

الهيئة العامة للطيران المدني  
GENERAL CIVIL AVIATION AUTHORITY



# Air Accident Investigation Sector

## Accident Investigation

### - Summary Report -

AAIS Case N° AIFN/0006/2024

# Parachute Collapse and Ground Impact Due to Canopy Suspension Line Breakage

Operator:	Skydive Dubai POA
Make and Model:	Fluid Wings, AirWolf2
Place of Occurrence:	Margham, Dubai
State of Occurrence:	The United Arab Emirates
Date of Occurrence:	8 March 2024



This Investigation is conducted pursuant to the United Arab Emirates (UAE) *Federal Act No. 20 of 1991*, promulgating the *Civil Aviation Law, Chapter VII- Aircraft Accidents*, Article 48. It is in compliance with the *Air Accident and Incident Investigation Regulation (AAIR)*, and in conformity with *Annex 13* to the Convention on International Civil Aviation.

The sole objective of this Investigation is to prevent aircraft accidents and incidents. It is not the purpose of this activity to apportion blame or liability.

The Air Accident Investigation Sector issued this Summary Report in accordance with national and international standards and best practices. Consultation with applicable stakeholders, and consideration of their comments, took place prior to the publication of this Report.

The Summary Report is publicly available at:

<http://www.gcaa.gov.ae/en/epublication/pages/investigationReport.aspx>

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## Investigation Process

The occurrence involved an instructor parachutist in freefall. The parachute canopy broke leading to freefall and ground impact. The parachutist sustained fatal injury.

The Air Accident Investigation Sector (AAIS) Duty Investigator was notified of the occurrence via the Hotline Number +971 50 641 4667.

Following the initial on-site investigation, the occurrence was classified as an 'Accident' due to the fatality of the parachutist. This investigation's scope is limited to the events leading up to the occurrence without in-depth analysis of non-contributing factors.

### Notes:

- Whenever the following words are mentioned in this Report with a first letter **Capitalized**, they shall mean the following:
  - (Accident) – this investigated accident
  - (Club) – Skydive Dubai POA
  - (Investigation) – the investigation into this accident
  - (Parachutist) – the skydiver who was fatally injured
  - (Report) – this accident investigation Summary Report.
- Unless otherwise mentioned, all times in the Report are the United Arab Emirates local time (LT = UTC plus 4 hours).
- The structure of this Summary Report is an adaptation of the Annex 13 Final Report format.

## Factual Information

### History of the Flight

On 8 March 2024, at 1315 United Arab Emirates local time; a DHC-6-400 fixed-wing light-sport aircraft, registration marks A6-SD1, owned and operated by Skydive Dubai POA, embarked on a commercial skydiving

mission from the Skydive Desert Drop Zone (DDZ) at Margham, Dubai, the United Arab Emirates. The aircraft carried 19 parachutists and one pilot.

After takeoff, the parachutists prepared for freefall as the aircraft cruised at approximately 13,000 feet altitude. Among them was the Parachutist making his fifth jump of the day out of six planned jumps. The Parachutist was acting as an instructor and providing training for a student skydiver at this time.

As observed from the Parachutist overhead camera video recording, during his descent, he performed spiral turns as part of the landing procedure in the designated landing area east of the desert drop zone (DDZ)<sup>1</sup>.

After completing one 360-degree left spiral turn, the parachute canopy A2-lines<sup>2</sup> at both sides disintegrated from the container<sup>3</sup> (figure 1), resulting in a freefall and

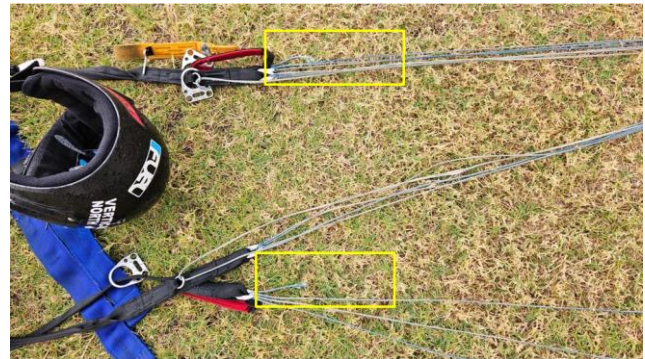


Figure 1. The involved parachute with broken lines

subsequent impact on the ground.

At 1335, the Club's ground control contacted the Operations Manager to report the Accident, and then called Dubai emergency medical services (EMS). The Operations Manager arrived at the scene and observed the severity of the situation. He instructed all departments to cease radio communication except for emergencies and suspended skydiving operations. The Parachutist was conscious but in critical condition. The Club ground controller, a skydive team member with 20 years of medical training experience, provided first aid. As the Parachutist began to lose consciousness and experienced difficulty in breathing,

<sup>1</sup> GCAA approved location to operate parachute activities at Skydive Desert drop zone.

<sup>2</sup> The lines, labelled A, B, C, and D, supported both sides of the canopy (figure 5).

<sup>3</sup> Container: The portion of the assembly that is used to store the folded parachute canopy.



the police and EMS were re-contacted to request helicopter support.

At 1352, an ambulance arrived and it took several minutes assessing the injured Parachutist at the site. Although he remained unconscious, he had a pulse, albeit low, and paramedics intubated him to secure his airway. At 1405, a helicopter arrived to airlift him to Rashid Hospital. The helicopter departed at 1417.

Upon arrival at the hospital, the Parachutist was declared dead by the medical team.

## Damage to the Parachute

The parachute's damage included the canopy's A2 lines being broken on both sides (as shown in figure 1).

## Personnel Information

The general data of the Parachutist are shown in table 1.

Age	39
Weight	90 Kg
Hight	177 cm
License Category	D <sup>4</sup>
Valid to	31 January 2025
License issued by	Parachute Association of the United States (USPA).
Rating	Coach, Accelerated Freefall Instructor (AFF-I) <sup>5</sup> , Tandem Instructor (TAN-I) <sup>6</sup>
Total Jumps	Over 5000

## Injuries to Persons

The Parachutist forensic examination report revealed a comminute open fracture in the left wrist,

<sup>4</sup> The 'D' license is the highest level of skydiving certification, signifying advanced proficiency and extensive experience in parachuting.

