UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT

PD Sabre2 Parachute, Serial Number 021700

412TH OPERATIONS SUPPORT SQUADRON
412TH TEST WING
EDWARDS AIR FORCE BASE, CALIFORNIA

LOCATION: PERRIS, CALIFORNIA

DATE OF ACCIDENT: 10 SEPTEMBER 2019

BOARD PRESIDENT: BRIG GEN PAUL E. KNAPP

Conducted IAW Air Force Instruction 51-307

DEPARTMENT OF THE AIR FORCE
AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

05 FEB 2020

ACTION OF THE CONVENING AUTHORITY

The report of the accident investigation board, conducted under the provisions of AFI 51-307, that investigated the 10 September 2019 mishap near Perris, CA involving a parachute jumper assigned to the 412th Operations Support Squadron, complies with the applicable regulatory and statutory guidance and on that basis is approved.

CARL E. SCHAEFER
Major General, USAF
Deputy Commander

EXECUTIVE SUMMARY
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION

PD Sabre2, S#021700
PERRIS, CALIFORNIA
10 SEPTEMBER 2019

On 10 September 2019, at approximately 1220 hours local time (L), a Survival, Evasion, Resistance and Escape Specialist, Mishap Jumper 1 (MJ1), sustained fatal injuries, and was pronounced dead, following a hard landing during a military parachute training jump from a civilian De Havilland Canada DHC-6 "Twin Otter", tail number N708PV. MJ1 was using an Advanced Parachute System with a Performance Design (PD) Sabre2-170 canopy, S#021700, at Skydive Perris, Perris, California. MJ1 was a member of the 412th Operations Support Squadron, assigned to Edwards Air Force Base, California.

The mishap occurred on the 4th lift of the day and MJ1's second jump. MJ1 was performing a Military Free-Fall jump with a 1.4:1 wing load, which made the parachute much more sensitive to his inputs. At approximately 1155L, the mishap aircraft (MA) took off and climbed to 12,500' Above Ground Level (AGL). MJ1 exited the MA without incident.

At approximately 3,350 ft AGL, MJ1 successfully deployed his parachute and opened to full canopy. MJ1 began flying toward the Desired Impact Point (DIP), setting up a basic landing pattern. At approximately 520 ft AGL, MJ1 turned to a base approach heading west. At 464 ft AGL, MJ1 made a brake input, descended to 401 ft AGL, and resumed full flight. At approximately 340 ft AGL, MJ1 turned to a final approach heading south. MJ1 continued full flight to approximately 274 ft AGL where he made a full brake input for approximately 10 seconds, at which time the canopy stalled. The canopy then collapsed, pitched forward, and started a left spin. This continued for one to two rotations until MJ1 impacted the ground, sustaining non-survivable blunt force injuries.

The Accident Investigation Board (AIB) President found, by a preponderance of the evidence, the mishap was caused by MJ1 over controlling his parachute system, which induced a stall and collapsed his canopy at an altitude too low to recover.

Additionally, the AIB President found, by a preponderance of the evidence, two factors that substantially contributed to the mishap. The first factor was inadequate real-time assessment of the risks associated with a particular course of action. On final approach to the drop zone, MJ1 was at a higher altitude than planned. Rather than overshoot his DIP, MJ1 made a dynamic input to the system without sufficient altitude to recover to a fully inflated canopy. The second factor was fixation. MJ1 was focused on landing at the DIP to the exclusion of recognizing that his altitude was too low for a full brake input. Finally, the AIB President notes that, while not identified as a substantially contributing factor, squadron supervision was unaware of the elevated risks associated with high wing loading when stepping down to smaller parachute sizes. A higher wing load results in a canopy more responsive to operator inputs and a correspondingly reduced margin for error in those inputs. Supervision's inadequate risk assessment enabled an environment of excessive autonomy where operations involving elevated risks, such as high wing loading, did not receive an appropriate level of scrutiny.

SUMMARY OF FACTS AND STATEMENT OF OPINION
PD Sabre2, S#021700
10 SEPTEMBER 2019

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

412 OG	412th Operations Group
412 OSS	412th Operations Support Squadron
412 TW	412th Test Wing
AF	Air Force
AFB	Air Force Base
AFE	Aircrew Flight Equipment
AFI	Air Force Instruction
AFMAN	Air Force Manual
AFMC	Air Force Materiel Command
AFTC	Air Force Test Center
AFTO	Air Force Technical Order
AGL	Above Ground Level
AIB	Accident Investigation Board
AMF	Advanced Military Free-Fall
APS	Advanced Parachute System
AUL	Approved for Use List
BOC	Bottom of Container
CYPRES	Cybernetic Parachute Release
CD	Coroner Deputy
CPR	Cardiopulmonary Resuscitation
DHC	De Havilland Canada
DIP	Desired Impact Point
DoD	Department of Defense
DPAS	Defense Property Accountability System
DZ	Drop Zone
EAAS	Electronic Automatic Activation Device
EMS	Emergency Medical Services
FAA	Federal Aviation Administration
FCIII	Flying Class III
FF	Free-Fall
Ft	Feet
HFACS	Human Factors Analysis and Classification System
HQ	Headquarters
IAW	In Accordance With
JM	Jumpmaster
K	Thousand
L	Local Time
MA	Mishap Aircraft
MAJCOM	Major Command
MC	Mishap Commander
MDZ	Mishap Drop Zone Controller
MFF	Military Free-Fall
MJ	Mishap Jumper
MMC	Major Military Command
MMT	Mishap Medical Technician
MO	Mishap Observer
MR	Mishap Rigger
MT	Mishap Team
NASA	National Aeronautical Space Administration
OG	Operations Group
OI	Operating Instruction
OPR	Office of Primary Responsibility
ORM	Operational Risk Management
OSS	Operations Support Squadron
PD	Performance Design
RSL	Reserve Static Line
SAR	Search and Rescue
SERE	Survival, Evasion, Resistance and Escape
SL	Static Line
SM	Statute Miles
SME	Subject Matter Expert
Sq	Square
STOL	Short Take Off and Landing
T&E	Test and Evaluation
TDY	Temporary Duty
TPP	Test Parachute Program
TW	Test Wing
US	United States
USAF	United States Air Force
WARNO	Warning Order

