Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

ACCIDENT
Cessna 182L, EI-CDP
Clonbullogue, Co. Offaly

8 August 2015

An Roinn Iompair Turasóireachta agus Spóirt
Department of Transport, Tourism and Sport

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13[1] to the Convention on International Civil Aviation, Regulation (EU) No 996/2010[2] and Statutory Instrument No. 460 of 2009[3], safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

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[1] **Annex 13**: International Civil Aviation Organization (ICAO), Annex 13, Aircraft Accident and Incident Investigation.
[2] **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.
[3] **Statutory Instrument (SI) No. 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI 460 of 2009, the Chief Inspector of Air Accidents, Mr Jurgen Whyte, on 8 August 2015 appointed himself as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report.

Aircraft Type and Registration:	**Cessna 182L, EI-CDP**
No. and Type of Engines:	**1 x Continental O-470-R**
Aircraft Serial Number:	**182-58955**
Year of Manufacture:	**1968**
Date and Time (UTC)[4]:	**8 August 2015 @ approximately 09.20 hrs**
Location:	**Clonbullogue, Co. Offaly**
Type of Operation:	**General Aviation - Aerial Work**
Persons on Board:	**Crew - 1 Passengers - 3**
Injuries:	**Crew - Nil Passengers - Nil**
Nature of Damage:	**Significant damage to aircraft empennage[5] and Student's main parachute**
Commander's Licence:	**CPL (A)[6] issue by the Irish Aviation Authority (IAA)**
Commander's Details:	**Male, aged 36 years**
Commander's Flying Experience:	**279 hours, of which 26 were on type**
Notification Source:	**Chief Pilot Clonbullogue and Duty Manager Shannon Air Traffic Control (ATC)**
Information Source:	**AAIU Report Forms submitted by the Pilot and the Student skydiver, AAIU Field Investigation**

[4] **UTC**: Co-ordinated Universal Time. All timings in this report are quoted in UTC; to obtain the local time add one hour.
[5] **Empennage**: Complete tail unit of an aircraft, including the Fin, Rudder, Horizontal Stabiliser and Elevator.
[6] **CPL (A)**: Commercial Pilot Licence – Aeroplane.

SYNOPSIS

The Pilot positioned the aircraft, with three skydivers on board, overhead Clonbullogue Airfield (EICL) at a height of 3,500 ft with the intention of releasing two students for static line parachute jumps.

Following his release from the right wing strut, the first student was jerked back and saw that his main parachute canopy was entangled around the right-hand side horizontal stabiliser of the aircraft. At the same time the aircraft pitched up suddenly. The Student immediately *'cut-away'* from his main canopy, his reserve parachute deployed and he landed within the drop zone at EICL.

Subsequent to the sudden pitch-up, the aircraft rolled to the right and entered a spin. The Pilot performed a spin recovery, which was achieved by 1,000 ft. The aircraft, with the remaining three persons on board, landed at EICL without further incident. Significant damage was found on the aircraft's empennage and the Student's main canopy. There were no injuries.

NOTIFICATION

The Chief Pilot at Clonbullogue and the Duty Manager, Shannon ATC reported the event to the AAIU shortly after the occurrence.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft, a Cessna 182L was engaged in Aerial Work and was scheduled to drop student skydivers from overhead EICL. Having already completed two lifts earlier in the morning, the Pilot took off at 10.10 hrs carrying one jumpmaster (JM) and two students on board with the intention of climbing to 3,500 ft to release both students on static lines[7]. A general description of parachutes, parachute deployment and sequence of deployment is provided at **Appendix A**.

Upon reaching 3,500 ft overhead the drop-zone, the first student was cleared by the JM to exit the aircraft ('*Climb Out*') onto the right-hand side undercarriage step. The Student then dangled (hung) from the wing strut, settled himself and on receiving the '*Go'* command from the JM, released his grip to fall away. See **Photo No. 1** for aircraft configuration for skydiving operations.

[7] **Static line:** A line with one end fixed to the aircraft and the other attached to the release pin of a parachute, so that the parachute opens automatically.

Photo No. 1: Aircraft configuration for Skydiving Operations

Within seconds, the Student was jerked back suddenly and saw that his un-inflated canopy had become entangled on the right-hand side horizontal stabiliser of the aircraft. He immediately *'cut-away'*[8] from the main canopy, following which his reserve parachute deployed and he landed back at the drop zone without injury.

The Pilot reported that following the release of the Student, the aircraft suddenly pitched-up and he felt that as if he had been thrown forward. The right wing then dropped and the aircraft started to spin to the right. The Pilot performed a spin recovery and regained full control of the aircraft by 1,000 ft. The Pilot then re-established his position in relation to runway (RWY) 09 at Clonbullogue, turned for an approach and landed without further incident. Following an examination of the aircraft it was found that there was significant damage to the tail area (empennage). There were no injuries.

1.2 Interviews

1.2.1 Pilot

The Pilot, who had a valid CPL(A), told the Investigation that he had completed two lifts earlier that morning with three persons on board to 8,000 ft and 5,000 ft respectively. For the third lift (the occurrence flight) it was his intention to drop two static line students and a JM from 3,500 ft.

He stated that when they were at 3,500 ft, he positioned the aircraft overhead the field on an into-wind heading of 230 degrees. The JM *'spotted'* the release position below, the Pilot *'cut power'* to maintain 80 mph indicated airspeed (IAS) and configured the aircraft for the release of the first student. The Student, who had pre-positioned himself at the door, then climbed out onto the right-hand side undercarriage step. When the Student was ready, he dangled from the strut and then received the *'Go'* command from the JM. The Student let go of the strut and some seconds later the aircraft lurched, *'throwing him'* (the Pilot) forward; the right wing suddenly dropped and the aircraft started to spin to the right. He commenced a spin recovery, the aircraft *'wobbled'* and then the spin stopped. He then applied back pressure on the control column and continued this until the aircraft levelled out at 1,000 ft.

