Shortly after the MM's arrival at the emergency department, the flight surgeon on call (FSOC) met DR1 at the MM's bedside (Tab X-28). FSOC and DR1 discussed DCS and potential options for treatment in a hyperbaric chamber as well as transport and logistics considerations (Tab X-28, Tab V-3.4). The MM had tests to rule out readily treatable conditions such as a collapsed lung or a blood clot in his lungs, all of which proved negative (Tab X-28 to X-29). The MM tested positive for COVID-19 and was given IV treatment (Tab X-29). The MM was also administered broad-spectrum antibiotics to address any potential bacterial cause for his shortness of breath. (Tab X-29). DR1 coordinated arrangements with the hyperbaric specialist at Virginia Mason Hospital in Seattle as the closest hyperbaric chamber for DCS treatment (Tab X-29). The first available fixed wing aeromedical transport team was in Fairbanks, Alaska, and would not be able to transport the MM until 0830L the next morning (Tab V-36.1).

The MM's blood pressure continued to drop despite the administration of IV fluids and three different medications to help increase his blood pressure (Tab X-28). By approximately 2200L, the MM's condition continued to deteriorate to the point that his lungs, liver, and kidneys began to fail despite aggressive treatment in the emergency department (Tabs V-36.1, Tab X-29). At approximately 0000L, the MM's condition required insertion of a breathing tube (intubation) and mechanical ventilation (Tab X-29). DR1 transferred care to the current physician on duty (DR2), at 0500L on 22 August 2023 (Tab V-36.1).

At approximately 0700L a pulmonary-critical care physician (DR4), arrived to assist with the MM's care (Tab X-29). After consultation with DR4, the MM was deemed critically ill, unstable, and requiring ventilatory support (Tab V-30.2). The physicians discussed transportation out of state for more specialized care but decided higher priority care at a local Intensive Care Unit (ICU) was necessary first (Tab V-36.1).

The MM's condition progressively became too unstable to support the proposed aeromedical flight to Seattle (Tab V-3.12). Arrangements were made for transfer to the local hospital ICU so the MM could undergo kidney dialysis to better prepare for transfer to a hyperbaric chamber (Tab V-36.1, Tab X-29).

Care was transferred to the next physician on duty (DR3) at 0800L on 22 August 2023 (Tab X-29). While transferring the MM to an ambulance gurney for transport to the nearby civilian hospital's ICU, the MM entered cardiac arrest at 0806L (Tab X-29). Emergency department staff worked aggressively to resuscitate the MM, but their efforts proved unsuccessful (Tab X-29). The MM was pronounced deceased at 0832L (Tab X-29).

5. MAINTENANCE

a. Forms Documentation

The AF uses the Air Force Technical Order (AFTO) Form 781 series forms collectively to provide a maintenance, inspection, service, configuration, status, and flight record for Air Force aircraft (Tab BB-143). The AF uses automated Maintenance Information Systems (MIS), referred to as G081, to support and enable maintenance business processes, document maintenance actions, and track fleet health (Tab BB-142).

A review of active 781 series forms and G081 for the 90 days preceding the MS revealed no overdue inspections or open Time Compliance Technical Orders that would affect the MA's flight operations or performance (Tab D-56 to D-66). G081 and the MA's AFTO 781s showed no historical record findings that contributed to this mishap (Tab D-36 to D-66, Tab D-13 to D-24).

A review of the maintenance documentation for the oxygen hoses and regulator on the mission C3 pallet revealed minor inconsistencies (Tab BB-34 to BB-72). In January 2022 there was a documented function check performed prior to the replacement of oxygen hoses with no subsequent documented follow-on checks as to ensure system integrity (Tab BB-34 to Tab BB-72). Of note the C3 pallet oxygen regulator function check also states that the test procedure requires a minimum of six personnel and lists only five personnel as the test personnel (Tab BB-44 to BB-45).

b. Inspections

A review of scheduled inspections was performed with no concerns noted (Tab D-62 to D-66). The aircraft was due a Heavy Maintenance 3 inspection on 21 August 2023 (the day of the MS) but was within allowable regulatory guidelines (Tab D-56, Tab D-61). All required Preflight, Walk-Around, and Basic Post-Flight Inspections were accomplished in accordance with all applicable technical orders with no discrepancies noted (Tab D-38 to D-54, Tab R-271). The MDA contractors ensured the serviceability of the C3 pallet oxygen system, to include regulators and hoses, with no discrepancies noted (Tab R-266, Tab R-318, Tab R-296, R-286, V-31.1).

The AIB's inspection of the C3 pallet noted minor buckling on the clamp flange securing the green flexible high pressure oxygen hose to the regulator (Tab Z-14 and Tab FF-11). After further inspection, the AIB determined this minor buckling would not prevent system operation or cause a significant source of pressure loss in the oxygen system (Tab FF-11).

c. Maintenance Procedures

A review of the MA's active and historical AFTO 781 series forms and MIS revealed all maintenance actions complied with standard approved maintenance procedures and TOs (Tab D-36 to D-66).

d. Maintenance Personnel and Supervision

All documented records for personnel who performed maintenance on the aircraft prior to the mishap were accurate and up to date with no concerns noted (Tab T-22).

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

Samples taken from the hydraulic system indicated slight contamination (Tab J-28 to J-35). This contamination would not affect the oxygen or pressurization systems and is not relevant to the mishap (Tab J-28 to J-35). LOX samples taken from the servicing oxygen cart had no discrepancies (Tab J-22). A sample taken from the 5000-gallon storage tank used to fill the LOX servicing carts had no discrepancies noted (Tab J-22).

f. Unscheduled Maintenance

A review of all unscheduled maintenance documented in the AFTO 781 series forms and applicable G081 databases indicated no maintenance performed on the oxygen or pressurization system in the previous 90 days (Tab D-13 to D-24, Tab D-36 to D-66).

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

(1) C-17 Environmental Systems

The C-17 can maintain a cabin altitude below 10,000 feet with flight levels up to 43,500 feet (Tab BB-168). Pressurization is achieved by routing air from the engine's compressor stages (known as bleed air) into the aircraft environmental system (Tab BB-168). The bleed air is supplied to the aircraft air conditioning packs (1 left, 1 right) where it is cooled for distribution into the aircraft's cabin (Tab BB-168). This air (now known as conditioned air) fills the cabin and increases the air density, in turn decreasing the cabin altitude (Tab BB-168). The Environmental System Controller monitors and regulates cabin pressure by controlling input and output to maintain the cabin altitude selected by the aircrew (Tab BB-168). The system utilizes an outflow valve which releases conditioned air from the aircraft to regulate the cabin altitude as well as depressurize the aircraft (Tab BB-168).