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

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 18 September 2019, Major General Carl E. Schaefer, Deputy Commander, Air Force Material Command (AFMC), appointed Brigadier General Paul E. Knapp to conduct an accident investigation of a mishap that occurred on 10 September 2019 involving a Military Free-Fall (MFF) Parachuting accident at Skydive Perris, Perris, California (Tab Y-3). The aircraft accident investigation was conducted in accordance with Air Force Instruction (AFI) 51-307, *Aerospace and Ground Accident Investigations*, at March Air Reserve Base, from 4 November 2019 through 22 November 2019 (Tab Y-3). Board members assigned were a medical member (Lieutenant Colonel), a legal advisor (Major), an aircrew flight equipment (AFE)/jumpmaster member (JM) (Master Sergeant), and a recorder (Staff Sergeant) (Tab Y-3 and Y-5 to Y-7). A jumpmaster (Master Sergeant) was assigned as a Subject Matter Expert (SME) (Tab Y-8).

b. Purpose

In accordance with AFI 51-307, *Aerospace and Ground Accident Investigations*, this accident investigation board conducted a legal investigation to inquire into all the facts and circumstances surrounding this Air Force aerospace accident, prepare a publicly releasable report, and obtain and preserve all available evidence for use in litigation, claims, disciplinary action, and adverse administrative action.

2. ACCIDENT SUMMARY

On 10 September 2019, at approximately 1220 hours local time (L), a Survival, Evasion, Resistance, and Escape (SERE) Specialist, hereinafter referred to as mishap jumper 1 (MJ1), sustained non-survivable injuries, and was pronounced dead, following a hard landing during a military parachute training jump at Skydive Perris, Perris, California (Tabs C-5, T-5 and CC-6 to CC-17). MJ1 was using an Advanced Parachute System (APS) with a Performance Design (PD) Sabre2-170 canopy (Tabs D-3 and CC-13). The mishap aircraft (MA) was a DHC-6, tail number N708PV (Tab CC-17). MJ1 was the sole fatality in the mishap (Tab CC-6 to CC-17). MJ1 was a member of the 412th Operations Support Squadron (412 OSS), Test Parachute Program (TPP), assigned to Edwards Air Force Base (AFB), California (Tab CC-3 to CC-4 and CC-16).

3. BACKGROUND

a. Air Force Materiel Command (AFMC)

AFMC is located at Wright-Patterson AFB, Ohio (Tab DD-3). AFMC delivers expeditionary capabilities to the warfighter through development and transition of technology, professional acquisition management, exacting test and evaluation, and sustainment of all Air Force weapon systems (Tab DD-3). AFMC oversees six centers including the Air Force Test Center (Tab DD-4).

b. Air Force Test Center (AFTC)

AFTC is located at Edwards AFB, California (Tab DD-11). AFTC leads the test and evaluation (T&E) mission, conducting developmental T&E and evaluation of air, space, and cyber systems to provide timely, objective, and accurate information to decision makers (Tab DD-11). AFTC has oversight of work accomplished at three primary locations across AFMC, to include: 96th Test Wing, Eglin AFB, Florida; 412th Test Wing, Edwards AFB, California; and Arnold Engineering Development Complex, Arnold AFB, Tennessee (Tab DD-11).

c. 412th Test Wing (412 TW)

The 412 TW plans, conducts, analyzes, and reports on all flight and ground testing of aircraft, weapons systems, software and components as well as modeling and simulation for the United States Air Force (USAF) (Tab DD-13). There are three core components for this mission: flying operations, maintenance, and engineering (Tab DD-13). Flying units under the Operations Group (OG) are called flight test squadrons (Tab DD-14).

d. 412th Operations Group (412 OG)

The 412 OG is the Air Force's largest Flight Test Operations Group (Tab DD-15). The 412 OG is responsible for executing over 300 test programs on 76 aircraft of 12 different types, both manned & remotely piloted (Tab DD-15). The Operations Group tests and evaluates new and modified aircraft and aircraft subsystems for Department of Defense (DoD), Civilian, and Allied customers (Tab DD-15). It provides test program guidance, safety planning, technical direction, and approval for flight and ground test plans (Tab DD-15). Executing the daily test missions are seven regular Air Force and one reserve Flight Test Squadrons, and two Combined Test Forces (Tab DD-15). The Operations Support Squadron oversees flight operations on three airfields and two lakebeds with 22 runways (Tab DD-15).

e. 412th Operations Support Squadron (412 OSS)

The 412 OSS supports the 412 TW and National Aeronautics and Space Administration (NASA) aviation with airfield operations, airspace management, resource scheduling, air traffic control, radio and navigation aid maintenance, flight service station and meteorological services (Tab CC-30). The 412 OSS manages flight records for over 600 aircrew (Tab CC-30). The 412 OSS provides survival training and aircrew flight equipment for personnel operating 17 distinct aircraft types and 81 total aircraft (Tab CC-30). The 412 OSS executes the USAF Test Parachutist Program and co-manages the R-2508 Airspace Complex with the Navy and Army (Tab CC-30).

f. Test Parachutist Program (TPP)

The TPP is the USAF Office of Primary Responsibility (OPR) for the certification of personnel parachute systems and equipment (Tab BB-8). Parachute systems and equipment are authorized via the USAF Approved for Use List (AUL) (Tab BB-8). Requests for TPP action are sent through the Major Military Command (MMC) Personnel Parachute Program Managers (Tab BB-8). The TPP completes a design and safety assessment and test and evaluation, as appropriate (Tab BB-8). After reviewing an item, the TPP will forward all test results, design studies, documentation and a usage recommendation to the requesting MMC and Headquarters (HQ) USAF/A3O-AS (Tab BB-8). HQ USAF/A3O-AS will make a usage approval decision and authorize modification of the USAF AUL (Tab BB-8).

g. Survival, Evasion, Resistance, and Escape (SERE) Specialist

SERE specialists serve as subject matter experts who train all aircrew personnel (and others at risk) on how to handle themselves if they are ever caught up in hostile territory (Tab DD-23). Each SERE Specialist goes through a grueling selection process and if successful, attends the USAF SERE Specialist Training Course (Tab DD-23). During the course, the Specialists must complete three months of intensive on-the-job training (Tab DD-23). Each graduate must attend Airborne School at the US Army Training Center (Tab DD-23). SERE Specialists complete additional qualification training at specialized schools as required such as Scuba Courses, Military Free-Fall Parachuting, and Altitude Chamber (Tab DD-23).