[8] **'Cut-away':** A skydiving term referring to disconnecting the main parachute from the harness-container in case of a malfunction in preparation for opening the reserve parachute. The 3-ring release system on parachutes allows a rapid cut-away in the event of an emergency.

At this point the Pilot sought to establish where the aircraft was in relation to the airfield. He saw RWY 09, turned for the approach and landed without further incident. The Pilot reported that he did not suffer any in-flight control restriction but that the aircraft did vibrate and fish-tail somewhat on final approach.

1.2.2 Jumpmaster (JM)

The JM (aged 71 years), who had over 650 jumps, was tasked to supervise the jumps on the occurrence flight. The plan was to conduct two circuits at 3,500 ft over the field and release each student separately. He confirmed that he had conducted a *'checkout of equipment'* on both students prior to boarding the aircraft. As each student boarded the aircraft the JM *'hooked-up'* each static line to the attachment point on the floor of the aircraft. At the assigned altitude, the JM called *'door'*, opened it and chose a spot for exit. Following the dispatch exit commands of *'Stand-by'* and *'Cut Power'*, the JM called *'Climb Out'* and the Student climbed out onto the step. The JM told the Investigation that during this time he managed the student's static line so that it would not snag on anything as he moved about the cabin and into position. The JM saw the Student step off the strut and dangle in the arch position from the right-hand side strut. The JM confirmed that he held the static line to control slack and remained within the cabin for the release. Once the Student was settled, the JM gave a *'thumbs-up'* and the *'Go'* command to the Student. The JM saw the Student break physical contact with the aircraft and adopt the exit position. About the same time he saw a '*black object'* flash by.

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As he monitored the Student performing his Dummy Ripcord Pull (DRP)[9], he saw the canopy go over the tail of the aircraft and the aircraft suddenly pitched up and rolled to the right. He said that while he was nearly thrown out of the aircraft, he managed to settle himself and then pulled in the static line and the deployment bag (D-Bag)[10]. On looking out he observed that the Student had already *'cut-away'* from his main canopy and the canopy fell away from the aircraft. It appeared to him that the main canopy did not inflate while entangled around the tail.

As the Pilot was recovering the aircraft, the JM closed the door and they landed a short time later without further incident.

The JM believed that the *'black object'* which he saw flash past him was in fact the D-Bag. In addition, he told the Investigation that at no stage during the release of the Student did he see the static line become snagged.

[9] **DRP:** This is part of the training syllabus and involves reaching to where your ripcord would normally be and pulling out a bright orange flag to show to your instructor. The aim of the exercise is to demonstrate that you are capable of pulling the ripcord.

[10] **D-Bag:** Attached to one end of the static line with the other end attached to the aircraft. The D-Bag contains the main canopy and suspension lines and serves two functions - it allows the suspension lines to straighten out in a controlled manner, and it prevents the canopy from inflating before the lines are fully stretched out.

1.2.3 Student

The Student (aged 21 years) told the Investigation that he was doing his first DRP static line jump which was the fourth jump of his skydiving course. He was the first student due out of the aircraft and was thus kneeling on the right-side of the pilot position. The Student recalled that it was windy, so the Pilot flew further to drop them. He pre-positioned to the door, which had been opened by the JM.

As the engine power was cut, he climbed out onto the step and assumed the hanging position from the right strut. He took a second or two to settle himself and, after getting the all clear from the JM, he let go. He counted *'One Thousand'*, *'Two Thousand'*, as part of his DRP drill, but was then jerked back and he immediately saw that his un-inflated canopy had become entangled on the tail of the aircraft. It appeared to pull the aircraft to one side. While suspended at full length *'on the lines'*, the Student *'cut-away'* from the main canopy, his reserve parachute deployed and he landed back at the drop zone without injury. The Student considered that the entanglement and *'cut-away'* all happened within less than seven seconds.

The Student told the Investigation that at no stage during the move across the cabin or onto the step did he see his static line become snagged.

1.2.4 Second Student

The second student confirmed that at no stage did he see the first student's static line become snagged.

1.3 Aircraft Information

1.3.1 Aircraft Details

The Cessna 182L is a four-seat, all-metal, high wing aircraft with a fixed landing gear and is powered by a 230 hp (172 kW) Continental piston engine. The accident aircraft was manufactured in 1968 and has a maximum gross weight of 2,800 lb (1,270 kg). It was first registered in Ireland on the 20 May 1991 and registered to the subject parachute Club on the 14 January 1997. It had a valid Certificate of Airworthiness (C of A) issued by the Irish Aviation Authority (IAA) and an Airworthiness Review Certificate (ARC) valid for the period 14 March 2015 to 13 March 2016.

1.4 Damage

1.4.1 Damage to Aircraft

On examination of the aircraft after the occurrence, it was determined that there was significant damage to the empennage, requiring its replacement. The damage included:

- Impact indentation on the leading edge of the right horizontal stabiliser close to the stabiliser tip (**Photo No. 2**).
- Skin damage in the form of a tear to the outer portion of the trailing edge of the horizontal stabiliser in the vicinity of the elevator trim tab (**Photo No. 3**).

- Significant structural damage to either side of the rear fuselage skin adjacent to the horizontal stabiliser root area (**Photos No. 4 & 5**).