The MC pressurized and depressurized the MA four times over the nearly seven-hour sortie as part of mission requirements (Tab AA-5). The MA was pressurized during departure and, approximately three hours into the flight, the MC depressurized the aircraft to 15,900 feet cabin altitude roughly two to three minutes before the start of the required 30-minute pre-breathing drill (Tab AA-5). Once the pre-breathing drill was complete, the aircraft was depressurized to the aircraft's actual flight altitude of 24,900 feet MSL (Tab AA-5). After the simulated drop and after the doors closed, the aircraft cabin was repressurized to an altitude equivalent to below 10,000 feet MSL (Tab AA-5).

Throughout this process, all applicable checklists and procedures were followed and there were no system discrepancies noted by the aircrew (Tab V-8.5).

(2) C-17 Oxygen System

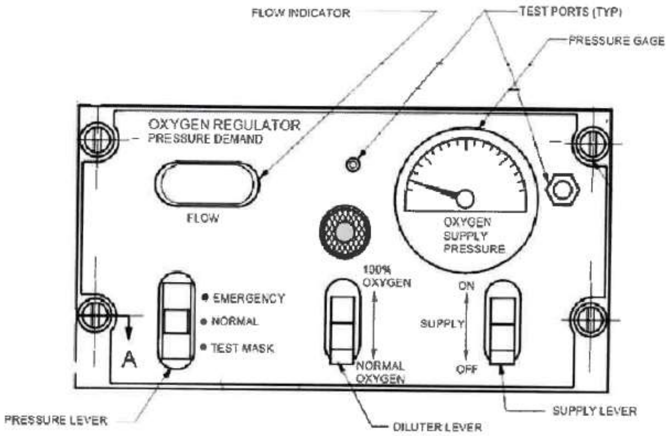

Figure 4 Tab B-57

The C-17 has three independent oxygen systems: one primarily for the crew, one that services the passengers, and an auxiliary system (Tab BB-176). The crew system is maintained by a 25-liter oxygen converter while the passenger and auxiliary systems each have their own 75-liter oxygen converter (Tab BB-176). The systems share a common indicator at the copilot's crew/passenger oxygen quantity panel that displays LOX quantity for each system (Tab BB-176). The passenger oxygen quantity can also be viewed from the flight deck and, by activating a cross feed valve, the copilot can transfer oxygen from the passenger to the crew system (Tab BB-176). This feature is typically used if there is a malfunction of the crew oxygen system to supply oxygen to the flight crew (Tab BB-176). Flight crew and passengers can access oxygen through the oxygen regulator panel assemblies located throughout the aircraft (Tab BB-176).

There were no faults in the aircraft oxygen system as noted by AF maintenance records or reported by aircrew or physiological technicians (Tab U-7, Tab V-4.3).

The C3 pallet utilized in the mission contained four oxygen regulator panel assemblies which operate identically to the assemblies equipped on the aircraft and utilized by the aircrew (Tab BB-131 and Tab BB-178). The regulator panel has three toggle levers: the left (red) lever tests the mask, allows for normal operation, and controls the emergency flow of oxygen to the individual's oxygen masks either at normal or under increased pressure flow settings; the middle (white) lever controls the dilution of the oxygen and individuals can toggle between 100% oxygen or normal oxygen; the (green) lever on the far right of the panel is the supply lever and controls whether oxygen is going to the panel or not with a simple on or off position (Tab Z-15, Tab BB-177).

The C-17 crew oxygen system provides oxygen to four seat positions on the C3 pallet through an armored oxygen hose connected to the C-17 portable oxygen recharger assembly located on the forward right sidewall of the aircraft (Tab BB-178). One seat position utilizes the standard High Altitude Low Opening (HALO) Oxygen Port. (Tab BB-132, Tab S-11).

The C3 pallet is maintained, loaded, and inspected in accordance with verified company procedures prior to each test evaluation (Tab V-17.2). The C3 pallet was installed in the MA at Cape Canaveral, Florida, where it underwent a company quality assurance inspection with no discrepancies noted (Tab V-17.2).

(3) Communications

The C-17 aircraft communication system performs several functions, including ground communication, internal communication, data transmission, and automatic calling features (Tab BB-170). It provides different types of radios to allow for a wide range of global communications, to include High Frequency (HF), Very High Frequency (VHF), Ultra High Frequency (UHF), Aeronautical Intermediate (AERO I), and multiband radios (Tab BB-170).

The HF radio provides long-distance communication capability (up to 2200 miles), the VHF radio is utilized for short-range communications (typically 5-10 miles, line-of-sight), and the UHF radio is also utilized for short-range communication (typically 30-40 miles) on a different frequency band (Tab BB-171). The AERO-I system employs satellite communication for the aircrew to conduct global communications while the multiband radios handle various communication modes, including secure UHF Satellite Communication (SATCOM) (Tab BB-173).

The Passenger Address system allows communication with passengers in the cargo area and between the cargo area and the cockpit (Tab BB-170). Internal communication supports communication among flight and ground personnel as well as passengers in the cargo compartment (Tab BB-170). Personnel are required to plug into one of the communication ports to enable internal communication (Tab BB-170).

The VHF and AERO-I communication systems were utilized at various points throughout the mission with no faults or mission impacting concerns noted (Tab R-37, Tab R-50, and Tab R-291).

(4) Command, Control, and Communications (C3) Pallet

Figure 5 Tab BB-131

The C3 pallet is part of the Airborne Support Equipment package and is required to support an air launched target missile (Tab BB-131). The C3 pallet is capable of providing communications to ground receiving stations at distances beyond line-of-sight and provides the command, control, power, and monitoring functions required to manage pre-launch, launch, and abort functions for a target launch of aerial delivery of munitions (Tab BB-130 to Tab BB-131).

During the pre-breathing portion of the mission, several MEPs reported internal communications failure with the C3 pallet and could not communicate, to include the MM (Tab R-50, Tab R-291). The effects were mitigated with hand signals with no significant impacts (Tab R-291).

Maintenance records indicate no discrepancies or faults noted in the communication system for the C3 pallet, and the investigation board was unable to establish a basis for the reported internal communication failures on the pallet. (Tab BB-35 to Tab BB-72).

(5) Pre-positioned Aircrew Flight Equipment (AFE)

Standard pre-positioned flight equipment for C-17 missions was inspected and installed by the 437th Operations Support Squadron AFE (Tab U-6 to U-7). This includes additional emergency oxygen equipment, flotation equipment, survival kits, parachutes, body armor and safety harnesses (Tab U-6 to U-7). All equipment listed on the AFTO Form 46 were current on inspections (Tab U-6 to U-7).

(6) Helmet, HGU-55/P

Figure 6 Tab Z-16

The HGU-55/P helmet is the primary qualified helmet issued to aircrew and MEP performing duties on the C-17 (Tab BB-145). Medium and large helmet sizes of the HGU-55/P are designed to satisfy the head size range from the 3rd to 98th percentile of all personnel (Tab BB-147 to BB-148). These sizes are supplemented with an X-large size for head sizes that range slightly beyond the 99th percentile (Tab BB-148). All members of the MS wore the HGU-55/P helmet with the exception of the MM (Tab V-13.9).