h. De Havilland Canada DHC-6-200 Twin Otter

The De Havilland Canada DHC-6 Twin Otter is a Canadian Short Takeoff and Landing (STOL) utility aircraft developed by De Havilland Canada (Tab DD-26). The aircraft has a fixed tricycle undercarriage, STOL capabilities, twin turboprop engines and high rate of climb (Tab DD-26).

i. Performance Design Sabre2 Main Canopy

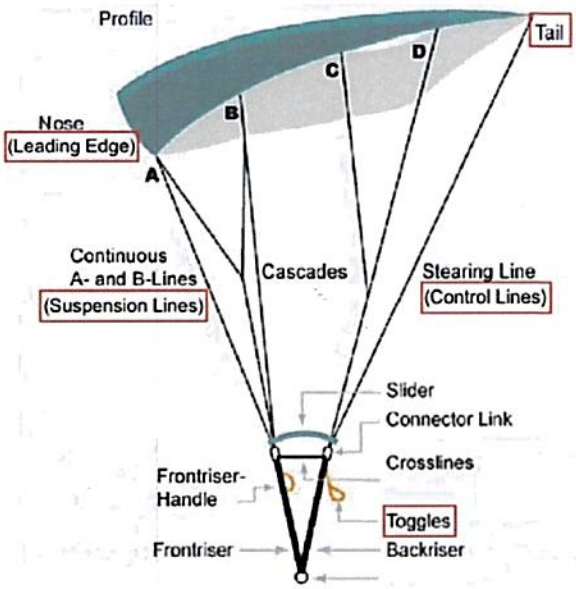
The Sabre2 is a semi-elliptical 9-cell ram-air canopy manufactured by Performance Design and available in 10 different sizes, ranging from 97 to 260 square feet (Tab DD-30). The manufacturer lists the Sabre2's characteristics as having a long recovery arc, steep glide, and powerful bottom-end flare (Tab DD-30). It is advertised to be great for: "novice to intermediate skydivers at lighter wing loads, advanced to expert skydivers at heavier wing loads, and learning the basics of high performance canopy piloting at heavier wing loads (under appropriate supervision)"(Tab DD-30).

j. Wing Load

Wing load is a ratio of the suspended weight of a parachutist in pounds relative to the canopy size in square feet (Tabs BB-157 to BB-158 and DD-32 to DD-37). A higher wing load equates to a heavier parachutist proportional to a smaller canopy size (Tab DD-32 to DD-37). A higher wing load results in a canopy more responsive to operator inputs (Tab DD-32 to DD-37). During landing procedures, a higher wing load reduces the operator's margin for error when applying inputs (Tab DD-32 to DD-37). Other factors being equal, higher wing loading also causes the canopy to reach the stall point with correspondingly less operator input (Tabs U-19 to U-20, BB-57 and BB-59). AFI 11-410, *Personal Parachute Operations*, mandates a maximum wing load ratio of 1:1 (Tab BB-158).

k. Ram-air Canopy Description

Ram-air canopies are made of two fabric layers with a cell-like airfoil in between, which, when moving, automatically fills with air (Tab BB-45 to BB-46). The canopy has a leading edge in the front and a tail in the rear (Tab BB-45). The ram-air canopy's leading edge is open, forming intakes that allow the cells to be ram-air inflated (Tab BB-51). The canopy's suspension lines distribute the suspended load under the canopy without distorting the canopy shape (Tab BB-46). Suspension lines converge to form front and rear risers (Tab BB-46). Control lines originate on the left and right trailing edges of the canopy tail, and converge into right and left steering toggles respectively (Tab BB-46 to BB-48). By manipulation of the toggles, the parachutist may turn, vary forward speed, and vary the rate of descent (Tab BB-52 to BB-55).

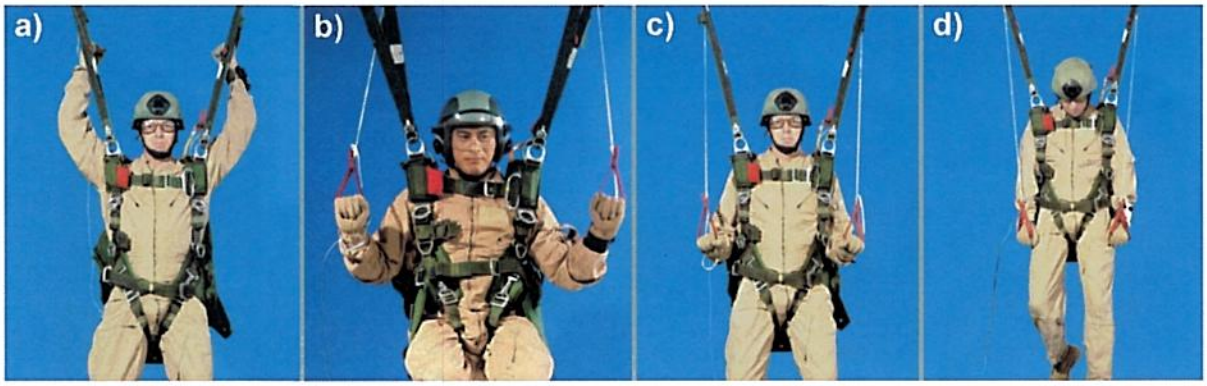


Ram-air Canopy Diagram (Tab Z-10)

l. Parachute "Braking"