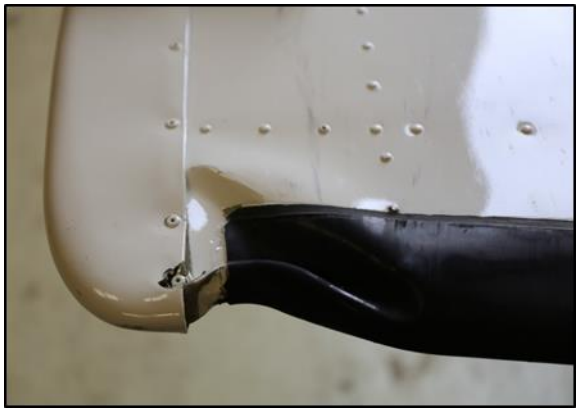
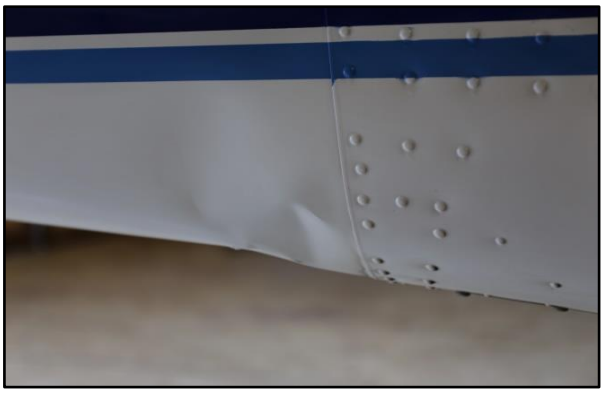


Photo No. 2: Leading edge indentation

Photo No. 3: Tear to trailing edge skin



Photos No. 4 & 5: Significant structural damage to either side of the rear fuselage

1.4.2 Damage to Student's Canopy and Harness

The main canopy, an Aerodyne Square Seven cell Triathlon 220, was *'cut-away'* by the Student and was subsequently located in a tree some distance from the airfield. An examination of the recovered canopy determined that:

- Four suspension lines on the right-hand side front riser were severed 33 cm from the connector Q-link (**Photo No. 6**). The parachute system[11] utilises four separate risers, with four separate suspension lines emanating from each.

- The two steel rings which were part of a three ring release system on the right-hand side riser were missing (**Photo No. 6**).

- There was also an 81 cm tear of the bottom skin of the main canopy on the 3rd cell from the left, along the seam between the 2nd and 3rd cells (**Photo No. 7**).

[11] **Parachute System:** Also referred to as a *'Rig'*.

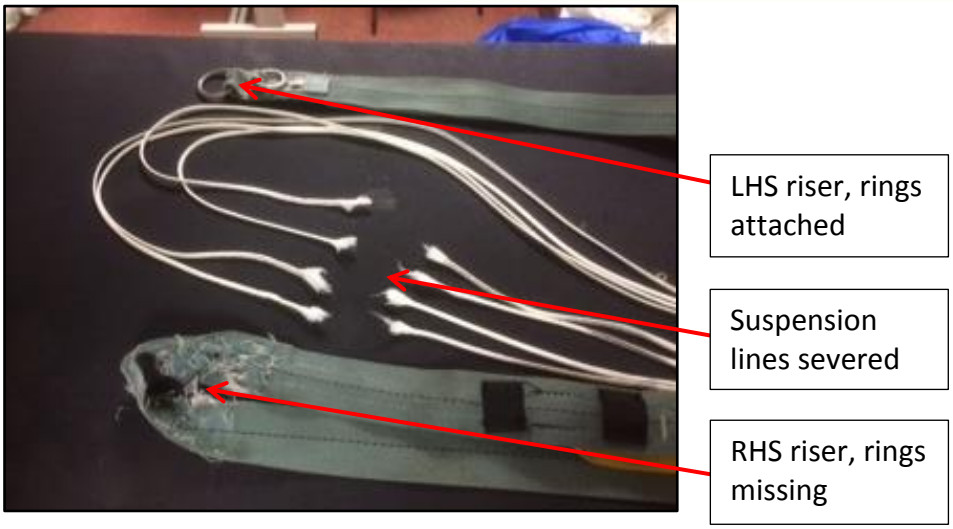


Photo No. 6: Four suspension lines severed and two rings missing from right-hand side riser

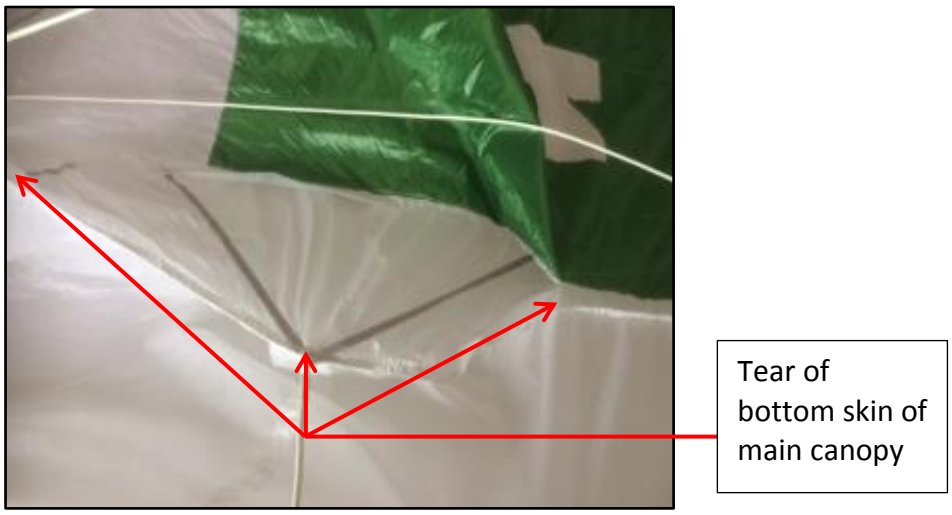


Photo No. 7: Tear of the bottom skin of the main canopy

1.5 Examination of Parachute Equipment

1.5.1 Student's Equipment

The Student was utilising a Thomas Sports Equipment (TSE) Student Zerox parachute *'Rig'*. The Investigation conducted a general examination of the Student's parachuting equipment, which included, amongst other things, the harnesses and container, main canopy, reserve canopy, static line bridle cord, D-Bag and the static line attachment point inside the aircraft. Apart from the damage mentioned in **Section 1.4.2**, all the associated equipment was in good condition.

The static line, which included the bridle cord and D-Bag, was measured and found to be 300 cm in length. This was within the requirement that the overall length was not to be greater than the shortest distance between the attachment point of the static line (on the floor behind pilot seat) and the leading edge of the aircraft's right horizontal stabiliser.