<sup>5</sup> AFF-I (Accelerated Freefall Instructor): Qualified to instruct and supervise students during accelerated freefall training, demonstrating high expertise and experience in skydiving.

<sup>6</sup> TAN-I (Tandem Instructor): Certified to perform tandem skydives with students or first-time jumpers, ensuring their safety and managing all aspects of the tandem jump.

<sup>7</sup> Automatic Activation Device (AAD): A precise microprocessor computer located within the skydiving container. This safety

severe bleeding in the left chest cavity, and multiple fractures in the chest. A toxicology report confirmed the absence of narcotics and alcohol in his body.

## Parachute Information

Table 2 illustrates the parachute equipment details:

Container	Rig Checked	Validity
	10 February 2024	8 August 2024
Manufacture	Vector	
Model	V316	
<b>Reserve Canopy</b>		
Manufacture	Performance Designs	
Model	Optimum 126	
<b>Main Canopy</b>		
Manufacture	Fluid Wings	
Model	AirWolf2, 79 sq. ft (Serial Number: AW2 79-00043)	
<b>Automatic Activation Device (AAD<sup>7</sup>)</b>		
Manufacture	Vigil Cuatro	
Model	Xteme	
<b>Reserve Static Line (RSL<sup>8</sup>)</b>	Yes	

## Main Canopy

The Parachutist borrowed the main canopy from his colleague who was an instructor at Skydive since 11 January 2024, because his own parachute had worn lines and was no longer airworthy. His previous main canopy was identical to the one he borrowed. Since receiving the parachute, the Parachutist had

system is responsible for deploying a skydiver's reserve parachute in the event that a jumper is unable to do so. [Source : <https://skydivemonroe.com/blog/what-is-a-parachute-aad/>].

<sup>8</sup> Reserve Static Line (RSL): The reserve static line has been designed to deploy the reserve as soon as the cutaway procedure has been performed. This allows for the reserve to deploy as soon as possible after a cutaway. This is particularly important during an unplanned low cutaway and the design has saved many lives. Equipment. [Source: [https://paraorg.dfv.aero/uploads/manual\\_reflex\\_iied3-02.02.pdf](https://paraorg.dfv.aero/uploads/manual_reflex_iied3-02.02.pdf)].

completed approximately 225 jumps in the period of 48 days with an average of 6-8 jumps per day.

The AirWolf2 79-inch main canopy is a high-performance parachute featuring a 7-cell, cross-braced, tri-taper design.



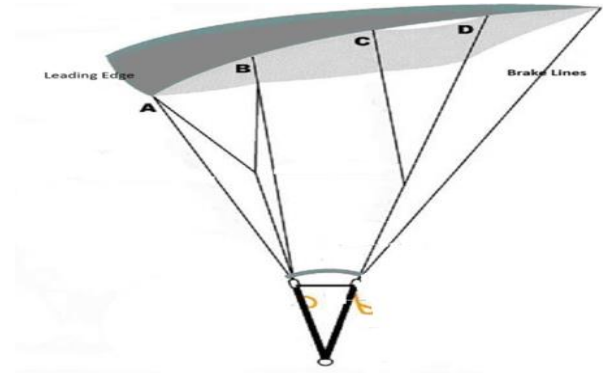
**Figure 2.** Main canopy

The canopy includes a split leading edge, steeper line trim, low line drag configuration, triple cascade lines, and a multi-braking system. It uses hybrid FT-30 and ZP cloth for enhanced rigidity and reduced pack volume. The main lines are 400 lbf standard, with an optional 580/400 lb hybrid Vectran, and the lower brake lines are 750 lb Vectran. The AirWolf2 series comes in various sizes, and the involved main canopy has the specific characteristics:

- Flat Area: 79.3 sq. ft
- Number of Cells: 21
- Flat Wingspan: 14.7 ft
- Max Chord: 5.9 ft-in
- Flat Aspect Ratio (AR): 2.8
- Projected Area: 68.3 sq. ft
- Maximum deployed speed: 120 kts
- Maximum weight: 190 lb

### Main Canopy Suspension Lines

Main Canopy suspension lines are crucial in ensuring a parachutist's safe and controlled descent. These lines are categorized into A-lines, B-lines, C-lines, D-lines, and brake lines, each playing a distinct role in maintaining the canopy's shape and stability during flight as shown figure 3.



**Figure 3.** Main Canopy Suspension Lines

A-lines, positioned closest to the leading edge of the canopy, are essential during the initial inflation phase, providing significant stability and control. They help maintain the shape of the canopy, ensuring it inflates properly and remains stable.

B-lines, located just behind the A-lines, assist in managing the midsection of the canopy, contributing to load distribution and structural integrity. They ensure that the canopy retains its aerodynamic shape and performs efficiently during descent.

C-lines, positioned further back from the B-lines, support the middle and rear sections of the canopy, aiding in controlling the descent rate and handling. They play a vital role in the overall stability and performance of the parachute.

D-lines near the trailing edge of the canopy fine-tune the performance of the trailing edge, enhancing control and responsiveness. They contribute to the parachute's precise manoeuvrability, ensuring smooth and controlled descents. Brake lines, attached to the trailing edge of the canopy, are crucial for steering and braking. They allow the parachutist to control the descent speed and direction, facilitating precise landings. By pulling on the brake lines, the parachutist

can slow down the parachute and adjust the flight path as needed.

### Parachute Line Inspection

As per the *Fluid Wings User Manual*<sup>9</sup>, parachute lines require detailed inspections and maintenance to ensure their safety and functionality. The inspection process involves evaluating lines for wear conditions, categorized as slight, medium, and heavy. Critical lines should never be used if they reach heavy wear and should be replaced when wear is at or beyond medium. It is essential to exercise professional judgment and adhere to all applicable standards, contacting the manufacturer if there are any uncertainties as shown in the figure 4.