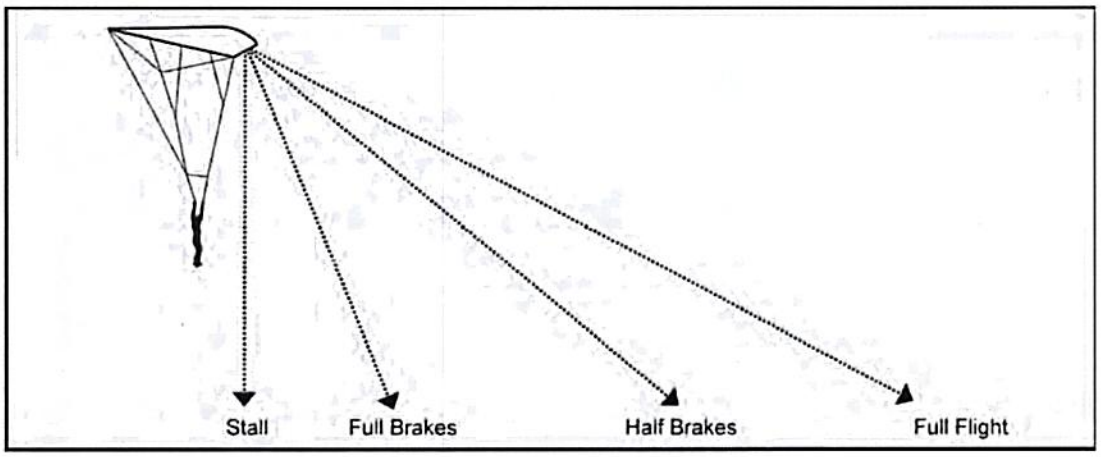
In full flight (no brakes), the toggles are in the all-up position behind the rear/backrisers (Tab BB-57 to BB-58). Pulling down on toggles applies "the brakes" by causing the canopy's trailing edge to deflect downward (Tab BB-51 and BB-57 to BB-58). The "half-brakes" position equates to the parachutist pulling the toggles down to shoulder or chest level (Tab BB-58 to BB-59). The speed of forward flight will decrease and the rate of descent will decrease (Tab BB-51). The glide angle increases with further lowering of toggles (Tab BB-57). "Full-brakes" position equates to the

parachutist pulling the toggles to about waist level (Tab BB-59 to BB-60). As "full brakes" are reached, the canopy is actually on the verge of a stall (Tab BB-59 to BB-60). Using this brake setting at too low an altitude has injured many jumpers (Tab BB-59). The wing ceases to generate dynamic lift, resulting in an increased rate of descent at an almost vertical descent angle (Tab BB-59). All canopies are prone to surging forward when coming out of this flight mode (Tab BB-59).



Full Flight Half Brakes Full Brakes Stall

(Tab BB-58 to BB-60)



Brake-setting glide angles (Tab BB-57)

m. Parachute Stall

Pulling the toggles beyond full brakes can cause the parachute to cease flying and enter a stall (Tab BB-59). The canopy will attempt to fly backward and the rate of descent can increase to a hazardous degree (Tab BB-59). During a stall, the forward speed is 0 mph, descent rate is 20 to 26 feet per second and canopy may have directional instability (Tab BB-60). Variances in stall point location can vary from canopy to canopy or on the same canopy with different wing loading, with higher wing loading corresponding to reaching the stall point with less input (Tabs U-19 to U-20 and BB-59). Air Force Manual (AFMAN) 11-411(I), *Special Forces Military Free-Fall Operations*, specifically warns parachutists to avoid inputs that would stall the parachute below 500 ft AGL (Tab BB-61). In Air Force Technical Orders and manuals, a "Warning" signifies "an essential operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in injury to, or death of, personnel or long term health hazards" (Tab BB-171).

WARNING

The parachutist must not move the toggles quickly from the stall to the full-flight position, as the canopy will surge forward with an increased rate of descent. The parachutist must avoid stalling the ram-air parachute below 500 feet AGL.

Stall warning (Tab BB-61)

4. SEQUENCE OF EVENTS

a. Mission

The 412 OSS mishap team (MT) was scheduled to be TDY 9-14 September 2019 from Edwards AFB to Perris, California, to conduct Static Line (SL)/Military Free-Fall (MFF) parachute jump training to maintain proficiency and current parachutist status (Tab G-3 to G-4). The MT parachutists were to perform SL and MFF operations (Tab G-3). Parachute systems to be utilized during proficiency training were as follows: APS, Low-Profile Parachute, MC-1, MC-6, Sigma Tandem System, T-10R and T-11R (Tab G-3). The mission was authorized by the Squadron Director of Operations, MO (Tab V-5.2). The MA was provided and operated by Skydive Perris (Tab V-9.2). Additional members of the 412 OSS present at the mishap site, hereinafter referred to as mishap team (MT), included mishap jumper 2 (MJ2), mishap jumper 3 (MJ3), mishap jumper 4 (MJ4), mishap jumper 5 (MJ5), mishap observer (MO), mishap drop zone controller/malfunction officer (MDZ), mishap rigger 1 (MR1), mishap rigger 2 (MR2), and mishap medical technician (MMT) (Tab G-3). MO is the 412 OSS Director of Operations and MJ3 is the TPP Superintendent (Tab V-4.1 and V-5.1).

b. Planning

On the morning of the mishap, the MT conducted mission preparation with in-depth briefs that included: emergency procedures, equipment inspections, calculated release point, walk-throughs of aircraft procedures and jump profile (Tab BB-71 to BB-128). The MDZ would maintain communications with the MA and JM to pass current winds (Tab BB-37).

c. Jumpmaster Briefing

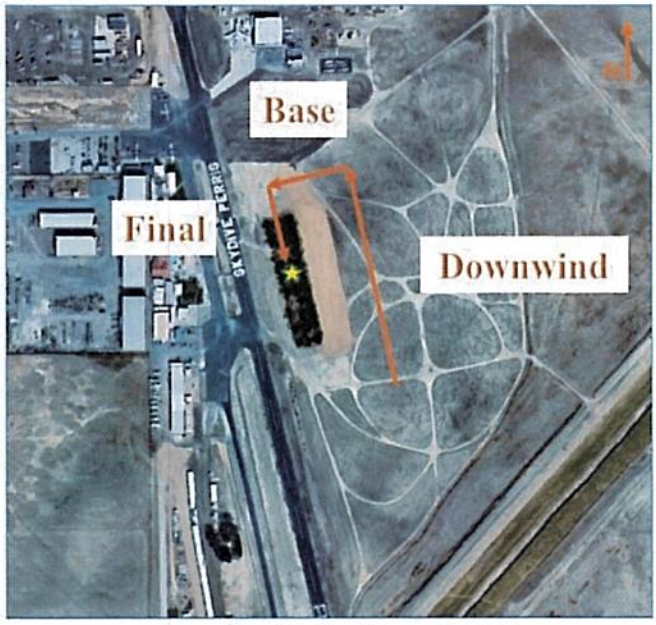
On 10 September 2019 at 0800L, MJ1, the JM, conducted the MFF JM brief from a squadron approved JM checklist (Tab BB-71 to BB-128). MO, the Squadron Director of Operations, was present for the mission planning and briefings (Tab V-5.2). According to witness testimony, the briefing was very thorough and covered all required emergency procedures for MFF parachute jump operations (Tab V-4.6 to V-4.7). However, a review of the JM checklist found several deficiencies (Tab BB-71 to BB-128 and BB-160 to BB-169). Examples include references to contacting and utilizing Fairchild AFB, WA, instead of their actual location, as a base of operations and having incomplete Bottom of Container (BOC) Emergency Procedures annotated on the checklist (Tab BB-73 to BB-74 and BB-173 to BB-175). There is no evidence to suggest that the JM brief given or deficiencies in the checklist were a factor in the mishap.

d. Summary of Accident

Due to morning low clouds on the day of the mishap, MT decided to perform two SL lifts before conducting MFF lifts (Tab EE-7). The MT conducted two SL lifts without incident (Tab EE-7 and EE-55). MJ1 did not jump in the first two lifts (Tab V-3.13). MJ1 jumped on the 3rd and 4th lifts

with a Sabre2-170 canopy and wing load of 1.4:1 (Tabs V-3.13 and X-5). The 3rd lift was an uneventful MFF (Tab V-4.14).