One static line bungee (*a rubber band*) was present on the securing point on the left-hand side of the container and one was found on the right-hand side (**see Section 1.6.1**).

The main release cable (Teflon-coated yellow cable) was in good condition. The length was measured as 12 cm, which was as per specification.

The main *'closing loop'* was deemed to be very slightly longer than that required (**see Section 1.6.3**).

1.5.2 Club Equipment

Following the occurrence, an examination of a random selection of the Club's parachuting equipment identified some variances in the standard of packing, including:

- Use of only one bungee (as opposed to two) on the left-side static line securing point.
- Some *'closing loops'* longer than that required.
- Suspension lines not double stowed (**Section 1.6.4**).

1.6 Specific Elements of Parachute Equipment

1.6.1 Bungee Securing Points

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The parachute container has one securing point on each side of the rear of the container (**Photo No. 8**). The left-side securing point utilises two static line bungees (two *rubber bands*) and is used to secure the static line to the container and provide a level of protection upstream of the main release cable. In other words the static line has to be pulled through the double bungees before a pull can occur on the main release cable. This reduces the risk of a premature pack opening by the effect of airflow or snagging. The second securing point (right-side) utilises one bungee and is used to secure excessive static line slack as the sky-diver walks to the aircraft. Once in the aircraft this particular bungee is released.

Photo No. 8: Bungee securing points

1.6.2 Main Release

The main release mechanism is generally of two different types. The first employs a metal pin (**Photo No. 9**) and is usually used by experienced skydivers. The second type, as was used in the subject event, is a Teflon-coated yellow cable (**Photo No. 10**) that measures 12 cm in length and is used by students and inexperienced skydivers. The increased length of the Teflon-coated cable over that of the metal pin, offers a greater element of pull-through protection, thereby reducing the risk of premature release.

Photo No 9: Main metal pin release

Photo No. 10: Main cable release

1.6.3 Closing Loop

A *'closing loop'* (**Photo No. 11**) is a short length of cord with a loop at one end and a knot and washer at the other end, which is connected to an inner flap on the container. The purpose of the *'closing loop'* is to secure the main pin/cable outside the container flaps in order to keep the main canopy D-bag and lines within the container until deployment.

Photo No. 11: Closing loop

During packing a *'pull-up'* (ribbon) is used to pull the '*closing loop'* through grommets on the container flaps and while under tension the main release pin/cable is inserted (**Photo No. 12**). Once the pin/cable is inserted, the *'pull-up'* is removed from the *'closing loop'* and a flap is placed over the main release pin/cable in order to protect it.

The main release pin/cable and *'closing loop'* should remain under tension to ensure that the main release pin/cable has a degree of resistance when pulled, thereby reducing the risk of premature release. No specified length is given for the *'closing loop'* as it is dependent on the type/size of the particular main canopy and how it is packed. However, a pull tension of between 6 – 22 pounds pressure is specified for the main release pin/cable when being pulled from the *'closing loop'*.

The TSE Zerox harness manual requires that the grommets should be as close to inline as possible when closing the rigs.

A *'closing loop'* that is too long, or a container system that does not secure the container flaps under tension, could allow a premature release of the main release cable and lead to an out-of-sequence deployment.

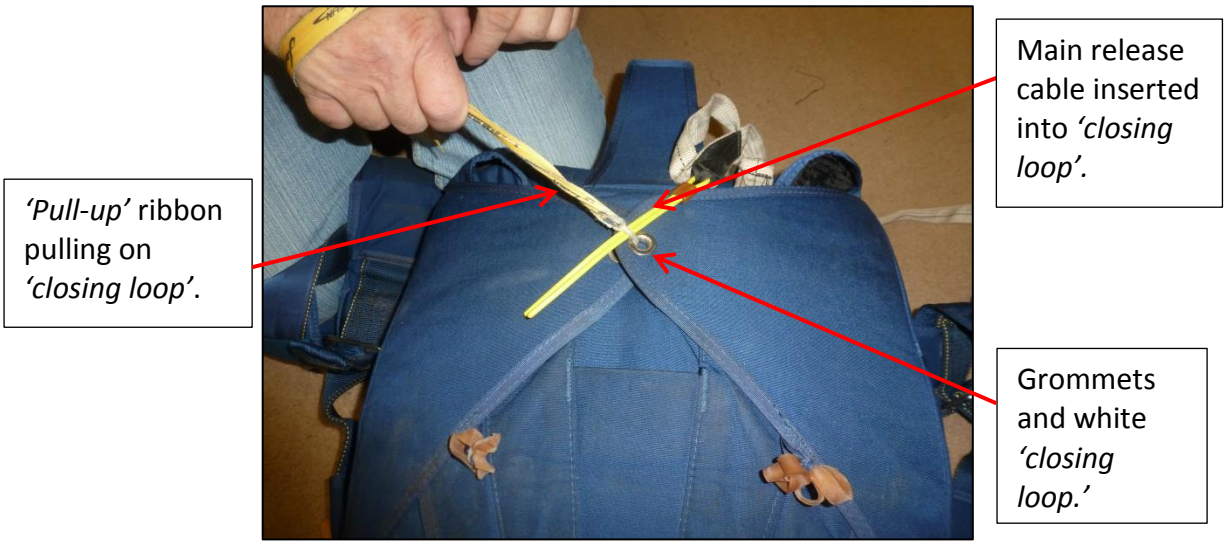

Photo No. 12: *'Closing loop'* being pulled by *'pull-up'* ribbon

1.6.4 Suspension Lines

The suspension lines, which connect the main canopy to the harness, are located on top of the D-Bag during packing (**Photo No. 13**) and placed within the container. The lines are arranged in 'S' loops to form a *'stow'* and are secured by bungees on the bag. It is considered good practice to double wrap the locking bungee *'stows'* in order to ensure proper tension (approx 12 pounds). This allows for a sequenced release of the lines during deployment. If the '*stows'* are not tightly wrapped (for example using only one bungee), little pull force would be required to pull the lines from the *'stow'* bungees and therefore there is a risk that the lines could suffer a *'Line-dump'*. A '*Line*-dump' occurs when the lines are dumped out of their *'stow'* bungees as the D-Bag releases from the container. Without '*stow'* bungees to hold the bag closed, the canopy will release into the airflow and will begin to inflate before the skydiver reaches the end of the lines.