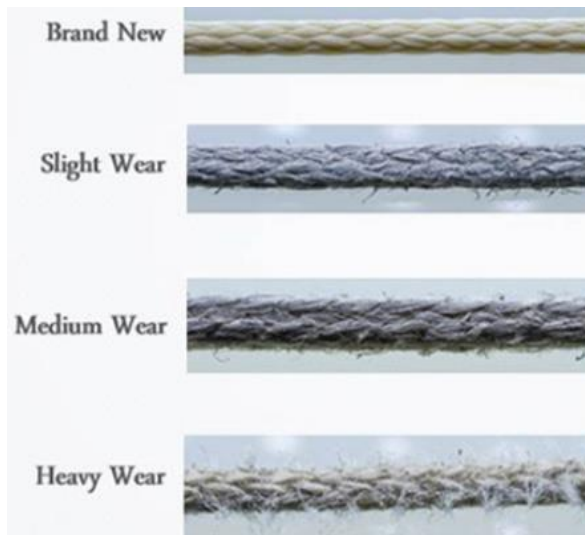


Figure 4. Evaluation of lines

A line plan should be obtained for the inspection, and magnification tools, such as smartphone cameras, should be used to assess the wear, particularly near the termination of the finger trap at the splice, where wear often appears first. The inspection guidelines are general and not all-inclusive but serve to ensure critical items are identified.

Visual signs of wear and typical wear locations are detailed, with a strong recommendation to replace lines before they reach a critical wear state. Environmental factors, such as sandy and dusty conditions, can significantly reduce the lifespan of the lines due to their abrasive nature. Therefore, it is crucial to understand these impacts and adjust maintenance schedules accordingly.

For high-performance parachutes, frequent relines are necessary due to the extreme flight manoeuvres and high-speed landings they endure. The lines are designed to minimize drag, so thinner lines are preferred, despite their higher susceptibility to wear and the increased need for maintenance as per the *Fluid Wings User Manual*.

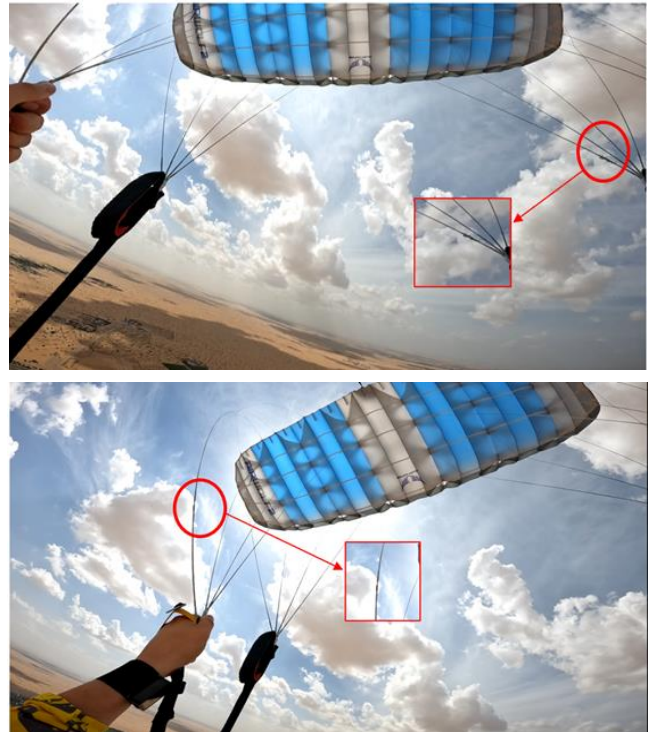


Figure 5. Right side (upper) and left side (lower) canopy suspension lines

The inspection records of the parachute shows that the inspection and registration were performed by a rigger on 10 February 2024, and were valid until 8 August 2024.

### Video Recordings

Video recordings are a crucial form of evidence in investigations of aerial light sports activities, offering valuable factual information.

While the Club's policy does not mandate the installation of video cameras as part of the essential equipment for parachutists, recording video during freefall jumps is optional.

<sup>9</sup> Fluid Wings, LLC. (n.d.). *Line Inspection Guidance: Fluid Wings* [https://www.fluidwings.com/files/ugd/5a932f\\_bb3a62fce84a4830a558a382a7633339.pdf](https://www.fluidwings.com/files/ugd/5a932f_bb3a62fce84a4830a558a382a7633339.pdf).

In this Accident, the Parachutist carried a GoPro camera mounted on his helmet, which captured 8 minutes 54 seconds of the freefall jump. The recording began when the Parachutist was already in the sky. The altitude was not displayed.

As captured by the GoPro camera, the main canopy suspension lines exhibited deterioration marks on both sides (figures 5).

At the 40-second mark of the recording, the Parachutist initiated a spiral descent as part of the landing procedure. The first turn was executed to the left, as indicated by the movement in that direction. However, after completing this leftward turn, the parachute lines broke, resulting in an uncontrolled freefall that began at the 45-second mark. The Parachutist impacted the ground within 8 seconds, hitting the crash point at the 53-second mark, as depicted in figure 6.

Post ground impact, the Parachutist stayed conscious and promptly called for help. At 2 minutes 35 seconds into the recording, he reported difficulty in breathing and an inability to feel his legs.

The footage captured by the CCTV installed in the Club showed that the ground controller performing first aid to keep the Parachutist conscious and stabilize his condition until emergency medical services arrive.



Figure 6. Crash point

Up to 8 minutes 54 seconds of the recording, the Parachutist remained conscious and was responsive to the first aid being administered.

### Meteorological Information

The Investigation reviewed the weather information provided by the National Centre of Meteorology (NCM) for the nearest station from Margham, and all data area illustrated in table 4.

Table 4. METAR at 1300 LT

Wind	Direction 310 degrees, speed 10.3 knots
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Visibility	8 kilometres or more, clouds
OAT	32°C
Dew point	24°C
Pressure (Altimeter)	1012 mbar
Condition	No significant change in the weather

The weather condition was suitable for skydiving, consistent with the Club's procedure.

### Aerodrome Information

The Club operates two parachute landing areas (PLA) locations in Dubai: Skydive Dubai Palm (PDZ) and Desert (DDZ) Drop zones in Margham. The Accident occurred at DDZ.

DDZ is situated at a latitude of 24°53'14.65"N and a longitude of 55°32'53.03"E, with an elevation of 515 feet above sea level (ASL). It includes a 1,600-meter (1 mile) runway dedicated to skydiving flight operations and a designated boarding area for skydivers (figure 7).



Figure 7 Skydive DDZ drop zone and runway for Skydiver flight operations

The PLA of DDZ was divided into four distinct zones: student landing area; main landing area; high-speed landing area; and swoop pond.