The mishap occurred on the 4th lift (Tab V-3.13). MJ1 and MJ2 were jumping and practicing camera work while MJ3 was conducting a tandem jump with MJ4 as a tandem passenger (Tab V-4.14). At approximately 1155L, the team loaded the MA, took off, and climbed to approximately 12,500 ft Above Ground Level (AGL) (Tab CC-31). At the direction of MJ2, the primary JM for this lift, the team exited the MA without incident (Tabs CC-45 and EE-6).



Map of Skydive Perris DZ with basic landing pattern (Tab Z-5)

At approximately 3,350 ft AGL, MJ1 successfully deployed his parachute and opened to full canopy. (Tab CC-45). MJ1 began flying toward the Desired Impact Point (DIP), setting up a basic landing pattern (Tab V-4.7 to V-4.8 and V-4.14).

At approximately 520 ft AGL, MJ1 turned to a base approach heading west. (Tab CC-42). At 464 AGL, MJ1 made a brake input, descended to 401 ft AGL, and resumed full flight (Tab CC-42). At approximately 340 ft AGL, MJ1 turned to a final approach heading south (Tab CC-43). MJ1 was at a higher altitude than planned as he approached the landing zone and was on course to overshoot DIP (Tab V-2.2 to V-2.3). MJ1 continued full flight to approximately 274 ft AGL where he made a full brake input for approximately 10 seconds at which time the canopy stalled (Tabs V-2.2, V-7.2, and CC-43). There was insufficient altitude at this point to recover to a fully inflated canopy (Tab V-2.2 and V-7.2). The canopy then collapsed, pitched forward, and started a left spin (Tab V-2.2 and V-3.3). This continued for one to two rotations until MJ1 impacted the ground, sustaining non-survivable blunt force injuries (Tabs V-3.4, V-7.2 to V-7.3, and X-3).

e. Landing Zone

At approximately 1220(L), MJ1 impacted the ground on the grassy landing area (Tabs C-5 and V-4.14 to V-4.15). From analysis of MJ1's altimeter, the approximate speed at impact was 29 mph (Tab CC-44).

f. Egress and Aircrew Flight Equipment (AFE)

MJ1's parachute system performed as designed (Tabs V-3.11, CC-45, and EE-7).

g. Search and Rescue (SAR)

MJ1 impacted within the designated landing zone of Skydive Perris (Tab V-4.14 to V-4.15). The MMT observed MJ1's impact (Tab V-8.8). Shortly thereafter, MMT was on-scene providing resuscitative medical care (Tab V-8.9). MMT observed MJ1 to be unconscious, pulseless, and exhibiting agonal breathing (Tab V-8.9). Cardiopulmonary resuscitation (CPR) was initiated by the MMT while 911 was contacted and an air ambulance was requested (Tab V-8.9). Riverside Emergency Medical Service (EMS) arrived on scene at 1231(L) (Tab X-3). Reach Air medical transport helicopter arrived on scene shortly thereafter (Tab X-3). The resuscitation efforts were unsuccessful (Tab X-3). Time of death was recorded at 1302(L) on the Skydive Perris landing zone (Tab X-4).

h. Recovery of Remains

Riverside County Sheriff's Department responded to the 911 call and arrived on scene at approximately 1247(L) (Tab CC-11). The responding officers contacted Riverside County Sheriff's Department Coroner's Bureau and notified them of the incident (Tab CC-11). The Coroner Deputy (CD) arrived at the scene and conducted a death investigation (Tab CC-11). CD transported MJ1 to the Riverside Coroner's Office in the City of Perris, California (Tab CC-11).

5. MAINTENANCE

a. Forms Documentation

The MA was commercially contracted and had valid Federal Aviation Administration (FAA) registration and airworthiness certificates properly posted in the interior (Tab Z-6 to Z-7). The pilot possessed a valid FAA First Class flying license and driver's license (Tab Z-8 to Z-9).

b. Inspections

(1) Aircraft

No documentation was provided by the contractor concerning pre-flight inspections. There is no evidence to suggest the aircraft was a factor in the mishap.

(2) Parachutes

The Sabre2-170 main canopy was packed in a Javelin Odyssey container, which is required to be inspected and re-packed every 180 days, in accordance with commercial manuals (Tabs D-3 to D-10 and U-72). The inspections were tracked in the Defense Property Accountability System (DPAS) and recorded on Air Force Technical Order (AFTO) Form 391 (Tabs D-3 to D-10 and Tab U-4 to U-14). Post-mishap inspection of MJ1's actual gear revealed that the majority of the parachute items on the DPAS electronic form were incorrectly annotated, to include the Electronic Automatic Activation Device (EAAD), the main and reserve canopy, and harness container (Tabs D-3 to D-10 and Tab U-4 to U-14).

MJ1's mishap parachute system received all of the required inspections (Tabs D-3 to D-10 and U-4 to U-14). The main parachute used by MJ1 was last inspected on 23 Aug 19, and the reserve parachute was last inspected on 15 May 19 (Tabs D-3 to D-10 and U-4 to U-14). All inspections were up to date on the day of the mishap (Tabs D-3 to D-10 and U-4 to U-14). There is no evidence to suggest that parachute maintenance was a factor in this mishap.

c. Maintenance Procedures

(1) Advanced Parachute System

Even though all inspections were up to date, the DPAS Form 1 contained incorrect information (Tabs D-3 to D-10 and U-4 to U-14). There is no evidence to suggest the incorrect annotations on the DPAS Form 1 were a factor in this mishap.