Sizing of the HGU-55/P helmet is accomplished by measuring the maximum head length and width using a specialized caliper tool (Tab BB-149). The measurements for an X-Large helmet, which is the largest size available, are 8.2-8.7 inches for head length and a maximum of 6.8 inches for head width (Tab BB-150, Tab Z-16). The vast majority of MEPs supporting MDA missions receive their proper fitting sizes during initial physiological training and are fitted by qualified aerospace physiology technicians and aircrew flight equipment personnel (Tab R-36, Tab V-13.10).

(7) Helmet, HGU-56/P

The HGU-56/P Aircrew Integrated Helmet System provides ear, eye and head protection for aircrew personnel (Tab BB-138). The helmet’s primary intended use is for rotary wing and tilt rotor aircrew (Tab BB-81). The HGU-56/P helmet does not currently have a Safe-to-Fly certification for the C-17, which means it is not a qualified/certified helmet option for use on C-17 missions (Tab BB-4).

Figure 7 Tab Z-6

Sizing of the HGU-56/P helmet is accomplished by marking a reference point 1 1/2 inches above the wearers pupil and then using a combination square to determine the length of the individual's head (Tab BB-136). The head length for an individual wearing an X-Large helmet is any length over 8 5/16 inches (Tab BB-137).

When the MM received initial physiological training in April 2022, aerospace technicians at Laughlin AFB, Texas, were able to correctly size and fit the MM to an HGU-55/P helmet, which is approved for use on the C-17 aircraft (Tab V-13.11, Tab BB-145). Upon return from training, the MM subsequently ordered his own HGU-55/P helmet through the MDA's equipment account using his initial training measurements (Tab V-13.8 to Tab V-13.9).

The MDA executes an interagency agreement with Redstone Test Center for helmet inspections and fitting in support of MDA missions (Tab BB-24, Tab BB-26). In July 2022, a Redstone Test Center technician assisting the MM was unable to properly fit an HGU-55/P helmet and an MBU-20/P mask because the helmet was sitting too high on the MM's head, in turn causing the mask to fit improperly (Tab V-22.4, V-23.3 to V-23.4). A Redstone Test Center supervisor suggested trying the HGU-56/P rotary wing helmet since it was larger (Tab V-22.4, V-23.5). This helmet change also prompted the change to an MBU-12/P mask since snaps were now being used to connect the new helmet with the mask as opposed to bayonet-style clips (Tab V-22.7, V-23.5).

The Redstone Test Center individuals involved in the fitting process were not aware this helmet would be used on a C-17 mission (Tab V-22.8 to V-22.9, V-23.10). The MM preferred the HGU-56/P for its more comfortable fit and subsequently brought both helmets – the HGU-56/P and HGU-55/P – on follow-on missions in the event the HGU-56/P was not allowed (Tab V-13.11). The physiological technicians on his first flight, unsure if this new helmet would qualify for use on MDA C-17 missions, contacted personnel at JB Charleston to confirm the suitability of this new helmet (Tab V-13.11 to V-13.12). It is unclear exactly who the physiological technicians spoke to at JB Charleston to receive this information (Tab V-13.12). According to an MDA colleague, the MM was informed that the helmet would be acceptable as long as the mask fit properly (Tab V-13.11). The MM utilized the HGU-56/P in five flights between July 2022 and July 2023 and was using the helmet on the MS (Tab V-13.11).

While not an approved helmet, the MM did not report any issues using this helmet and mask combination on any of his previous C-17 flights (Tab V-13.11, Tab Z-3).

The HGU-56/P, MBU-12/P and CRU-60/P were sent to the Human Systems Division of the Air Force Life Cycle Management Center at Wright Patterson AFB for testing (Tab J-6). The test results concluded that the combined equipment worked properly and was within the limitations specified by the CRU-73A regulator (Tab J-21). No discrepancies were noted with the HGU-56/P (Tab J-8).

(8) MBU-12/P Pressure Demand Oxygen Mask

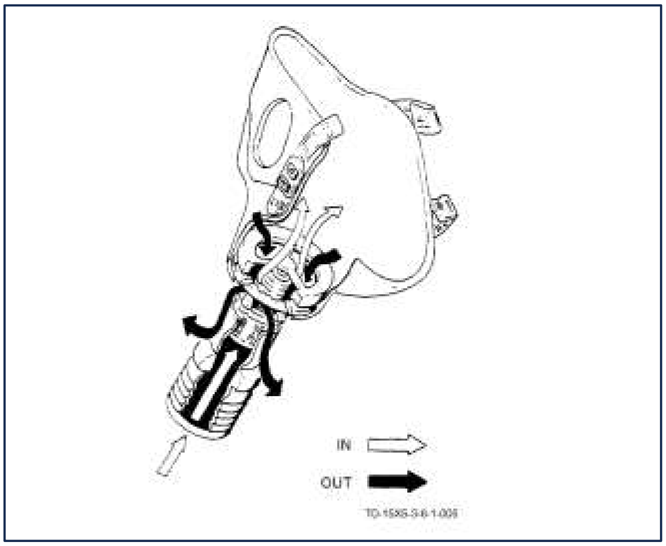

Figure 8 Tab BB-157

The MBU-12/P oxygen mask is an in-flight oxygen-breathing device which can be utilized with a flight helmet and microphone, a quick don suspension, or a head strap assembly (Tab BB-155). Oxygen enters the flexible delivery tube and travels through the inhalation/exhalation oxygen valve to the facepiece (Tab BB-157). Typically, the mask connects to the helmet with two secure bayonet assemblies that are part of the mask straps (Tab BB-155, Tab Z-5).

Of note, the MM's mask was attached to the HGU-56/P helmet by snaps instead of bayonets (Tab Z-9). This is an authorized modification of the helmet and mask so that the ensemble can be used together (Tab BB-158).

After a mask fitting, either a temporary or permanent tacking is required to prevent the movement of the straps to ensure proper fit of the mask to the member (Tab BB-156). A tacking is completed by using a needle and thread to secure the free end of the mask strap to itself (Tab BB-156).

The individual who fit the mask to the MM cannot explicitly remember tacking the MM's mask (Tab V-23.5). An examination by the AIB noted no evidence of tacking on the MM's mask (Tab Z-9). During pre-breathing, the MM did not report any mask issues and appeared normal (V31.1). There is no conclusive evidence to indicate that the MM had any mask issues that contributed to the mishap.

The HGU-56/P, MBU-12/P and CRU-60/P were sent to the Human Systems Division of the Air Force Life Cycle Management Center at Wright Patterson AFB for testing (Tab J-6, Tab J-8). The test results concluded that the combined equipment worked properly and was within the limitations specified by the CRU-73A regulator (Tab J-21). No discrepancies were noted with the MBU-12/P.