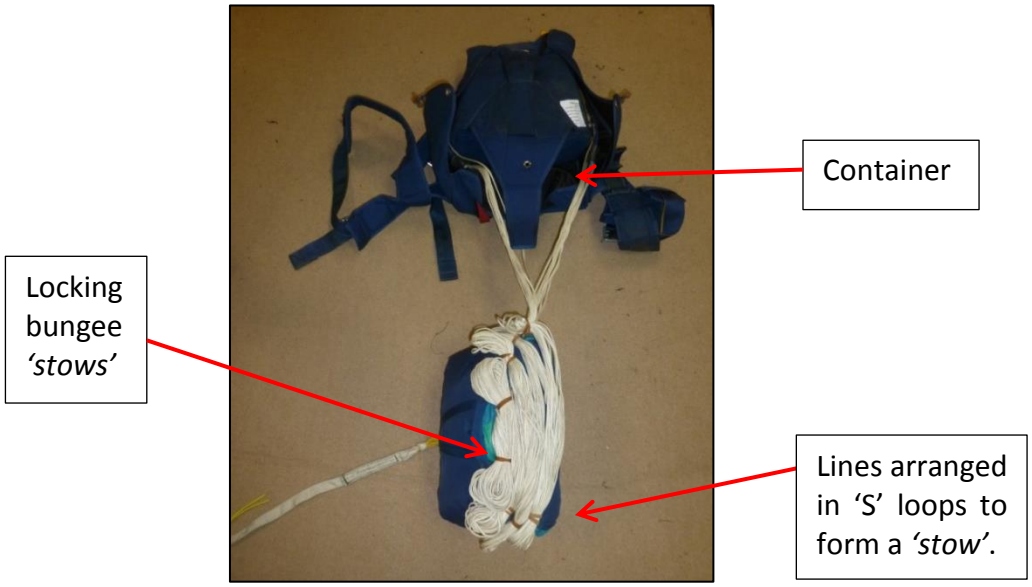

Photo No. 13: Suspension lines in 'S' loops and double wrapped locking bungee *'stows'* on the D-Bag.

1.7. Packing Procedures

1.7.1 General

A parachute *'Rig'* is generally made up of four separate components, namely, the harness/container, a main canopy, a reserve canopy and an automatic activation device (A.A.D). These components can be sourced from different manufacturers; an Owner's Manual is provided with each of these items giving procedures for assembly and packing.

In parachuting clubs it is normal practice that the only person permitted to assemble a parachute rig and pack a reserve parachute is a *'Rigger'*[12]. On completion of assembly, a *'Rigger'* threads and seals the reserve pin with their own individual tamperproof seal. A log card that accompanies all rigs is then completed and inserted into a pocket on the *'Rig'*.

Specific to the subject parachute Club, the reserve parachutes must be inspected and repacked, regardless of use, every 180 days with each rig's log card completed to reflect the work carried out. An entry is then made on the manifest computer showing that an a reserve is in date and the rig may now be used. The manifest computer will also show when a reserve goes out of date, effectively grounding the rig. All rigs are also externally tagged on the harness to show the next reserve due date. A rig with an out of date reserve is not permitted to be used.

Any visiting jumpers must present their licence, log book and rig to the Club *'Rigger'* or the Chief Club Instructor (CCI) for inspection. Following this inspection, their rig will then have an external tag fitted, thus allowing them to jump.

Most qualified skydivers at the subject parachute Club have their own equipment and pack their own main canopies.

[12] **Rigger:** A person who is qualified to assemble and maintain parachuting equipment.

1.7.2 Club Equipment

Club parachute equipment is subject to the same procedures with regard to assembly and maintenance as privately owned equipment. The subject parachute Club currently has 35 student rigs of various sizes. All Club equipment has either a number or a *'Rig'* name assigned to it and is kept in the *'gear room'*, a secure temperature-controlled room where all rigs have their own slot on hanging racks, with the name/number and both the reserve and main canopy sizes clearly displayed.

The *'gear room'* is staffed by either an instructor or a jumpmaster on a daily basis. No individuals may remove equipment without the approval from an instructor or a jump-master. All equipment must be signed out by the individual on the daily gear hire sheet with the time the rig was removed and the rig name/number. Attached to all rigs in the gear room is a packing slip. The packing slip contains the rig identification, the date of when it was last packed and the name of the packer.

When a rig is handed back to the *'gear room'* it must be signed back in on the daily gear hire sheet adjacent to where it was signed out and a new packing slip filled out and placed in the closing flap. The packing slip book is in triplicate. The *'Packer'* will keep the first part, the second is attached to the rig and the Club keeps the third for its records. All gear hire sheets are retained for record purposes.

Students at the parachute Club are encouraged to learn how to pack parachutes at the earliest opportunity. The Club regularly runs seminars on packing, during which an instructor or jumpmaster will first go through the canopy lay out, explaining parachute nomenclature and operation. The students are shown the practical side of packing and there are two decommissioned rigs available for students to practice on.

In addition to the practical side of packing, the parachute Club has also introduced a packing theory test. It is designed to test a candidate's knowledge on the workings of a parachute and its makeup, components and terminology. A student wishing to take a packing test will first complete the theory test and then pack a main canopy under the supervision of an instructor, jumpmaster or a suitably qualified person. The examiner may quiz the candidate on certain elements of the canopy or *'Rig'*. On successful completion of the test the instructor will endorse the student's log book indicating he/she is cleared to pack main canopies. The student's theory tests are also kept on file for reference. The endorsement is normally achieved at 25 jumps and is referred to as an 'A' Licence. Prior to obtaining an 'A' Licence, a student's main canopy is packed by qualified *'Packers'.* It is noted by the Investigation that once *'Packers'* are licenced, they are not subject to periodic testing.