MJ1 parachute maintenance records/items	DPAS Form 1	AFTO Form 391	Actual Parachute System jumped
EAAD	Military CYPRES 2		Vigil 2
Harness Container	Vector 3	No data recorded	Javelin Odyssey
Main Canopy	190 sq ft Silhouette		170 sq ft Sabre2
Reserve Canopy	PR-235 sq ft		193 sq ft Optimum

Maintenance Records Summary (Tabs D-3 to D-10 and U-4 to U-14)

d. Maintenance Personnel and Supervision

Not applicable.

e. Fuel, Hydraulic, and Oil Inspection Analyses

Not applicable.

f. Unscheduled Maintenance

Not applicable.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS

a. Structures and Systems

(1) Advanced Parachute Systems

During the medical response, MJ1's gear and clothes were cut off and removed (Tab V-8.9). MJ1's parachute system was otherwise not damaged. MJ1's APS harness assembly was comprised of RSL, Reserve Ripcord Handle, BOC Pilot chute, and main cut-away pillow (Tab U-74 to U-98). The Board found no evidence to suggest the APS was a factor in the mishap.

(2) Personal Equipment

MJ1's helmet, camera, and altimeter were not damaged during the mishap (Tab CC-48). The wrist altimeter can be toggled to display altitude or speed and functioned as designed during the mission (Tabs U-447 and CC-45). In his Go Pro video, MJ1 visibly checked the wrist altimeter multiple times during his descent (Tab CC-45). The audible altimeter screen was cracked and unreadable (Tab Z-4). There is no evidence to suggest personal equipment was a factor in this mishap.

b. Evaluation and Analysis

A thorough inspection and layout of MJ1's parachute, helmet, and altimeter were conducted following the mishap (Tab CC-48). The altimeter data was synchronized by the Safety Board to show the altitude and speed on free-fall, parachute opening, action under canopy, and landing approach (Tab CC-31 to CC-44).

7. WEATHER

a. Forecast Weather

At 0800L, the forecast weather from March Air Reserve Base, California, the closest weather station to Skydive Perris, included low morning clouds dissipating to clear sky conditions and light winds (Tab W-4 to W-6).

b. Observed Weather

At 1155L, MDZ reported winds out of the south light and variable for the DZ (Tab V-3.3).

c. Space Environment

Not applicable.

d. Operations

MJ3 and MDZ, both members of the TPP, mention suggestively the wind conditions in their statements, with MJ3 suggesting that a dust devil might have had a role in the canopy stalling (Tab V-3.11 and V-4.17). However, no one witnessed a dust devil near the landing zone or any wind conditions at the time of the mishap that would be unfavorable for safe operations (Tab V-1.5, V-2.3 to V-2.4, V-3.3, V-3.11, V-4.8, V-4.14, and V-8.10). Observed weather, cloud cover, ceilings, wind limitations and visibility met the requirements to conduct SL and MFF operations in accordance with AFI 13-217, *Drop Zone and Landing Zone Operations* (Tab BB-22 to BB-23).

8. CREW QUALIFICATIONS

MJ1 was an Air Force Staff Sergeant SERE Specialist with 7 years and 10 months of active-duty service (Tab T-3). MJ1 was assigned to 412 OSS as the Non-Commission Officer In-Charge of the SERE Operations and Training (Tab T-3). MJ1 was qualified as a Master Parachutist with 346 total jumps, two combat deployments and a distinguished service record (Tabs O-27 to O-74 and T-5 to T-8). MJ1's decorations include an Air Force Commendation Medal and two Air Force Achievement Medals (Tab T-3).

MJ1 was a qualified and current SL, Static Line JM, MFF and Military Free-Fall JM parachutist (Tab O-75 to O-80). MJ1 graduated from the U.S. Army Airborne Course on 19 July 2013, the U.S. Navy Military Free-Fall Course on 2 February 2018, the U.S Army Static Line Jumpmaster Course on 23 July 2018, and the U.S. Army Military Free-Fall Jumpmaster Course on 21 May 2019 (Tab O-75 to O-80). MJ1's last training jump occurred on the same day as the mishap, 10 September 2019 (Tab V-4.14). Additional unit qualifications and completion dates are as follows: APS 7 March 2018, Test Parachutist 26 Jun 2018, Advanced Military Free-Fall (AMF) Photo 2 November 2018, and Emergency Parachute System 25 July 2018 (Tab O-12 to O-23). MJ1 has a start date with no completion date of the following qualifications: Certified MFFJM start date of 3 June 2019, APS JM start date of 3 June 2019, Emergency Parachute JM start date of 3 June 2019 and Test Parachutist JM start date of 3 June 2019 (Tab O-15). There are no dates annotated on either the AF Form 797 or AF Form 623A for certification of the following qualifications, however, these are certified by the unit commander on a standard consolidated document called the Letter of X's: Advanced Military Free-Fall (AMF) and Free-Fall (FF) (Tab O-76).

Jump History (Tab O-27 to O-74)

Member (MJ1)	Static Line	Military Free-Fall	Jumpmaster	Total Jumps
30 Days	4	19	23	23
60 Days	5	29	34	34
90 Days	11	38	49	49
Career Total	61	285	53	346

Ratings:
Basic Parachutist - 19 Jul 13 (Tab O-80)
Master Parachutist – Met requirements but not officially processed at time of mishap (Tab CC-18).

9. MEDICAL

a. Qualifications

At the time of the mishap, MJ1 was medically qualified for flying duty (X-3). There is no evidence to suggest physical and medical qualifications were factors in the mishap.

b. Health

MJ1 was in good health and had no performance limiting conditions or illnesses at the time of the mishap (Tab X-3 to X-4). There is no evidence to suggest that any medical condition or illness contributed to the mishap.

c. Pathology

On 11 September 2019, an autopsy of MJ1 was conducted at Riverside County Coroner, Perris, California (Tab X-3 to X-4). Results from the autopsy revealed that MJ1 died from blunt force injuries sustained during the mishap (Tab X-4).

d. Lifestyle

Toxicology screens on MJ1 revealed no evidence of alcohol, carbon monoxide poisoning, or drug abuse (Tab X-3). The Armed Forces Medical Examiner performed toxicology screens on MJ2, MJ3, MJ4, MO, MDZ, MR1, and MR2, which revealed no evidence of alcohol or drug abuse and an absence of carbon monoxide poisoning (Tab X-3). 72 hour and 7 day histories were collected from all mishap jumpers (including MJ1), MO, MDZ, MR1, and MR2 (Tab X-3). There is no evidence to suggest lifestyle factors contributed to the mishap.

e. Crew Rest and Crew Duty Time

All 72 hour histories were reviewed, and revealed crew rest and crew duty time requirements, as specified in AFI 11-410, *Personnel Parachute Operations*, were satisfied (Tab X-3). There is no evidence to suggest crew rest or crew duty time contributed to the mishap.