(9) CRU-60/P Oxygen Mask To Regulator Connector Assembly

Figure 9 Tab Z-7

The CRU-60/P connector is used to connect the oxygen mask to the aircraft's oxygen supply system when oxygen is supplied by a panel mounted regulator (Tab BB-161). If the assembly is improperly inserted into the aircraft oxygen delivery hose, the user will experience resistance while breathing (Tab BB-161).

The HGU-56/P, MBU-12/P and CRU-60/P were sent to the Human Systems Division of the Air Force Life Cycle Management Center at

Wright Patterson AFB for testing (Tab J-6). The test results concluded that the combined equipment worked properly and was within the limitations specified by the CRU-73A regulator (Tab J-21). No discrepancies were noted with the CRU-60/P (Tab BB-162).

Additionally, the AIB conducted a pull test on the mishap CRU-60/P to ensure the security and serviceability of the connector when inserted into an oxygen regulator mask hose (Tab BB-162). The force required to disconnect the connector should be between 12 and 20 pounds (Tab BB-162). The MM's CRU-60/P registered a 10.1 pounds pull force (Tab BB-161, Tab Z-8). Although this test did not meet the minimum requirements outlined in the technical orders, there is no indication that the CRU-60/P became disconnected during the MS or was a contributing factor to the mishap (Tab BB-162, Tab Z-7).

(10) Folding Quick-Don Mask Assembly

The Folding Quick-Don Mask Assembly is designed to provide oxygen and communication capabilities to crew members in the event of aircraft decompression or smoke and fumes in the cabin (Tab BB-165). The mask is placed over the nose and mouth and held to the wearer's face by means of a spring-loaded assembly (Tab BB-165). After donning the mask, the wearer connects the oxygen and communication connections to the aircraft systems if they are not already connected (Tab BB-165). The oxygen hose connector is designed to warn the wearer if the oxygen hose is not properly connected to the aircraft oxygen system (Tab BB-165). Visual inspection indicated no discrepancies or faults noted in the oxygen system for the emergency mask (Tab FF-10).

Figure 10 Tab BB-166

b. Equipment Configuration and Maintenance

During the MS, the MM was wearing an HGU-56/P helmet with an MBU-12/P mask and CRU-60/P connector attached (Tab Z-3).

After the MS, pictures were taken of the MM's HGU-56/P helmet, MBU-12/P mask, and the CRU-60/P (Tab Z-6). Overall, each piece of equipment appeared in good condition (Tab Z-6).

The HGU 56/P helmet displayed cosmetic damage but nothing affecting the operation of the helmet (Tab Z-12).

The MBU-12/P communication cord's casing had a small cut, which would normally be replaced during routine inspection, but it is cosmetic and should not affect the function of the system (Tab Z-10). Additionally, the photos showed that the MBU-12/P straps were not tacked in accordance with the technical orders (Tab BB-156, Tab Z-9). An improperly tacked mask could result in an altered fitting, an insufficient mask seal, and inadvertent leaking of the mask (Tab BB-156). Parts of the MBU-12/P were disassembled showing the condition of the installed washers, rings and valve (Tab Z-11, Tab Z-13). All items were in good condition with the valve showing signs consistent with recent use (Tab Z-11). All items were the correct parts according to the technical data (Tab BB-159, Tab Z-11 and Tab Z-13).

The helmet and mask were issued, fit, inspected, and maintained by the Redstone Test Center per the interagency agreement and with the expectation of maintenance in accordance with AF standards (Tab BB-26). The helmet and mask inspections were current and annotated on a Department of the Army Form 2408-22 (Tab U-4 to U-5). There was no documented inspection for the CRU-60/P because the MM did not provide his own CRU-60/P (Tab U-4 to U-5, Tab V-22.7, and V-23.5). The technicians at the Redstone Test Center used a CRU-60/P from their shop to complete the MM's mask fitting (Tab V-22.7, V-23.5 to V-23.6). It is unclear as to where the CRU-60/P used during the MS came from or if it was inspected prior to use (Tab V-22.7, V-23.5 to V-23.6).

The helmet, mask, and regulator were connected to the CRU-73A regulator on the C3 pallet during the MS (Tab J-6). The CRU-73A was sent to the Human Systems Division of the Air Force Life Cycle Management Center at Wright Patterson AFB for testing (Tab J-6, Tab J-11). Upon arrival at the test center a crack was discovered on the CRU-73A's face plate which is assumed to have occurred during transit as the photos taken after the MS did not show any damage to the regulator (Tab J-9, Tab Z-15). The test results concluded that the attached equipment worked properly and was largely within the limitations of the CRU-73A regulator while noting some divergence at higher testing levels (Tab J-6 and Tab J-21). The breathing rates tested were consistent with the lower workloads expected of an individual sitting down on an aircraft, not performing any duties, which aligned with the mission profile (Tab J-21). Furthermore, the MM was under direct care when, in distress, his breathing profile may have briefly approached the upper limits of the equipment (Tab V11.11).

7. ENVIRONMENTAL CONDITIONS

a. Forecast Weather

The forecast on 21 August 2023 was light winds from the west at 9 knots with slight cloud coverage at 6,000 feet MSL and 20,000 feet MSL (Tab F-4). The temperature was forecasted to be 61 degrees Fahrenheit (F) with a slightly elevated pressure system moving through the area (Tab F-4). The flight plan would transit forecasted light rime icing conditions (icing that forms from water vapor) between 8,000 and 12,000 feet MSL (Tab F-6, F-22 to F-34). All forecasted weather was well within operating limitations for the MS (Tab F-4, F-6 to F-7, F-16 to F-17, F-28 to F-29).

b. Observed Weather

The observed weather at the time of the mishap was consistent with the forecasted weather described above (Tab F-4, F-6 to F-7, F-16 to F-17, F-28 to F-29).

c. Space Environment

Not applicable.

d. **Operations**

There is no evidence to suggest that the MS operated outside prescribed operational limits with respect to weather conditions (Tab F-4, F-6 to F-7, F-16 to F-17, F-28 to F-29).

8. PERSONNEL QUALIFICATIONS

a. **Mishap Instructor Pilot (MIP)**

The MIP is a qualified Airdrop Instructor Pilot with 1,095.9 hours in the C-17A (Tab T-7). The MIP was initially qualified for airdrop operations on 02 June 2021 and was current for airdrop operations on the day of the mishap (Tab G-126, Tab T-15).

The MIP's recent flight time is as follows (Tab T-8):

	Hours
30 days	13.7
60 days	24.0
90 days	47.9

b. **Mishap Copilot 1 (MCP1)**

The MCP1 is a qualified Copilot with 769.4 hours in the C-17A (Tab T-9). The MCP1 was initially qualified for airdrop operations on 17 March 2023 and was current for airdrop operations on the day of the mishap (Tab T-19, Tab T-15).