The red arrow in figure8 indicates the designated landing direction for parachutists, always pointing into the wind (opposite to the wind direction), as specified in the SOP.



Figure 8. DDZ landing area

## Organizational and Management Information

The Club operates under the Parachute Approved Organization (PAO) approval, issued by the General Civil Aviation Authority (GCAA) of the United Arab Emirates, in accordance with *Civil Aviation Regulations – Light Sport Aircraft (CAR-LSA)*.

### Organization Structure

According to the Club's organisation structure, the following job roles are designated for the parachute operations:

- Accountable Manager
- Operations Manager (s) (Palm Drop Zone and Desert Drop Zone)
- Special Project Manager
- Safety & Compliance Manager
- Manifest Manager
- Manifest
- Chief Instructor
- Instructor
- Ground Controller
- Master Rigger
- Senior Rigger
- Packer.

The designations involved during the parachute freefall operations were as follows:

#### Manifest

The role of the Manifest is to efficiently allocate instructors, students, and licensed parachutists to aircraft loads and organize aircraft timings. Manifest

reports to the Manifest Manager and his duties also include:

- Establishing radio contact with ground control and aircraft pilot(s).
- Confirming operations start clearance with ground control
- Manifesting parachutists to aircraft loads
- Providing manifest load sheets to necessary personnel
- Making public announcements about aircraft timings
- Generating daily aircraft manifest reports
- Ensuring licensed skydivers meet requirements and maintaining appropriate documents.

For the Accident flight, the Manifest team reviewed and balanced the list of instructors, students, and licensed parachutists, ensuring safety and compliance as everything proceeded normally. Manifest team organized the aircraft timings with the pilots and ground control, confirmed pre-flight checks and clearance, and assigned parachutists to the aircraft loads.

Detailed load sheets were distributed, and public announcements informed participants of departure times and safety procedures. The team also verified that all skydivers' licenses and medical certificates were up-to-date, maintaining proper documentation in accordance with the operations manual. Following the Accident, the manifest team immediately suspended all skydiving activities for the remainder of the day.

#### Ground Controller

Ground Controllers monitor and ensure skydiving activities are carried out safely. They report to the Operations Manager and duties include:

- Conducting all necessary inspections before authorizing operations to commence
- Ensuring Skydive Dubai airspace is activated and closed as required
- Continuously monitoring all parachuting activities in progress
- Issuing clearances for aircraft to dispatch parachutists
- Responding to emergencies and enacting emergency procedures
- Reporting safety incidents and/or accidents to the Operations Manager.



For the Accident flight, the Ground Controller ensured that the skydiving activities were carried out safely and followed procedures. Before operations commenced, the Ground Controller completed all necessary inspections and confirmed that the Skydive Dubai airspace was properly activated as required. During the flight, the Ground Controller continuously monitored all parachuting activities and issued clearances for the Aircraft to dispatch parachutists. Upon witnessing the Parachutist in freefall, the Ground Controller immediately contacted the EMT and Operations Manager to report the Accident.

#### Instructor

Instructors report to the Chief Instructor and provide training and guidance to student parachutists. Their responsibilities include:

- Holding and maintaining valid skydiving licenses and instructor ratings
- Ensuring all training is conducted safely and in compliance with regulations
- Reporting any incidents or accidents to the Chief Instructor or Operations Manager.

On the day of the Accident, the Parachutist, who was certified as a USPA coach, accelerated freefall instructor, tandem instructor, and served as a coach instructor at the Club, was scheduled to conduct training for a student parachutist. He provided the necessary briefings on safety procedures, equipment handling, and emergency protocols. Throughout the day, he completed four jumps with the same student. At the time of the Accident, he was actively engaged in coaching the student.

#### Master Rigger

The Master Rigger oversees the daily activities of the rigging loft and packing mat, reporting to the Operations Manager. Responsibilities include:

- Carrying out rigger induction and ensuring riggers understand their duties.
- Ensuring riggers hold appropriate ratings.
- Maintaining parachute rigging and packing records.

#### Senior Rigger

Senior Riggers report to the Master Rigger and are responsible for:

- Holding and maintaining valid rigger ratings
- Assembling, inspecting, maintaining, and repairing parachute equipment.

- Performing duties in compliance with all relevant standards and regulations.

#### Packer

Packers report to the Master Rigger and their duties include:

- Holding and maintaining an approved packing certificate
- Inspecting and packing parachutes according to manufacturer requirements
- Maintaining packing records as required.

The Master Rigger, Senior Rigger, and Packer carried out their responsibilities by ensuring that the parachute rig was inspected, issued a rig registration approval, and tagged with a validity date which started on 10 February 2024, and a due date of 8 August 2024.

As outlined in the *Parachuting Operation Manual (POM)*, Section 6 — *Equipment*, the responsibility for inspecting and maintaining parachute equipment rests entirely with the parachutist. Parachutists are required to ensure their equipment are in proper working order before each jump, which includes conducting regular checks and following the manufacturer's maintenance guidelines to ensure all components are functioning correctly for a safe descent. Additionally, the rig registry must be updated and reviewed every 180 days to ensure compliance with safety standards.

#### Training

The Club hosts various training programs for the instructors, including comprehensive courses on human factors and safety management system (SMS). These programs emphasize the critical role of human performance and error management in aviation safety. As part of their training, instructors are required to submit ROSY (Risk and Opportunity System) and VOSYM (Voluntary Safety Management System) reports. Additionally, the training includes discussions of previous accident cases to provide practical insights and lessons learned.

The Parachutist had completed both training programs, ensuring he was familiar with identifying and mitigating risks and enhancing overall safety standards during operations.



### Skydiving license requirements<sup>10</sup>

Table 3 illustrates the licensing requirements for parachutists:

Skydiving license level	Minimum number of jumps	Minimum controlled freefall time
A license	25	not applicable
B license	50	30 minutes
C license	200	60 minutes
D license	500	3 hours

As per the Club's standard operating procedure (SOP), the minimum container opening is allowed at 3,000 feet AGL for students and 'A' and 'B' license holders; 2,500 feet AGL for 'C' and 'D' license holders; and 5,000 feet AGL for tandem jumps.