1.8 Parachute Jumping in Ireland

An Operations Advisory Memorandum (OAM No: 02/15) issued by the IAA on the 3 July 2015 provided information for persons engaged in parachute jumping in Ireland. The OAM identifies, *inter-alia*, that:

"Sport parachuting is generally considered an aeronautical activity because parachutists usually use civil aircraft to transport them to a point above their chosen 'Drop Zone' (DZ). However, unlike pilots who must hold a pilot licence and aircraft which must have an airworthiness certificate, parachutists are not required by European aviation law to hold any specific qualification issued by a civil aviation authority. Parachute centres which provide parachute dropping services and equipment may be commercial companies dealing with members of the public or they may be clubs where every parachutist is a club member. Parachute centres in Ireland conducting flights in support of parachute dropping for commercial purposes available to members of the public are required to declare their aircraft operational capabilities to the Irish Aviation Authority (IAA) and may only use pilots holding a Commercial Pilot Licence. Parachute centres where all the parachutists are members of a club and any profits stay within the organisation, may choose to operate their aircraft according to the rules for non-commercial flights (i.e. private flights). In this case the parachute centre (club) is not required to declare their aircraft operational capabilities to the IAA".

Regarding Aircraft Operations, the OAM also states that:

"European Aviation Regulations for aircraft operations regard the transport of parachutists as a specialist operation (SPO). This means that parachutists (including novice parachutists) are considered to be participants in the operation rather than passengers in the aircraft. Parachutists are considered to be 'Task Specialists' when they are being transported in an aircraft for the purpose of a parachute jump. The aircraft operator must assign the duties to be performed on the ground, on board and from the aircraft to each task specialist. The 'Task Specialist' is required to have specific knowledge of those duties. This is also the case when two parachutists jump using the same parachute equipment (normally referred to as a tandem jump). The EU regulations also allow aircraft operating in support of parachute dropping to use the floor of the aircraft as a seat. This is a higher level of risk than normally allowed for passengers in an aircraft on a private or commercial flight where a seat and a seatbelt must be provided. This higher level of risk assumes that the Task Specialist is aware and accepts a lower level of safety as part of their activity. The aircraft operator and the Pilot in Command are responsible to ensure that Task Specialists are appropriately briefed and understand their role in the aircraft operation and any associated risks, particularly in the event of an on-board emergency or an emergency landing".

Regarding Technical Standards for Parachutists and their Equipment, the OAM provides that:

"There are no technical standards published in European Aviation Regulations for parachutists or their equipment. This means that sport parachute jumping (i.e. the actual parachute jump and the parachute equipment) is not regulated by the IAA.

Parachute centres generally adopt the best practices and parachutist qualification standards recommended by organisations like the Fédération Aéronautique Internationale (FAI), the United States Parachute Association (USPA), the Canadian Sport Parachuting Association, the British Parachute Association (BPA) or the Parachute Association of Ireland (PAI).

Novice parachutists usually complete a formal training course at an organisation that has equivalent training programs to these organisations or another best practice industry standard. Parachute equipment will normally have technical standards and operating instructions detailed by the equipment manufacturer. Novice parachutists who want to learn more about technical standards and parachutist qualifications should inquire directly with their parachute centre or from their equipment provider".

1.9 Additional Information

A review of AAIU databases indicate that this is the first reported/recorded occurrence in Ireland where a main canopy has become entangled on the empennage of a parachuting aircraft.

1.10 Safety Actions

Following this particular occurrence and in response to the identification of variances in the standard of packing, the subject parachute Club held a seminar for club members to emphasize, amongst other things:

- The general packing standards.
- The use and length of the *'Closing Loop'* and in particular the importance of having the appropriate tension.
- The importance of having double bungees on the static line securing point.
- The requirement to double wrap the locking bungee *'stows'*.

In addition, the parachute Club advised the Investigation, that when the aircraft EI-CDP comes back into service, they will review the following areas:

- The packing/stowing and security of the static line.
- The method that the jumpmaster uses to control the static line while the student exits the aircraft.
- The running-in speed of the aircraft while the student is exiting.

2. ANALYSIS

2.1 General

The Student was conducting a static line jump under the supervision of a JM. Following his release from the wing-strut, the Student's main canopy became entangled on the starboard horizontal stabiliser, which resulted in the aircraft pitching-up and rolling to the starboard side. The quick reaction of the Student to *'cut-away'* his canopy, effectively released the main canopy from the horizontal stabiliser and thus allowed the Pilot to regain control of the aircraft as he responded to the sudden upset and spin.

The static line system is designed to operate in such a way that the main cable release and initiation of the main canopy deployment occurs when the static line is at its full length. This allows the skydiver to clear the general confines of the aircraft and ensures that the deployment of the main canopy does not occur in close proximity to the aircraft structure, or near the aircraft control surfaces.

On this occasion, the Investigation is satisfied that the D-Bag/main canopy emerged from the container prematurely and started to deploy as the Student was about to release, with the result that the unfurling main canopy and lines made contact with the right-hand side horizontal stabiliser. Had the controllability of the aircraft been compromised further, it is likely that the outcome of this event would have been far more serious.

2.2 Premature Deployment

Premature deployment of the D-Bag/canopy can only occur if the main release cable is pulled from its *'closing loop'*. When the main release cable is pulled, the flaps on the container open and the D-bag, containing the main canopy and lines, falls out and is released into the airflow. None of the skydivers on board reported seeing the static line becoming snagged as the Student moved about the cabin or during the *'climb-out'* onto the step and wing-strut. Neither did the JM report seeing anything untoward prior to giving the *'thumbs-up'* and *'go'* signal to the Student.

It is therefore considered likely that the 'pull' on the main release cable, which in turn initiated the premature deployment, occurred just as the Student released from the wing-strut and while he was still in close proximity to the aircraft structure.