The MCP1's recent flight time is as follows (Tab T-10):

	Hours
30 days	40.1
60 days	110.5
90 days	141.9

c. **Mishap Copilot 2 (MCP2)**

The MCP2 is a qualified Copilot with 244.7 hours in the C-17A (Tab T-5). The MCP2 is not qualified for airdrop operations and was only onboard as an augmenting crew member (Tab T-4).

The MCP2's recent flight time is as follows (Tab T-6):

	Hours
30 days	30.4
60 days	93.5
90 days	119.7

d. **Mishap Instructor Loadmaster (MIL)**

The MIL is a qualified Airdrop Instructor Loadmaster with 3,141.7 hours in the C-17A (Tab G-55). The MIL was initially qualified for airdrop operations on 19 December 2013 (Tab G-101). The MIL had not accomplished the "Airdrop Med/High Altitude" currency requirement since 22 June 2021 (Tab T-18). "Airdrop Med/High Altitude" is an 'Annual' currency requirement which expires at the end of the last day of the Fiscal Year after the training was accomplished (Tab BB-106 to BB-107). Prior to October of 2022, this currency would have been due by 31 December 2022 because 'Annual' currency aligned with the Calendar Year (Tab BB-103). However, to align with the Air Force Force Generation (AFFORGEN) training and deployment model, AMC changed its 'Annual' currency requirement to align with the Fiscal Year, pushing the MIL's currency due date back to 30 September 2022 (Tab BB-107). Since this reduced the training timeline for the accomplishment of currencies, the 437 OG published guidance extending currencies originally due between 1 July 2022 and 30 September 2022 to 30 September 2023, thus making the MIL current despite not accomplishing an "Airdrop Med/High Altitude" currency requirement for 2 years and 2 months (Tab BB-13).

The MIL's recent flight time is as follows (Tab T-12):

	Hours
30 days	2.6
60 days	2.6
90 days	2.6

e. **Mishap Loadmaster (MLM)**

The MLM is a qualified Airdrop Loadmaster with 466.4 hours in the C-17A (Tab G-158). The MLM was initially qualified for airdrop operations on 30 January 2023 and was current for all airdrop operations on the date of the MS (Tab G-154, Tab T-15).

The MLM's recent flight time is as follows (Tab T-14):

	Hours
30 days	25.7
60 days	65.3
90 days	95.4

f. **Mishap HAAMS 1 (MH1)**

The MH1 is a qualified Instructor/Primary HAAMS crewmember with 306.6 hours of flight time (Tab G-18). The MH1 was initially qualified 07 November 2018 and was current for all airdrop operations on the date of the MS (Tab G-16 to G-27, Tab T-20 to T-21).

The MH1's recent flight time is as follows (Tab G-22):

	Hours
30 days	0
60 days	15.6
90 days	15.6

g. **Mishap HAAMS 2 (MH2)**

The MH2 is a qualified Secondary HAAMS crewmember with 46.0 hours of flight time (Tab G-5). The MH2 was initially qualified 12 January 2023 and was current for all airdrop operations on the date of the MS (Tab G-5 to G-15).

MH2's recent flight time is as follows (Tab G-11):

	Hours
30 days	0
60 days	0
90 days	2.9

h. **Mishap HAAMS 3 (MH3)**

The MH3 is a qualified Instructor/Primary HAAMS crewmember with 204.9 hours of flight time (Tab G-44). The MH3 was initially qualified 24 August 2020 and was current for all airdrop operations on the date of the MS (Tab G-37 to G-48, Tab T-16 to T-17).

The MH3's recent flight time is as follows (Tab G-45):

	Hours
30 days	0
60 days	0
90 days	3.7

Of note, MH1, MH2, and MH3 each operated four prior sorties in Alaska between 05 August and 20 August 2023, totaling 34.5 hours each, that were not captured in their 30-60-90 day times (Tab AA-8 to Tab AA-9).

9. MEDICAL

a. Qualifications

(1) Flight Physicals

At the time of the mishap, all members of the MC had current flight physical examinations and were medically qualified for worldwide flight duty without restrictions (Tab X-8). The MM had a current Federal Aviation Administration (FAA) Flying Class III flight physical (Tab X-31).

(2) Physiological Training

All MC members were current in their required physiology training (Tab T-15). The MM completed initial physiology training on 20 April 2022 which remained valid until 30 April 2027 (Tab T-3).

b. Health

(1) Mishap Crew Members

A medical records review of all MC members showed no relevant medical conditions or illnesses that contributed to the mishap (Tab X-30). MH3 had a previously documented diagnosis of DCS, but this was not contributory in the current mishap (Tab X-30).

(2) Mishap Member

A review of the MM's electronic medical record showed a history of hypertension and obesity, a prediabetes diagnosis, and an active prescription for metformin (Tab X-31). The Federal Drug Administration approves metformin to treat diabetes (Tab X-34). Metformin has also been used to prevent pre-diabetes as well as for weight loss (Tab X-34).

A review of the medical history the MM provided to the FAA for his Flying Class III physical stated the MM had obesity, hypertension, hay fever, and obstructive sleep apnea (OSA) (Tab X-31). He was currently taking medication for hypertension and hay fever (Tab X-31). He further stated that the metformin medication was being taken for weight loss (Tab X-31). The MM was using a Continuous Positive Airway Pressure (CPAP) machine for his OSA and was issued his Flying Class III certificate under special issuance for OSA requiring an annual renewal as opposed to the standard five-year valid time frame (Tab X-31). His physical was valid until 31 July 2024 (Tab X-31).

c. Lifestyle

(1) Mishap Crew Members

Prior to performing flight duties, aircrew members must have proper crew rest defined as a minimum of a 12-hour, non-duty period before the designated flight duty period begins (Tab BB-79). Crew rest is defined as "free time and includes time for meals, transportation and the opportunity for at least eight hours of uninterrupted sleep" (Tab BB-79). The MC arrived one week before the mishap and reported no issues with crew rest (Tab V-5.12, V-1.7, V-7.6, V-9.10, V-14.3). The HAAMS technicians arrived to JBER at the beginning of August and the MH3 reported there were no issues with proper crew rest among the technicians (Tab V-4.11 to 4.12).

(2) Mishap Member

In the week prior to the mission, members of the test team reported that the MM was upbeat and exhibited no symptoms that would prevent participation on the flight (Tab V-13.14 to

V-13.15). The MM was well liked among his colleagues with an easy and outgoing personality (Tab V-11.16, Tab V-17.1). He was extremely proud of his family and frequently shared pictures of them with other crew members both leading up to and on the actual flight (Tab V-11.16, Tab V-17.1). The MM was recognized for his expertise in this mission set, had been identified as an “up-and-comer" with the MDA, and was actively instructing another MDA colleague as part of the mission (Tab V-13.13, Tab V-11.8).

d. Pathology

(1) Mishap Crew Members

Toxicology screening for the MC was performed by the Armed Forces Medical Examiner’s (AFME) office and initial samples were collected on 22 August 2023, after the MM’s death, at approximately 1700L, nearly 24 hours after the MS was complete (Tab X-33). Results of the aircrew testing did not show any abnormal findings (Tab X-33).