### Skydiving Instructor Categories<sup>11</sup>

#### Coach (C)

A USPA Coach must hold a USPA B license and have completed at least 100 jumps. Certification requires completing the USPA Coach Proficiency Card and a Coach Rating Course. Coaches are authorized to conduct non-method-specific skydiving ground school, teach transition training from tandem to solo methods, and supervise recurrency jumps and static-line students.

#### Tandem Instructor (TI)

A Tandem Instructor should hold or have held a USPA instructional rating and have a minimum of 500 jumps with three years of parachuting experience. They must also hold a current FAA Class 3 Medical Certificate. Certification involves completing practice tandem cutaways, the USPA Tandem Instructor Proficiency Card, and a Tandem Instructor Rating Course, including training on specific tandem equipment. Tandem Instructors can conduct tandem jumps, first-jump courses, and supervise Coaches.

#### Accelerated Freefall Instructor (AFF-I)

To become an AFF Instructor, one must hold or have held a USPA instructional rating and have at least 500 jumps or 12 months of experience as a Coach or Instructor, along with six hours of freefall time. Certification includes completing the AFF Instructor Proficiency Card and passing a written and practical evaluation. AFF Instructors can conduct AFF jumps, first-jump courses, and supervise various student jumps.

#### Instructor Examiner (IE)

An Instructor Examiner should hold a USPA D license and have completed 500 jumps, with extensive experience in freefall student training and first jump courses. Certification requires completing the Instructor Examiner Rating Course and gaining approval after supervising rating courses. Instructor Examiners can facilitate rating courses, verify licenses, and renew ratings across multiple disciplines.

The Parachutist was certified as a USPA Coach, Accelerated Freefall Instructor (AFF-I), and Tandem Instructor and served as both a Coach Instructor and an Accelerated Freefall Instructor (AFF-I) at the Club. At the time of the Accident, he was actively engaged in coaching a student.

## Additional Information

### Similar Cases

During the Club's site visit, four parachutists came forward to share their experiences of similar incidents over the past four years, all involving main canopy suspension line breakages from the same manufacturer. All of the cases were considered as incidents since the reserve parachutes were deployed correctly and the parachutist landed without any issues.

#### Case #1

In January 2024, a parachutist experienced a hard opening with an HK2-69 canopy, resulting in a broken C-line on the left cell of the canopy. The lines were relatively new, with only 90 jumps. This incident highlighted the potential for new lines to fail under extreme forces generated during hard openings,

<sup>10</sup> There are four types of skydiving licenses. These are categorized as A, B, C and D licenses. The A license is the first license obtained by a new skydiver and each license is progressively more challenging to achieve, requiring the skydiver to prove certain skills and reach certain experience levels. The D license is the highest level of skydiving license and skydivers need a minimum of 500 and to have completed all requirements of the previous licenses as well as two-night jumps. [Source:

[https://skydiveparacletexp.com/2017/02/15/skydiving-license-levels/#:-:text=Skydiving%20%E2%80%9CB%E2%80%9D%20License&text=B%20license%20skydivers%20have%20proven,including%20planned%20jumps%20with%20groups\].](https://skydiveparacletexp.com/2017/02/15/skydiving-license-levels/#:-:text=Skydiving%20%E2%80%9CB%E2%80%9D%20License&text=B%20license%20skydivers%20have%20proven,including%20planned%20jumps%20with%20groups].)

<sup>11</sup> The Skydive Dubai Parachuting Activity Operation Manual (SDD PAO OM) provides information on the requirements and instructor categories for skydiving.



suggesting the need for rigorous quality checks and potentially identifying material defects or anomalies in the deployment sequence.

#### Case #2

In April 2023, another reported incident involved an HKT-67 Fluid Wings canopy where a line broke at the end of a multiple rotation turn. The line in question, with approximately 200 jumps, snapped near the soft link following the stitching. This case underscores the importance of regular inspection, especially at connection points where lines are attached to risers and canopies. It also highlights the stress that dynamic manoeuvres can place on these critical points.

#### Case #3

In October 2020, A further case involved a Brazilian skydiver flying an HKT67 canopy over the Maldives. After deploying and flying the canopy normally, two lines broke simultaneously at around 1,800 feet, rendering the canopy uncontrollable and necessitating a cutaway. According to the manufacturer, the lines, which had 250 jumps, were found to be contaminated with sand, which likely contributed to their degradation. This incident points to the significant impact of environmental factors on line integrity and the need for meticulous cleaning and inspection protocols in such conditions.

#### Case #4

In 2022, a parachutist using an HK2 canopy experienced a line snap during the recovery phase of 450 degrees turn at 1,230 feet. The parachutist felt a significant shift and noted a snapped A-line, but managed to land safely using rear risers and toggles. The canopy and lines had 221 jumps. This case highlighted the high stress placed on main canopy suspension lines during aggressive manoeuvres and the importance of robust materials and proper load distribution to withstand such forces. According to the manufacturer, the jumper used 300lb competition lines designed for sub-terminal deployments, which failed when used for freefall-terminal velocity deployments.

#### **Manufacturer's analysis**

The manufacturer's analysis of the line wear revealed significant changes in the patterns of line breakage in high-performance wings over the past several years. Historically, lines were made with larger diameters, resulting in greater strength and more visible signs of wear.

However, modern high-performance wings have reduced these margins to achieve superior speeds and performance. Previously, line breakage typically occurred at cascade points (A-B or C-D junctions) during openings. Nowadays, breakage is more likely to

occur near the lower finger trap close to the riser due to wear from slider grommets, removable deployment system (RDS) rings, or rubbing on the container during deployment. Additionally, while lines used to break during openings, they now tend to break during accelerated flight because the critical loads are placed on the lines after opening due to soft openings and intense flight conditions.

Environmental exposure significantly impacts line wear, with harsh conditions like sandy environments or muddy swoop competitions drastically reducing line lifespan. Lines in the 300-400 lbf range can last as few as 100 jumps under such conditions. Proper care and maintenance play a crucial role in line durability, as contaminants like sand and dirt cause abrasive wear and microscopic cuts that significantly reduce line strength. The construction of lines involves weaving multiple groups of fibers (carriers) to distribute load uniformly. Damage to these carriers impairs the weave's ability to redistribute load effectively, leading to localized overloading and potential cascading failure.