Although it is not possible to be definitive, the 'pull' on the static line could have been caused by a number of different factors, singularly or in combination, including:

- Airflow effect – where the airflow exerted sufficient pressure on the static line itself to pull on the main release cable.
- Snagging of the static line while climbing out of the aircraft (albeit unseen by all concerned).
- Short-lining of the static line, in which there may have been insufficient slack to allow the Student position freely to the step/wing-strut and tension came to bear on the main release cable.

- Rapid movement of the Student towards the wing-strut, with the JM remaining within the confines of the aircraft interior – the Student may have gotten ahead of the JM as he managed the slack on the static line.

The tension on the *'closing loop'*/main release cable itself could have been a factor regarding the level of force that would have been required to pull the cable from the *'closing loop'*. The Investigation recognises that once the canopy is released from its container, it is not possible to determine how well the canopy was packed or how secure the canopy was within the container itself. However, as the *'closing loop'* was slightly longer than required, it is possible that the main release cable was not as secure as it should have been and an applied force less than that specified may have been sufficient to pull the cable from the *'closing loop'* prematurely.

The use of only one bungee on the static line securing point, as opposed to the two prescribed, meant that less pull-tension would have been required to pull the static line through the securing bungee and made it less likely that any premature pulling on the static line would have been felt by the skydiver. Also, if a force was exerted on the static line (e.g. airflow), the securing tension at the securing point would have been sufficient to keep the static line in place and thus retain the protection upstream of the *'closing loop'*/main release cable. It is considered likely that had the *'closing loop'* been at the appropriate tension and both bungees utilised at the securing point, the risks of a premature deployment of the D-Bag/lines would have been minimised.

Furthermore, even with a premature deployment of the D-Bag from the container, had the suspension line *'stows'* been double wrapped, it is considered likely that the securing tension would have been sufficient to keep the lines in place, and as such, the D-Bag would have just hung below the container and not deployed.

Notwithstanding this, it is clear that some force was exerted on the static line and the combination of a low pull-tension on the *'closing loop'*, only one bungee being utilised on the static line securing point and the possibility that the suspension line *'stows'* were not double wrapped, all eroded the design protections against premature deployment, whilst the Student was still in close proximity to the aircraft.

2.3 Aircraft Damage

Significant damage was caused to the empennage of the aircraft as a result of excessive, asymmetric loads coming to bear on the horizontal stabiliser. It is considered likely that the unfurling (un-inflated) canopy positioned itself over the top section of the right-hand side horizontal stabiliser and the lines ran over the leading edge tip of stabiliser and down towards the descending Student. When the Student became suspended at full length *('on the lines'*) his deceleration would have exerted significant loads in the fore and aft plane of the horizontal stabiliser. This resulted in denting of the leading edge of the horizontal stabiliser and significant damage to the empennage. Once the Student *'cut-away'* his main canopy, the tension/load would have been released from the lines. It is possible that around the same time, some form of initial inflation occurred to the main canopy, thereby creating a force to pull the now-released lines and canvas risers over the starboard horizontal stabiliser.

The two steel rings, which are part of a three ring release mechanism on the harness, were ripped off the right-hand side riser and four lines were severed 33 cm from the connector Q-link. The two steel rings, which are part woven into the riser canvas, would have required significant loads to be exerted in that area in order to cause such damage. From examination of the metal tearing damage in the area of the trailing edge horizontal stabiliser and elevator trim tab, it is considered likely that the right-hand lines and riser ran through the gap between the elevator trim and the horizontal stabiliser as the main canopy released from the aircraft structure.

2.4 Parachute Packing

An examination of Club's parachuting equipment, post-event, determined that some variances existed in the general standard of packing. Variances such as the use of one static line bungee at the securing point instead of two, a longer than normal *'closing loop'* and suspension line *'stows'* single wrapped (instead of the prescribed double wrap) in themselves, would not prevent a main canopy from deploying. However, such variances could contribute to an increased susceptibility to premature deployment of the main canopy, in that there would be a reduced level of protection against main cable release, if tension was inadvertently exerted on the static line. Furthermore, the suspension lines could suffer a *'Line-dump',* which could have implications for a smooth deployment of the main canopy.

It is noted by the Investigation that once an individual has received an appropriate amount of training and is subsequently qualified to pack his/her own equipment, or if an individual is a qualified *'Packer',* there is no re-testing requirements or testing schedule to determine continued competency.

2.5 AAIU Comment

Skydiving is an adventure sport that is conducted widely in Ireland and, as with any adventure sport, there are inherent associated risks. However, skydiving is usually achieved through the use of an aircraft, so there are two different aspects of the sport that must be considered, i.e. the aircraft itself and the persons and equipment engaged in the activity.

Aircraft engaged in parachuting operations are subject to European Aviation Regulations and Regulatory compliance by national regulatory authorities. The aircraft operator and the Pilot in Command must therefore ensure that the aircraft is operated according to the appropriate rules as applicable to the operation and they are audited in that regard.

Skydiving and the serviceability or operation of parachute equipment is not regulated under European Aviation Regulations or by national regulatory authorities; nor is the training and the associated qualifications that are provided by the parachute centres/clubs. This self-regulation is normally achieved by parachute centres/clubs adopting the best practices and qualification standards recommended by international and national organisations and by setting their own internal safety procedures.

As stated earlier, some variances were found in the standard of packing in the parachute Club. The repetitive nature of packing is such that individuals may, over a period of time, evolve their own technique of packing and/or develop idiosyncrasies that could compromise the packing standards and the overall safe use of the equipment itself.

While it is recognised that specific safety actions were carried out following the occurrence, the Investigation considers that it would be appropriate for the parachute Club to develop procedures to prevent variances in standards of parachute packing. The Investigation accordingly issues a Safety Recommendation to the subject parachute Club in this regard:

Safety Recommendation No. 1

The Irish Parachute Club should develop, and thereafter ensure continued compliance with, procedures to prevent variances in standards of parachute packing (**IRLD2016-012**).