(2) HAAMS Crew Members

Toxicology screening for the HAAMS crew members was performed by the AFME’s office and initial samples were collected on 22 August 2023, after the MM’s death, at approximately 1700L, nearly 24 hours after the MS was complete (Tab X-33). The MH1 tested positive for ethanol in both the blood sample (0.036 g%) and urine specimen (0.053 g%) and 11 Nor-9-carboxy-delta-9-tetrahydrocannabinol (THC) in the urine specimen (5 ng/ml) (Tab X-33). Results of the other HAAMS crew members did not show any abnormal findings (Tab X-33).

(3) Autopsy

An autopsy was completed at Madigan Army Medical Center at Joint Base Lewis McChord, Washington, on 26 August 2023 (Tab X-43). The Medical Examiner (ME) determined the cause of death as aerospace decompression sickness with contributing factors of obesity, hypertension, and atherosclerotic cardiovascular disease, with an unknown role for SARS-CoV-2 infection (Tab X-43). The medical examination also revealed an enlarged left ventricle of the heart and advanced blockage of a major coronary artery (Tab X-43). The manner of death was declared as accident (Tab X-43).

The ME further noted decompression sickness occurs when a rapid reduction in ambient pressure causes nitrogen to form bubbles and escape into the bloodstream, as well as the varied clinical presentations expected when those bubbles impact different tissues (Tab X-49). Breathing 100% oxygen prior to reduction in ambient pressure (such as that found at altitude) displaces nitrogen from the airspaces in the lungs, creating a gradient that allows nitrogen to exit the body through exhalation (Tab X-49). Further, adipose tissue holds a greater proportion of dissolved nitrogen than any other body tissue, creating a greater reservoir of nitrogen under obesity conditions (Tab X-49).

Additionally, the examiner commented that enlargement of the heart, in this case with a pathologically thickened left ventricle free wall and interventricular septum (the walls of the heart chamber that pumps blood to the body), was a significant finding (Tab X-49). MM's heart weighed nearly twice the upper limit of the established reference range (Tab X-49). Thickening of the walls reduces the amount of oxygenated blood delivered to the body because the left ventricle is unable to fully relax and fill with blood during the relaxation phase of the heartbeat cycle (Tab X-49).

Finally, the examiner noted both a history of and microscopic evidence of hypertension (high blood pressure) as well as visually evident coronary atherosclerosis (cholesterol buildup causing narrowing of the arteries of the heart) (Tab X-50). Hypertension could contribute to enlargement of the heart, but it would not be expected to cause the degree of enlargement found here (Tab X-50).

10. OPERATIONS AND SUPERVISION

a. Operations

Before each flight duty period, aircrew are required to complete an Aviation Operational Risk Management (AvORM) worksheet to identify then mitigate potential mission risks and ensure safe operations (Tab BB-113 to BB-114). The AvORM system "provides a process to identify operational hazards that require mitigation. [The] process reduces risk to personnel and equipment while successfully accomplishing the mission" (Tab BB-113). The morning of the mishap, the aircrew noted an elevated Health and Stress Score on the AvORM worksheet but were approved for flight by the 618th Air Operations Center (AOC) as the mission's approval authority (Tab K-16, Tab K-24). The elevated AvORM score was attributed to the higher level of stress the MIP experienced regarding mission planning and possible contingency plans requiring the MA to land at a challenging airfield in the Aleutian Islands (Tab V-5.11).

The AvORM worksheet also noted a "suitable" Crew/Mission Match as opposed to "ideal" in reference to the experience level of the aircrew members with this type of airdrop mission (Tab K-24). MCP2 was an inexperienced crew member and was not qualified to act as a primary crew member for the airdrop portion of this mission, thereby requiring direct instructor supervision for supplemental oxygen use (Tab G-4). Though lacking certification to actively participate in airdrop, MCP2 was approved to fly on the sortie as a passive observer under supervision (Tab V-15.1 to V-15.3). Additionally, the MIP was only recently certified as an instructor pilot and identified lower proficiency levels among some of the MC within the previous 30 days as a factor (Tab V-5.5). The lower cumulative experience level of the crew was a direct reflection of challenges in assembling the optimum crew qualification/proficiency mix as a result of the 16 AS's higher operations tempo (Tab V-15.3).

The 437 OG is responsible for the process of ensuring proper qualification and training before assigning personnel to missions as listed on a flight authorization (Tab BB-127). The MC's flight authorization had one minor discrepancy: the failure to annotate when and where the "in-command" pilot assumed command of the mission as well as which mission segments the new pilot would command (Tab BB-127 to BB-128, Tab K-6 to K-8). Of note, the MC's flight authorization had a multitude of "pen-and-ink" changes which approving authorities noted were unusual but necessary to correct for system limitations with the computer program utilized to create flight authorizations (Tab V-15.2, Tab K-6 to K-8, Tab V-34.1). There is no indication these discrepancies contributed to the mishap.

As part of post-mission reporting, HAAMS technicians are required to fill out a Sortie Report, dated March 2023, following each sortie which notes the times while depressurized as well as any actions taken for physiological events. (Tab AA-10). Following the MS, HAAMS members completed a report, in reference to MM, stating: “One of the Eng started hyperventilating after ramp was close on the way back below 10,000 ft. Slowed his rate and depth of breathing down and made him drop his mask around 11,700 so he can perform valsalvas. He got better below 10” (Tab AA-10).

b. Supervision

Special Airlift Assigned Missions (SAAM) assigned by the 618 AOC are in accordance with AFI 11-208, *Mobility Air Forces Management*, and are planned by the 618 AOC’s SAAM Planning Cell at Scott AFB, Illinois (Tab BB-109 to BB-110). Mission execution is closely monitored by the SAAM Execution Cell (Tab BB-111). The 618 AOC, in cooperation with JBER Command Post, monitored the MS for mission completion (Tab BB-111).

MEP are personnel required for mission execution but not authorized aeronautical orders (Tab BB-125). MEPs can include military personnel, United States Government employees, and Government Contractor employees (Tab BB-125). The 437 OG oversaw the MEP approval process for the MS (Tab K-26). Under Department of the Air Force Manual (DAFMAN) 11-401 AMC Sup, *Aviation Management*, four prerequisites are required to qualify for MEP status: 1) a current flight physical (when required) 2) physiological training (when required) 3) aircraft egress training and 4) aircrew flight equipment training (Tab BB-125 to BB-126). DAFMAN 11-401 lacks clear guidance on what type of aircraft egress or aircrew flight equipment training is required to operate on the C-17 (Tab V-2.5). The 437 OG MEP approval letter directs aircraft egress training will be accomplished by an aircrew brief prior to aircraft operations (Tab BB-133, Tab K-27). The 437 OG MEP approval letter does not specifically direct aircrew flight equipment training will be conducted by the aircrew prior to aircraft operations (Tab K-28). Of note, unit leadership stated that the standardized briefing used by AMC aircrew prior to each flight satisfies the requirement for aircraft egress and aircrew flight equipment training (Tab V-35.1).