Evaluating lines for wear and determining the necessity for replacement involves several indicators: visible dirt or debris within the weave, significant color changes indicating dirt contamination or abrasive wear, broken or hanging fibers suggesting strength reduction, and visible damage to more than 50% of a carrier requiring immediate replacement. Regular inspection and proactive replacement based on visible condition are crucial, as a broken line during a final approach could result in fatal consequences, underscoring the importance of vigilance and maintenance.

## **Analysis**

### **The Parachutist**

The Parachutist possessed held a valid skydiving license for parachute freefall activities. With more than 5,000 jumps recorded in his skydiving logbook and a Skydiving 'D' license issued by the USPA valid until 31 January 2025. He was authorized to carry out all his jumps.

On the day of the Accident, it was his fifth jump, with the previous four being uneventful. He was equipped with all essential gears, including a container, main parachute, reserve parachute, and automatic activation device (AAD), which had been certified by an authorized rigger. The authorization was valid from 15 February 2024 until 11 August 2024.

Additionally, he had completed all necessary training, including advanced courses in freefall maneuvers, human factors, emergency procedures,

and safety management systems. He had also signed a Solo Jumper Waiver<sup>12</sup>, acknowledging the risks involved in solo skydiving and affirming his readiness and capability to undertake such activities independently.

Furthermore, he signed an acknowledgment and agreed to the rig register condition, which required him to report any changes to his rig. As stated in the rig registration, the Parachutist was responsible for maintaining the airworthiness and ensuring that all maintenance is performed according to the manufacturer's requirements. However, there was no evidence that he followed the procedures related to maintaining the airworthiness and ensuring all maintenance had been performed.

### Calculating the Height of the Free Fall

The CCTV installed at the Club recorded the following sequence of events:

- Frame 2180: The Parachutist is descending under an open parachute, still relatively high above the ground.
- Frame 2190: The Parachutist has descended further, showing a rapid decrease in altitude.
- Frame 2200: The Parachutist is closer to the ground.
- Frame 2210: The Parachutist is very close to the ground, moments before impact.
- Frame 2220: The Parachutist impacted the ground.

To estimate the height of the freefall, the Investigation analysed the vertical positions of the instructor parachutist in each frame.

#### Vertical positions:

- Frame 2180: Approximate y-coordinate of the Parachutist: 150 pixels
- Frame 2190: Approximate y-coordinate of the Parachutist: 250 pixels
- Frame 2200: Approximate y-coordinate of the Parachutist: 350 pixels
- Frame 2210: Approximate y-coordinate of the Parachutist: 450 pixels

- Frame 2220: Approximate y-coordinate of the Parachutist: 550 pixels

#### Pixel distances:

As the given above frames, the distance between one to the next frame is 100 pixels.

#### Conversion factor:

According to the program's<sup>13</sup> calculations, 1 pixel is approximately equal to 0.05 meters.

#### Actual heights:

The reduced height between one to the next frame can be determined by calculating 100 pixels multiplied by 0.05 meters/pixel which is equal to 5.0 meters.

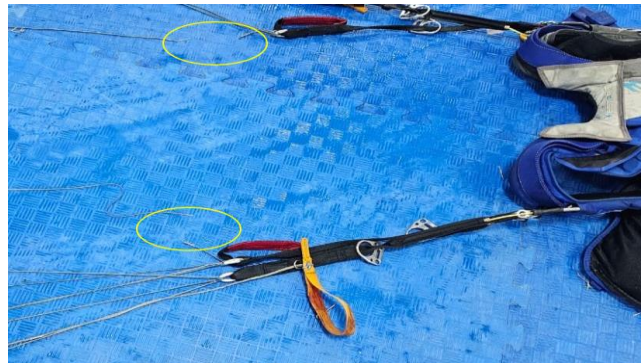
#### Total height of the freefall:

The total height from frame 2180 to 2220 is equal to 4 multiplied by 5.0 meters, which is 20.0 meters.

Therefore, it can be concluded that the Parachutist experienced a freefall from an approximate height of 20 meters (about 66 feet) before making impact to the ground, as captured by the Club's CCTV footage.

### Canopy

The Investigation determines that the canopy collapse was caused by broken A lines, as evidenced by the findings at the Accident site. The wreckage



**Figure 9.** Canopy broken lines

inspection revealed that several lines were severed, which likely led to the malfunction and subsequent collapse of the canopy during the descent (figure 9).

The Parachutist borrowed the canopy from another parachutist who works as instructor at Skydive. Prior to borrowing this canopy, the Parachutist had used an

<sup>12</sup> A "Solo Jumper Waiver" is a legal document or agreement that a skydiving organization or drop zone might require a solo jumper to sign before they are allowed to jump on their own without an instructor. This waiver typically outlines the risks

involved in solo skydiving and releases the organization from liability in case of an accident or injury.

<sup>13</sup> Video Analysis Software: The Motion View video analysis software, along with photo analysis and distance calculations



identical main canopy and after borrowing he performed 225 jumps prior to the Accident jump as per Club records. The rigger stated that the worn condition of the lines existed before the Accident jump.

The rigger inspected the parachute and registered it without thoroughly considering the condition of the lines, assuming the Parachutist's expertise was sufficient. This extensive usage may have caused wear on the lines, as observed in video recordings, which most likely contributed to their eventual failure.

Additionally, the Parachutist did not report the change of the main canopy, as the rig registration did not specify the serial number, and the borrowed canopy was of the same model and size.

The canopy sustained a tear in one of the cells due to the impact.

### A-lines Breakage

Impaired canopy inflation is one of the primary concerns when A-lines fail. During the initial deployment phase, a failure in the A-lines would severely disrupt the inflation process, potentially resulting in partial or asymmetric inflation where the canopy fails to achieve its intended aerodynamic shape. This could lead to a lopsided canopy, causing uneven drag forces, which may result in an uncontrolled or spiraling descent.

Another significant consequence is the loss of stability and control. Without the stabilizing effect of the A-lines, the canopy may exhibit excessive oscillations and instability, making it more susceptible to turbulent air conditions and increasing the risk of canopy collapse. The parachutist would find it challenging to maintain control over the descent, particularly during the critical initial moments of deployment where stable and controlled descent is essential.