10. OPERATIONS AND SUPERVISION

a. Operations

The MT proficiency jump was a recurring event at Skydive Perris and was scheduled well in advance of the mishap jump (Tabs G-3 to G-4). MT and all involved support personnel had enough notice to complete required coordination, briefings, and administrative paperwork without undue haste or confusion (Tabs G-3 to G-4, V-4.6 to V.47, and V.5.2 to V-5.3). MJ1's jumpmaster brief was professional and well developed (Tab V-4.6 to V-4.7). 412 OSS leadership described their operations tempo as busy, but normal (Tabs V-5.3). There is no evidence to suggest that operations tempo was a factor in this mishap.

b. Supervision

The 412 OSS coordinated and scheduled the MFF operation at Skydive Perris in accordance with guidance and procedures (Tab G-3 to G-4).

A qualified JM, Drop Zone Control Officer, medical technician, and support personnel were present during MFF operations in accordance with guidance and regulations (Tabs G-3 to G-4, BB-4 to BB-6, BB-10 to BB-43, and BB-130 to BB-131).

Operational Risk Management (ORM) for the MFF operation was assessed as "Low" prior to the start of the mission and was briefed on 10 September during MJ1's jumpmaster briefing in accordance with applicable guidance and regulations (Tabs V-4.6 to V-4.7). The TPP does not sign and maintain copies of ORM worksheets, therefore, the Accident Investigation Board (AIB) could only verify the accuracy of the briefed risk through witness testimony (Tab V-4.7).

Squadron supervision was insufficiently aware of the elevated risks associated with high wing loading when stepping down to smaller parachute sizes (Tab V-4.10, V-6.4, and V-6.9). AFI 11-410 mandates a maximum wing load ratio of 1:1 (Tab BB-157 to BB-158). MJ1 was jumping on a 170 square foot APS with a wing loading of 1.4:1 (Tab X-5). A higher wing load results in a canopy more responsive to operator inputs and a correspondingly reduced margin for error in those inputs, including increased risk for abrupt canopy stall on an APS (Tabs DD-32 to DD-37 and U-19 to U-20).

In 2014, the TPP had an exception to policy to operate up to a 1.5:1 wing load ratio (Tab CC-46 to CC-47). This exception to policy was expired and had not been reviewed or renewed. HQ USAF waivers are valid for only the period of time required to correct the waiver condition, not to exceed 24 months from the date of approval (Tab BB-133). Squadron supervision provided an email response from the Air Force PPPM, dated 6 March 2017, as a justification to proceed with the higher wing-loading ratios allowed in the expired exception to policy (Tab CC-49 to CC-50). However, the email does not clearly grant such an extension and was 30 months old at the time of the mishap (Tab CC-49 to CC-50). Additionally the TPP did not have an AF/A3O-AS approved step down plan of instruction (Tab CC-19 and CC-46 to CC-47). "Step down" refers to jumping a smaller parachute with a correspondingly higher wing load (Tab CC-46). The waiver stipulated that "step down" training be documented in the jumper's training record and there is no evidence or documentation to support that this training was accomplished appropriately or completely (Tab CC-19 and CC-46 to CC-47). Under AFI 11-410, paragraph 2.11, the commander of an organization with active parachutists is responsible for proper use of parachute systems (such as following wing loading requirements), appropriate implementation of waivers, and proper accomplishment of training requirements (such as step down training) (Tab CC-52). Given that higher levels of wing loading correspond to increased risk of serious injury or death, waivers relating to wing loading merit the special attention of squadron leadership.

Several witnesses, including current and former 412 OSS leadership, indicated a very high level of autonomy in TPP and the lack of a strong understanding of the risks in TPP operations (Tabs V-5.3, V-6.4, EE-23 to EE-24, and EE-46 to EE-48). The evidence suggests the autonomy afforded to the TPP was excessive and enabled an environment where operations involving elevated risks, such as high wing loading, did not receive an appropriate level of scrutiny.

11. HUMAN FACTORS

The Department of Defense Human Factors Analysis and Classification System 7.0 (DoD HFACS 7.0) lists potential human factors that can play a role in aircraft mishaps (Tab BB-134 to BB-137). Human factors describe how a person's interaction with tools, tasks, working environments, and other people influence human performance (Tab BB-138 to BB-154). The AIB considered all human factors as prescribed in the DoD HFACS 7.0 (Tab BB-134 to BB-137).

Two human factors were identified as being relevant to the mishap: (1) Inadequate Real-Time Assessment and (2) Fixation.

a. Inadequate Real-Time Assessment (AE 201)

Inadequate Real-Time Assessment is a factor when an individual fails to adequately evaluate the risks associated with a particular course of action and this faulty evaluation leads to inappropriate decision-making and subsequent unsafe situations (Tab BB-139).

b. Fixation (PC102)

Fixation is a factor when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others (Tab BB-146).

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Publically Available Directives and Publications Relevant to the Mishap

(1) AFI 51-307, *Aerospace and Ground Accident Investigations*, 18 March 2019
(2) AFI 11-410, *Personnel Parachute Operations*, 4 August 2008
(3) AFI 13-217, *Drop Zone and Landing Zone Operations*, 10 May 2007
(4) AFI 91-204, *Safety Investigation and Hazard Reporting*, 27 April 2018

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

b. Other Directives and Publications Relevant to the Mishap

(1) ATP 3-18.11 (FM 3-05.211)/AFMAN 11-411(I)/NTTP 3-05.26M, *Special Forces Military Free-Fall Operations*, 24 October 2014

c. Known or Suspected Deviations from Directives or Publications

(1) AFI 11-410, *Personnel Parachute Operations*, 4 August 2008, paragraph 8.1.4

Digitally signed

28 JANUARY 2020

PAUL E. KNAPP
Brigadier General, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

PD Sabre2, S#021700
SKYDIVE PERRIS, CALIFORNIA
10 SEPTEMBER 2019

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

1. OPINION SUMMARY

On 10 September 2019, at approximately 1220 hours local time (L), a Survival, Evasion, Resistance and Escape Specialist sustained non-survivable injuries following a hard landing during a military parachute training jump from a civilian De Havilland Canada DHC-6 Twin Otter, tail number N708PV. Mishap jumper (MJ1) was using an Advanced Parachute System (APS) with a Performance Design (PD) Sabre2-170 canopy, Serial Number 021700, at Skydive Perris, Perris, California. MJ1 was a member of the 412th Operations Support Squadron (412 OSS), assigned to Edwards Air Force Base, California.