As part of the process to generate aircrew from home station, the 16 AS creates a folder with all pertinent paperwork and training records to include Go/No-Go charts (training currency to ensure all aircrew are current and qualified), AvORM worksheets, and expected mission locations with schedules (Tab V-15.1 to V-15.2). The 16 AS supplied the MC with these products but included a July 2018 AvORM sheet that was superseded in October 2022 (Tab K-24, Tab BB-181). The MIP subsequently assessed the MS’s risk factors based on the outdated 2018 AvORM sheet, resulting in a minimized assessment of the MS’s overall risk (Tab K-24, Tab BB-181).

11. HUMAN FACTORS ANALYSIS

The Department of Defense Human Factors Analysis and Classification System 8.0 (DoD HFACS 8.0) lists potential human factors that can play a role in aircraft mishaps and identifies potential areas of assessment during an accident investigation. The following human factors played a part in this mishap:

PC 311: Decompression Sickness (Evolved Gas Disorder):
When inert-gas evolves in the blood causing an unsafe situation. This includes chokes, Central Nervous System manifestation, bends, paresthesia or other conditions caused by inert-gas evolution (Tab FF-24).

The MM developed aerospace decompression sickness as a result of the unpressurized, high altitude conditions required for the simulated test airdrop mission (Tab X-4, Tab X-43). The MM exhibited multiple symptoms across DCS's four main symptom categories: limb pain, skin, neurologic, and respiratory symptoms (Tab V-12.10, Tab V-24.1, and Tab R-292).

PC 305: Physical Illness/Injury:
When a physical illness, injury, deficit of diminished physical capability causes an unsafe situation. This includes pre-existing and operationally-related medical conditions, over-exertion, and motion sickness (Tab FF-23).

The MM's underlying medical conditions, to include obesity, hypertension, an enlarged heart, and blockage of the coronary arteries, exacerbated the effects of DCS and substantially contributed to the outcome of the mishap (Tab X-43).

AE 201: Inadequate Real-Time Risk Assessment/Action:
When an individual, through inexperience, faulty logic, poor judgment, or insufficient information, selected or proceeded with the wrong course of action based on an ineffective real-time assessment of immediate hazards during execution of a task/mission/activity, which resulted in the near-miss or mishap (Tab FF-18).

The HAAMS personnel failed to recognize DCS and instead treated the MM for hyperventilation (Tab V-9.3, Tab V-17.1, Tab V-4.3).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publicly Available Directives and Publications Relevant to the Mishap

(1) AFMAN 11-202V3, *Flight Operations*, 10 January 2022
(2) AFMAN 11-202V3_AMCSUP, *Flight Operations*, 14 June 2021
(3) AFMAN 11-2C-17V3, *C-17 Operations Procedures*, 29 July 2019
(4) AFMAN 11-409, *High Altitude Airdrop Mission Support Capability Program*, 19 November 2020
(5) AFMAN 11-301V2, *Management and Configuration Requirements for Aircrew Flight Equipment (AFE)*, 12 February 2020

(6) AMCI 11-208, *Mobility Air Forces Management*, 07 February 2017
(7) AMCI 90-903, *Aviation Operational Risk Management (AVORM) Program*, 03 August 2022
(8) DAFMAN 11-401_AMCSUP, *Aviation Management*, 21 June 2023

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) Technical Order (T.O.) 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies, and Procedures*, 26 September 2022 (Tab BB-139)

c. Known or Suspected Deviations from Directives or Publications

(1) T.O. 14-1-1, *U.S. Air Force Aircrew Flight Equipment Clothing and Equipment*, 3 October 2023 (Chap 6, Para 6.1 (NOTE and Table 6-1)) (Tab BB-144)

The MM was provided an HGU-56/P helmet that did not have a Safe-to-Fly certification per Air Force Life Cycle Management Center (AFLCMC)/WNUV or the approving Major Command (Tab BB-4).

(2) DAFMAN 11-401, AMC Sup, *Aviation Management*, 22 June 2023 (Chapter 4, Para 4.1.11.1.1) (Tab BB-124)

The incoming aircraft commander failed to appropriately annotate assumption of mission command in the remarks section of the flight authorization (Tab K-6, Tab V-15.1).

(3) AFMAN 11-409, *High Altitude Airdrop Mission Support Capability Program*, 20 November 2020 (Attachment 2, A2.2.1) (Tab BB-82)

There was no clear evidence that the intent of establishing constant communication between aircrew and HAAMS was met throughout the duration of the flight (Tab V-5.8, Tab V-7.5).

(4) AMCI 90-903, *Aviation Operational Risk Management*, 4 August 2022 (Chapter 3) (Tab BB-112)

The MC correctly completed an AvORM worksheet per requirements prior to flight, however the worksheet utilized was out of date resulting in an imprecise assessment of the MS's overall risk (Tab K-24, Tab BB-181).

Digitally signed by
SALMI.DEREK.M

27 February 2024

DEREK M. SALMI
Brigadier General, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

C-17A, T/N 10-000215
JOINT BASE ELMENDORF-RICHARDSON, ALASKA
21 AUGUST 2023

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 by the United States or by any person referred to in those conclusions or statements.

1. OPINION SUMMARY

On 21 August 2023, during a high-altitude test mission off the coast of Alaska, the Mishap Member (MM), a General Schedule (GS) 13 civilian assigned to the Missile Defense Agency (MDA), experienced decompression sickness (DCS) symptoms shortly after the unpressurized simulated airdrop portion of the sortie. High Altitude Airdrop Mission Support (HAAMS) physiological technicians aboard the C-17 (T/N 10-000215) mishap aircraft (MA) rendered initial assistance for hyperventilation and mission essential personnel (MEP) attempted to assist the MM for the return portion of the flight. The aircraft was met by emergency medical services upon landing at Joint Base Elmendorf-Richardson (JBER), Alaska, where the MM was taken to the JBER Emergency Room for additional treatment for the DCS-related symptoms. The MM subsequently entered cardiac arrest upon preparatory transfer to a higher-level of care and was pronounced deceased on 22 August 2023.

I find, by the preponderance of the evidence, that the fatality in this mishap was the result of decompression sickness, induced in the high-altitude, unpressurized portion of the military test mission.

I also find, by the preponderance of the evidence, the following factor substantially contributed to the mishap: the pre-existing and underlying medical conditions of the mishap member.