3. CONCLUSIONS

(a) Findings

1. The Pilot was appropriately qualified and had a valid commercial pilot licence (CPL).

2. The aircraft had a valid Certificate of Airworthiness (C of A) and an Airworthiness Review Certificate (ARC) valid for the period 14 March 2015 to 13 March 2016.

3. The Jumpmaster conducted a check of all equipment on both students prior to boarding the aircraft.

4. None of the persons on board observed the static line of the Student snagging.

5. Only one static line bungee, as opposed to the two prescribed, was used on the securing point of the parachute container.

6. Tension of undetermined origin came on the static line which was of sufficient force to pull through the static line single bungee securing point and pull the main release cable out of its *'closing loop'*.

7. The D-bag/main canopy and lines likely fell from the container as the Student was about to release from the wing-strut.

8. The premature deployment resulted in the unfurling canopy and lines coming in contact with the right-hand horizontal stabiliser and elevator prior to the Student becoming suspended at full length on the lines.

9. It is possible that the locking bungee line *'stows'* were single wrapped as opposed to double wrapped.

10. The *'closing loop'* was slightly longer than that required and thus the possibility exists that the *'closing loop'*/main release cable required less force to release than that which would have been desired.

11. While a number of scenarios were examined on how premature tension came on the static line, it was not possible for the Investigation to come to a definitive conclusion on this matter.

12. Post occurrence examination of Club parachuting equipment found variances in standards of packing.

13. There were no Club procedures in place to ensure continued compliance with the prescribed procedures for parachute packing.

14. Club personnel are not subject to periodic revalidation following their initial approval to pack parachutes.

15. The quick reaction of the Student to *'cut away'* the entangled main canopy, released the canopy from the horizontal stabiliser, thus allowing the Pilot to regain controllability of the aircraft following the upset.

16. The Pilot who was faced with an unexpected and unusual control upset recovered the aircraft in an appropriate manner which ensured the safety of all persons on board.

(b) Probable Cause

1. Entanglement of the main canopy and lines over the right-hand horizontal stabiliser leading to a control-upset of the aircraft.

(c) Contributory Cause(s)

1. Premature deployment of the D-Bag and deployment of the main canopy and suspension lines in close proximity to the aircraft structure.

2. Premature tension on the static line, the cause of which could not be determined.

4. SAFETY RECOMMENDATIONS

No.	It is Recommended that:	Recommendation Ref.
1.	The Irish Parachute Club should develop, and thereafter ensure continued compliance with, procedures to prevent variances in standards of parachute packing.	IRLD2016012

View Safety Recommendations for Report 2016-017

Appendix A

General Information – Parachutes

A skydiver carries two parachutes, namely the main canopy and a backup reserve parachute.

The backpack worn by the skydivers consists of a container which holds the main canopy and the reserve chute. The container also includes thick shoulder harnesses and leg straps that keep the container firmly attached to the skydiver.

The main canopy is *'stuffed'* into the deployment bag (D-Bag), and the D-bag is placed into the container. The D-bag is secured within the container by means of envelope flaps that are brought together by pulling a *'closing loop'* through the grommets on each flap and inserting a main release pin or cable through the *'closing loop'* on the outer flap.

All of the main canopy suspension lines are stowed in 'S' loops or zig-zag patterns by looping them underneath rubber bands attached to the D-Bag. These lines run from the canopy itself to the container through a pair of thick straps called 'risers'. In general, the risers are made from *'Type 17'* webbing and are used to connect the parachute canopy via suspension lines to the parachute harness. Each riser has two separate pieces of webbing for front and back suspension line attachments. There are two sets of risers enabling even load distribution, i.e. suspension lines are split into four groups, front and back, left and right and are called A-lines, B-lines, C-lines, D-lines. In addition, there are a set of brake lines (left/right) which incorporate 'toggles' that are used for directional control.

A main canopy can be deployed using different methods. The first is by use of a pilot chute; a small 30 to 45 cm diameter parachute that the skydiver uses to start the deployment sequence to open the main canopy. The pilot chute normally rides in a little pouch attached to the bottom of the container. When clear of the aircraft, the skydiver throws out the pilot chute, it catches the airflow and pulls on a 2 to 3 m long piece of nylon webbing (known as the bridle). The bridle is connected to both the main release pin secured by a *'closing loop'* and the D-bag. After the pilot chute inflates, the subsequent force causes the bridle to pull the pin out of the *'closing loop'*, releasing the D-bag from the bottom of the container. As the pilot chute and bridle continue to pull on the D-bag, all of the lines unfold and stretch out, followed by the main canopy so that it can inflate

A second method is by use of a static line where no freefall is involved. A static line jump is where the static line is attached at one end to the aircraft and at the other end to the top of the skydivers D-Bag. The skydivers fall from the aircraft causes the static line to become taut and it pulls the main release cable on the container. The flaps open on the container and the D-bag containing the main canopy and lines falls out and release into the airflow. As the skydiver falls away, tension comes on the anchored static line, which also is connected to the D-bag and the lines and main canopy are pulled from the D-bag.

The static line and D-Bag remain with the aircraft as the skydiver falls away, and are pulled back into the aircraft. Once free of its D-Bag, the lines and canopy unfurl and the airflow enters the canopy. The canopy is allowed to inflate as the skydiver continues to fall.

Effectively, the skydiver drags the parachute behind him, causing the upward-rushing airflow to force open and inflate the canopy. The canopy should inflate and begin supporting the skydiver within four seconds. The aim of static line progression is to train students to maintain the correct, stable body position upon exiting the aircraft, and to teach how to deploy the canopy via the pilot chute mechanism.

As the lines completely unfold and start to pull with the tension from the pilot chute or static line, they pull the risers out of the container. The risers also contain a release mechanism for the main canopy's lines in case the need arises to cut the main canopy away.

In order to have a smooth and controlled inflation of the main chute canopies have a piece of nylon called a ‘slider’ that holds the lines together and slides down the lines as the parachute opens. This slows down the opening and keeps the lines from tangling as the canopy inflates.

Once the canopy is out and open, the skydiver can grab the two toggles and start steering the parachute toward the landing site.

- END -

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

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