I find, by a preponderance of the evidence, the mishap was caused by MJ1 over controlling his parachute system, which induced a stall and collapsed his canopy at an altitude too low to recover.

Additionally, I find, by a preponderance of the evidence, two factors that substantially contributed to the mishap. The first factor was inadequate real-time assessment of the risks associated with a particular course of action. On final approach to the drop zone, MJ1 was at a higher altitude than planned. Rather than overshoot his desired impact point (DIP), MJ1 made a dynamic input to the system without sufficient altitude to recover to a fully inflated canopy. The second factor was fixation. MJ1 was focused on landing at the DIP to the exclusion of recognizing that his altitude was too low for a full brake input.

Though not identified as a substantially contributing factor, I note that squadron supervision was unaware of the elevated risks associated with high wing loading when stepping down to smaller parachute sizes. Supervision's inadequate risk assessment enabled an environment of excessive autonomy where operations involving elevated risks, such as high wing loading, did not receive an appropriate level of scrutiny.

I developed my opinion by analyzing factual data from historical records, Air Force directives and guidance, expert analysis, and witness testimony.

2. CAUSE

I find, by a preponderance of the evidence, the mishap was caused by MJ1 over controlling his parachute system, which induced a stall and collapsed his canopy at an altitude too low to recover.

On 10 September 2019, MJ1 and his teammates were conducting routine parachute proficiency

training at Skydive Perris, Perris, CA. The mishap occurred on MJ1's second jump of the day, which was a Military Free-Fall jump. MJ1 exited the plane at 12,500 ft Above Ground Level (AGL) and deployed his canopy without incident at approximately 3,350 ft AGL. At approximately 520 ft AGL, MJ1 turned to base approach heading west. At 464 ft AGL, MJ1 made a brake input, descended to 401 ft AGL, and resumed full flight. At approximately 340 ft AGL, MJ1 turned to a final approach heading south. MJ1 continued full flight to approximately 274 ft AGL where he made a full brake input for approximately 10 seconds at which time the canopy stalled. The canopy then collapsed, pitched forward, and started a left spin. This continued for one to two rotations until MJ1 impacted the ground, sustaining non-survivable blunt force injuries.

3. SUBSTANTIALLY CONTRIBUTING FACTORS

a. Inadequate Real-Time Assessment (AE 201)

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

On final approach to the DZ, MJ1 was at a higher altitude than planned. Rather than overshooting his DIP, MJ1 made a dynamic input to the system without sufficient altitude to recover to a fully inflated canopy. Evidence indicates that his altimeter was working as designed and that he had checked it multiple times during his descent. At approximately 274 ft AGL, he applied a full brake input that resulted in a stalled canopy. The stalled canopy collapsed and MJ1 entered an uncontrolled spin until impact with the ground. Applying "full brakes" places a canopy at risk of stall. AFMAN 11-411(I) *Special Forces Military Free-Fall Operations* carries a warning, "The parachutist must avoid stalling the ram-air parachute below 500 ft AGL." In Air Force Technical Orders and manuals, a "Warning" signifies "an essential operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in injury to, or death of, personnel or long term health hazards." MJ1's inadequate real-time assessment substantially contributed to the mishap.

b. Fixation (PC102)

Fixation is a factor when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others.

MJ1 was focused on landing at the DIP and did not recognize that his altitude was too low for a full brake input on final approach. MJ1's fixation on the DIP to the exclusion of other critical cues substantially contributed to the mishap.

4. Performed Inadequate Risk Assessment

Squadron supervision was unaware of the elevated risks associated with high wing loading when stepping down to smaller parachute sizes. Air Force Instruction (AFI) 11-410 *Personnel Parachute Operations* mandates a maximum wing load ratio of 1:1. MJ1 was jumping on a 170 square foot parachute with a wing loading of 1.4:1. A higher wing load results in a canopy more responsive to operator inputs and a correspondingly reduced margin for error in those inputs. It also involves an increased risk of stalling the parachute. In 2014, the Test Parachute Program (TPP) had an exception to policy to operate up to a 1.5:1 wing load ratio. This exception to policy

was expired and had not been reviewed or renewed. Headquarters Air Force (HQ AF) waivers are valid for only the period of time required to correct the waiver condition, not to exceed 24 months from the date of approval. Even if the waiver was still valid, the TPP did not have a HQ AF/A3O-AS approved step down plan of instruction as required in the exception to policy waiver. "Step down" refers to jumping a smaller parachute with a correspondingly higher wing load. Additionally, the waiver stipulated that "step down" training be documented in the jumper's training record and there is no evidence or documentation to support that this training was accomplished appropriately or completely. Supervision's inadequate risk assessment enabled an environment of excessive autonomy where operations involving elevated risks, such as high wing loading, did not receive an appropriate level of scrutiny.

5. CONCLUSION

I find, by a preponderance of the evidence, the mishap was caused by MJ1 over controlling his parachute system, which induced a stall and collapsed his canopy at an altitude too low to recover.

Additionally, I find, by a preponderance of the evidence, two factors that substantially contributed to the mishap. The first factor was inadequate real-time assessment of the risks associated with a particular course of action. On final approach to the drop zone, MJ1 was at a higher altitude than planned. Rather than overshoot his DIP, MJ1 made a dynamic input to the system without sufficient altitude to recover to a fully inflated canopy. The second factor was fixation. MJ1 was focused on landing at the DIP to the exclusion of recognizing that his altitude was too low for a full brake input.

Finally, though not identified as a substantially contributing factor, it should be noted that squadron supervision was unaware of the elevated risks associated with high wing loading when stepping down to smaller parachute sizes. Supervision's inadequate risk assessment enabled an environment of excessive autonomy where operations involving elevated risks, such as high wing loading, did not receive an appropriate level of scrutiny.

28 JANUARY 2020

PAUL E. KNAPP
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