2. CAUSES

I find, by the preponderance of evidence, the mishap member's death was the result of aerospace decompression sickness, manifested during the high-altitude airdrop test mission.

The Medical Examiner's autopsy report, conducted the week following the mishap at Madigan Army Medical Center, Joint Base Lewis-McChord, Washington, states "aerospace decompression sickness" as the diagnosis for the MM's cause of death.

These findings are consistent with the DCS-like symptoms witnessed and described by numerous MEP and crew members in close-proximity to the MM in the aircraft's cargo compartment for the nearly seven-hour mission. The personnel onboard the MA described a largely routine flight profile until approximately four hours into the mission when, following aircraft depressurization to 24,900 feet Mean Sea Level (MSL) and a simulated payload drop with the cargo doors open, the MM motioned physiological distress. The MM specifically signaled for the attention of the physiological technicians, while indicating he was having trouble breathing.

Fellow MEP noted the MM then:

- Complained of a lack of mobility in his right arm
- Could barely write on the whiteboard provided by the HAAMs technicians
- Right arm appeared "droopy"
- Complained of not being able to breathe
- Was sweating profusely
- Had "difficulty even standing up" and "looked like a guy that had been drinking all night"

Approximately one hour later, the MM attempted to rest on an inflatable mattress during the return flight. The MM:

- With MEP assistance, lowered his flight suit around his waist to attempt to cool down
- Could not chew any food
- Could not hold his water bottle
- Appeared pale
- Appeared in pain

Upon landing and after being transferred to medical care, the MM:

- Reported he could not use his right arm in flight
- Continued having difficulty breathing

Decompression sickness may present itself in a number of ways; however, the primary symptoms fall into four major categories:

- **Limb Pain** – Typically joint or muscle pain
- **Skin** – Mottling, pins & needles, tingling, prickling
- **Neurologic** – Cold sweat, sudden onset of fatigue, motor and/or sensory loss, nausea
- **Respiratory** (pulmonary) – Dyspnea (difficult or labored breathing), substernal distress (tightness and/or pain in chest, especially during inspiration)

Comparing the MM's observed in-flight symptoms with documented DCS symptoms results in a match.

The U.S. Air Force has long recognized the potentially dangerous effects of DCS, dating to studies of aircrew members flying in unpressurized bomber aircraft at high altitudes during World War II, and has subsequently developed a series of mitigation measures to include limiting exposure time, pre-breathing 100% oxygen and mandating specialized training and equipment to moderate against its effects.

Despite this increased knowledge, and the layered mitigation efforts required by the U.S. Air Force, the risk of encountering decompression sickness cannot be moderated to zero. In fact, recent medical studies note a 30% chance for any member participating in high-altitude operations to develop some symptoms of DCS that may range from mild to severe.

The MM, despite the limited exposure time and uneventful pre-breathing exercise, as well as the required prior training and protective equipment, displayed each of the prevalent symptoms of DCS at various points across both the flight and subsequent medical treatment.

Based upon these facts, and the reports of the medical personnel, I find by a preponderance of the evidence that the MM's death was the result of DCS.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

I find, by a preponderance of evidence, MM's underlying medical conditions substantially contributed to the mishap.

In addition to the final autopsy diagnosis of DCS, the ME noted obesity, hypertension, an enlarged heart, and blockage of the coronary arteries as contributory factors to the MM's passing.

The MM was a 33-year-old GS employee of the MDA who had participated in high-altitude test airdrop missions for a little more than one year. This sortie was his sixth flight in such a mission profile.

On the day of the mishap, the MM possessed a current Federal Aviation Administration Class III physical as required under Air Force Instruction 11-401, *Flying Operations Aviation Management.* In previous medical examinations he had a documented history of hypertension (blood pressure measured greater than 140/90 systolic/diastolic millimeters of mercury) as well as obesity. The MM had also been diagnosed with prediabetes and was prescribed metformin.

The effects of decompression sickness are more pronounced when the body liberates more excess nitrogen at the reduced atmospheric pressures consistent with higher altitude operations. Additionally, when a member has a Body Mass Index greater than 40 kg/m^2, the increased body mass and resulting greater tissue area corresponds to greater potential for stored excess nitrogen forming into potentially dangerous nitrogen bubbles. These bubbles can damage tissue and nerves as well as block blood flow throughout the body. The autopsy reports the MM's BMI as greater than 45 kg/m^2, contributing to the unusual severity of his DCS symptoms.

Furthermore, the MM's enlarged heart, measured at more than twice the expected size for someone of a similar profile, would be expected to interfere with the effective circulation of blood throughout his body, limiting the critical amount of oxygen that could be delivered and the nitrogen that could be eliminated. These effects were potentially magnified by arterial blockage, in some areas as high as 50% and particularly affecting the Left Anterior Descending artery, which supplies the left ventricle, or the heart's "pumphouse," further hampering the effective movement of blood and oxygen. This lack of blood flow to the tissues in turn allowed the high amounts of nitrogen present to continue to damage the MM's organs, ultimately intensifying the DCS effects.

Of note, the MM also tested positive for COVID-19, a virus that damages blood vessels in the body and lungs, making it more difficult for the body to obtain oxygen, remove carbon dioxide, and limit tissue damage, which may result in respiratory failure. While the ME could not determine the ultimate effects of this infection on the MM, its potential effects on the lungs and blood vessels remain a consideration in the MM's passing.

The failure to recognize DCS by the HAAMS personnel, who instead treated hyperventilation, likely delayed available treatment measures such as continued oxygen use by the MM as well as descent by the aircraft to a lower cabin altitude. Additionally, I was unable to satisfactorily resolve the reason for the lack of follow-on care during the return portion of the flight by the HAAMS personnel despite the persistent and significant symptoms exhibited by the MM and witnessed by onboard MEP. However, ultimately the MM's case of aerospace decompression sickness, coupled with his underlying medical condition, was so severe that actions taken by the HAAMS personnel or the aircrew to mitigate its effects would not, by a preponderance of the evidence, have likely proven successful.

The MM was highly respected by peers, subordinates, and superiors alike and was lauded for his intelligence, future potential, and innate kindness within the MDA community and beyond. His dedication to the mission inspired others to give their best and he left a lasting positive impact on both the mission as well as the colleagues and friends he served with. He will be missed by family, friends, the MDA, and those with whom he served.

4. CONCLUSION

I find, by the preponderance of the evidence, that the fatality in this mishap was the result of decompression sickness, induced as a result of the high-altitude, unpressurized portion of the military test mission.

I also find, by the preponderance of the evidence, the following factor substantially contributed to the mishap: the pre-existing and underlying medical conditions of the mishap member.

Digitally signed by SALMI.DEREK.M

27 February 2024

DEREK M. SALMI
Brigadier General, USAF
President, Accident Investigation Board

INDEX OF TABS