A-lines failure also results in increased load on other lines. The load that would have been borne by the A-lines will be redistributed to the remaining B-lines, C-lines, and D-lines, potentially overstressing these lines and increasing the risk of further line failures. Overloading other suspension lines compromises the structural integrity of the entire parachute system, potentially leading to catastrophic failure.

The impact on descent rate and maneuverability is another critical issue. The loss of A-lines would result in an unpredictable and erratic descent rate, making it difficult for the parachutist to anticipate landing. Steering and maneuvering the parachute would be significantly impaired, with precise adjustments required for safe landing becoming nearly impossible, heightening the risk of injury upon landing.

In the context of the Accident case, the failure of the A-lines significantly impaired the canopy's performance, leading to its collapse. This malfunction caused an unstable descent and redistributed the load to the remaining lines, ultimately resulting in the Parachutist losing control.

### Wing loading analysis

Wing loading is a measure of the load carried by each unit area of the wing (or canopy) and is typically calculated using the formula:

$$\text{Wing Loading} = \frac{\text{Weight}}{\text{Wing Area}}$$

Given the specifications of the AirWolf2 parachute, the wing loading can be calculated as follows:

- Maximum weight: 190 lb
- Flat Area: 79.3 sq. ft

Using the flat area for standard wing loading:

$$\text{Wing Loading} = \frac{190 \text{ lb}}{79.3 \text{ ft}^2} \approx 2.4 \text{ lb/sq. ft}$$

The wing loading of the AirWolf2 parachute, based on the given maximum weight and flat area, is approximately 2.4 lb/ft<sup>2</sup>.

Reflecting on the Parachutist's weight, which exceeded the maximum weight indicated on the label (90 kg, approximately 198.416 lb) and the weight of the gear (typically around 20-25lb), the load factor will be

$$\text{Wing Loading} = \frac{198.416 \text{ lb} + 25 \text{ lb}}{79.3 \text{ ft}^2} \approx 2.81 \text{ lb/sq. ft}$$

The Parachutist's weight with the gear of 223.416 lb exceeds the AirWolf2 parachute's maximum weight capacity, resulting in a wing loading of 2.8 lb/sq. ft compared to the maximum designed wing loading of 2.4 lb/sq. Ft.

On the other hand, according to the Fluid Wings wing loading chart (figure 10), the maximum wing loading for the AirWolf2 is 3.2 lb/sq. ft, which

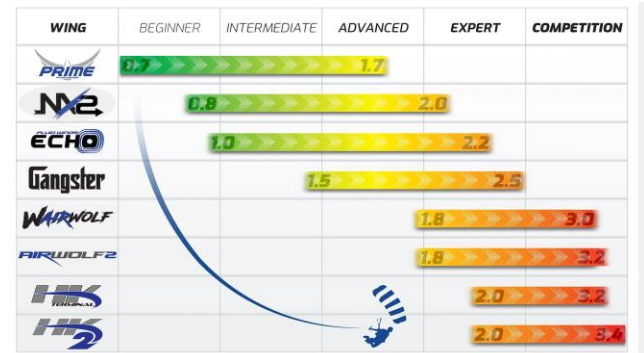


Figure 10. Wing loading chart



contradicts the label. This might lead skydivers to believe that the maximum exit weight while jumping an AirWolf2 with a 79 sq. ft canopy is 250 lb (114 kg), not 190 lb (86.16 kg) as reported on the parachute label.

The wing loading chart provided by Fluid Wings is designed to help skydivers understand the relationship between parachute performance and pilot skill across various sizes. It is intended as a guide, and jumpers should consult a qualified professional to determine the appropriate size and loading for their skill level. The chart does not dictate weight minimums or maximums but highlights performance changes over different sizes and loadings.

Main parachutes are not regulated products, and Fluid Wings does not have statutory authority to enforce maximum weight limits. During development, parachutes are tested at weights above those indicated in the chart. However, for safety and to promote the use of larger canopies, the company labels the parachutes with conservative weight limits.

The parachute label specifies a maximum weight of 190 lb (86.18 kg), while the Fluid Wings wing loading chart suggests a maximum weight of 250 lb (114 kg) for the AirWolf2 with a 79 sq. ft canopy. In this Accident, the Parachutist's weight was 198 lb, slightly exceeding the labelled maximum weight. During the recovery from a high-speed dive close to the ground, which resembled a low-level aerobatic manoeuvre, the change in flight direction likely generated a load factor higher than 1g. The already worn A2-lines were likely unable to withstand this increased load, resulting in their failure (broken lines).

## Manufacture Testing Results

The parachute was sent for further examination at the manufacturer's facility following the Accident.

Comprehensive testing and inspection revealed severe abrasion and wear on the lower A8 and upper D5 lines<sup>14</sup>. The parachute lines, originally rated to handle 400 lb, showed significant weakening over time. When tested, their tensile strengths ranged from only 247 to 321 lb, indicating substantial degradation due to extensive use in harsh conditions.

Inspection revealed that the lines had suffered from visible wear and tear, including fraying and other signs of deterioration. This damage compromised their strength, rendering them unsafe for continued use. The wear was most pronounced in areas where the lines

made contact with components like the slider grommets or RDS rings, ultimately leading to their failure.

The Investigation concluded that the canopy collapse was caused by severely worn and unairworthy lines. This degradation was a result of excessive use and exposure to adverse conditions, which accelerated their wear and tear. The rigger's inspections in thoroughly checking the lines were not carried out properly, due to the assumption that the Parachutist's expertise as an instructor ensured the parachute reliability. No material or manufacturing deficiencies were identified. The observed wear and subsequent failure were consistent with the expected failure modes for parachute lines subjected to prolonged and harsh usage.

## Conclusions

Based on the available evidence, the following findings, causes, and contributing factors were identified in relation to this accident. These findings are presented without assigning blame or liability to any specific organization or individual:

- Findings: Statements of all significant conditions, events, or circumstances pertaining to this Accident. These findings highlight crucial steps in the accident sequence but are not necessarily causal or indicative of deficiencies.
- Causes: Actions, omissions, events, conditions, or combinations thereof that directly led to the Accident.
- Contributing Factors: Actions, omissions, events, conditions, or combinations thereof that, if eliminated, avoided, or absent, would have decreased the likelihood of the Accident occurring or mitigated the severity of its consequences. The identification of contributing factors does not imply fault or liability, whether administrative, civil, or criminal.

## Findings

- (a) The Club was practicing operations under a valid *Parachute Approved Organization (PAO)* issued by the GCAA.

<sup>14</sup> Lower A8- and upper D5-lines refer to specific parachute lines: A-lines attach to the front, D-lines to the rear of the canopy, with numbering indicating their position from the center. 'Lower' and

'upper' specify their connection points to the risers or the canopy."



- (b) The Parachutist held a valid USPA-D license with ratings of AFF-I, Coach and Tandem-I.
- (c) The Parachutist had license acceptance with over 5,000 jumps,
- (d) The Accident jump was the fifth jump out of six jumps planned for the day.
- (e) The Parachutist was using a borrowed parachute, similar to his own since 11 January 2024, because his own parachute had worn lines and was no longer airworthy.
- (f) The Parachutist's previous main canopy was identical to the one he borrowed.
- (g) The Parachutist performed 225 jumps in 48 days since receiving the borrowed parachute.
- (h) The Parachutist completed the rig registration on 10 February 2024, valid until 8 August 2024. The registration form did not include serial number of the canopy or container. There is no evidence of inspection completion in accordance with manufacturer's and the Club's inspection standards and practices for parachutes.
- (i) The Parachutist signed a waiver agreeing to report any changes to his rig registration.
- (j) The Parachutist completed all the required training, including courses on human factors and safety management system, ensuring his readiness and qualification for his role as a coach instructor and an accelerated freefall instructor at the Club skydiving activities.
- (k) The parachute canopy A2-lines broken on both sides after one 360-degree spiral turn during landing.
- (l) The Parachutist impacted the ground and sustained a fatal injury.
- (m) Four other Club's parachutists experienced broken lines in their parachutes in different occasions and models, suggesting a potential issue with equipment maintenance or quality control.

## Causes

The Air Accident Investigation Sector determines that the cause of the Accident was the parachute collapse due to broken A-lines on both sides of the canopy after a 360-degree spiral turn during landing. The A2-lines

were worn out and could not hold the weight during the landing, leading to their breakage.

The wear on the A2-lines went unnoticed by both the riggers and the parachutist, who did not follow the manufacturer's and the Club's inspection standards and practices for parachutes.

## Safety Recommendations

### Safety Actions Taken

The manufacturer has mandated an immediate maintenance inspection for all parachutes equipped with 400 lb. suspension lines to ensure their airworthiness and safety. The action was determined due to concerns about the durability of these lines, particularly those in the 300-400 lb range, which were susceptible to reduced lifespan when exposed to harsh conditions like sand and abrasive materials.

The new inspection protocol requires that suspension lines be evaluated before every jump and undergo a detailed inspection every 20-30 jumps or every two weeks. This inspection should be conducted using magnification (1.5x to 2x) with a bright light to detect any damage accurately. Lines with visible broken carriers or filaments must be immediately removed from service and replaced. Special attention should be given to critical areas, such as the lower portion of the A-line groups, to prevent severe consequences in case of failure. A cautious and proactive approach is advised, with a strong emphasis on safety.

This paragraph was included when the safety action was taken, emphasizing that the responsibility for determining the airworthiness of the parachute lies solely with the jumper or rigger using it. Since main parachutes do not have regulatory airworthiness requirements, these decisions are subjective and rely heavily on the user's judgment. The materials used in the suspension lines, such as Vectran, Technora, and Spectra, are high-performance fibers sourced from a limited number of suppliers and tested multiple times for tensile strength during manufacturing. Damage to these lines can cause localized stress and potential failure, highlighting the importance of regular inspection and maintenance<sup>15</sup>.

<sup>15</sup> Fluid Wings, LLC, Mandatory Maintenance Inspection, [https://www.fluidwings.com/\\_files/ugd/5a932f\\_823caac223434fe28628bfd7cdc3f6b8.pdf](https://www.fluidwings.com/_files/ugd/5a932f_823caac223434fe28628bfd7cdc3f6b8.pdf).



## Safety Recommendations

The Air Accident Investigation Sector recommends that:

### Safety Actions taken by Fluid Wings

After the Accident, Fluid Wings issued inspection guidance for the riggers to evaluate the condition of parachute lines and determine when replacement is required.

Furthermore, Fluid Wings has initiated a user education campaign aimed at increasing awareness of line wear detection.

Fluid Wings has engaged in collaboration with other parachute manufacturers. Recognizing that many industry participants utilize the same line suppliers, the company has shared data and insights to support the adoption of enhanced safety protocols across the sector.

### Skydive Dubai

#### SR15/2024

The Parachutist did not follow the procedures related to maintaining the airworthiness and ensuring all maintenance had been performed as outlined in the *Parachuting Operation Manual (POM)*, Section 6 — *Equipment*.

Therefore, the Investigation recommends the Club reinforce among their parachutists to adhere to the procedures of maintaining parachute airworthiness. This should include additional random inspections.

#### SR16/2024

While the Club has established procedures, the already worn and unairworthy A2-lines were not appropriately inspected before the Accident jump, which resulted in broken lines.

Therefore, the Investigation recommends that the Club reinforces among Instructors and Licensed Sky\ divers the responsibility to adhere to the inspection and maintenance of their own equipment. Additionally, the Club should emphasize to Riggers the importance of thorough inspections at the designated times, and to Packers the importance of reporting or refusing to pack any parachute that appears unairworthy.

#### SR17/2024

The rig registration did not specify the serial number of the Club's parachutes.

In order to trace each parachute used by the Club, the Investigation recommends the Club include the serial numbers for the main and reserve parachute and container on the registration form and attach a validity tag to the container.

## Fluid Wings

### SR18/2024

Although the manufacturer has implemented a safety action and mandatory inspection, the initial measures may be insufficient. It is recommended to focus on the strength and reliability of the main canopy lines, particularly the nylon/cotton blend, which is susceptible to performance variations under different temperature and humidity conditions. Investigations have shown that the cotton component's lifespan and strength can deteriorate significantly below the manufacturer's recommended limits, reducing its ability to withstand forces such as snatch force and sustained force.

Fluid Wings should establish a feedback process to test unairworthy parachutes for their ultimate load capacity relative to age and share the results with the suspension line manufacturer to support potential design improvements and increase reliability

This Summary Report is issued by:

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