Investigation report

B1/2011L

Collision between two sailplanes in Hattula on 12 June 2011

Translation of the original Finnish report

OH-920 (competition sign YX)
OH-983 (competition sign BO)

Ventus 2a
ASW 27-18

Onnettomuustutkintakeskus
Olycksutredningscentralen
Safety Investigation Authority, Finland

Osoite / Address:	Sörnäisten rantatie 33 C FI-00500 HELSINKI	**Adress:**	Sörnäs strandväg 33 C 00500 HELSINGFORS
Puhelin / Telefon: **Telephone:**	(09) 1606 7643 +358 9 1606 7643		
Fax: **Fax:**	(09) 1606 7811 +358 9 1606 7811		

Sähköposti: turvallisuustutkinta@om.fi tai etunimi.sukunimi@om.fi
E-post: turvallisuustutkinta@om.fi eller förnamn.släktnamn@om.fi
Email: turvallisuustutkinta@om.fi or first name.last name@om.fi

Internet: www. turvallisuustutkinta.fi

Henkilöstö / Personal / Personnel:

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Muut onnettomuudet / Övriga olyckor / Other accidents	
Johtava tutkija / Ledande utredare / Chief Safety Investigator	Kai Valonen

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Translation: Leila Iikkanen

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SUMMARY

An aircraft accident occurred near lake Renkajärvi in Hattula, southern Finland, on Sunday 12 June 2011 at 15:57 Finnish local time, when two single-seat sailplanes collided in the air. The pilot of the other plane rescued himself with a parachute, and the other pilot was killed. Both sailplanes were destroyed.

The sailplanes involved were participating in Finnish Gliding Championships. The collision occurred in gliding flight in good weather conditions between the turnpoints of Forssa and Syrjäntaka, at a height of approximately 1400 m inside Pirkkala Military Control Area (Airspace class D) of which southern part was reserved for the competition. Both pilots were experienced sailplane pilots and competitors.

Before the collision, the planes were flying almost the same route and occasionally very close to each other. The collision happened when the lower flying plane increased altitude and reduced speed, finally hitting the bottom of the higher flying plane.

From the force of the impact, the rear fuselage and right wing of the lower plane broke off and the canopy was shattered. The plane went into a steep dive, and also the left wing broke off. The fuselage crashed into the ground at high speed. The pilot was found outside the wreckage. He had unfastened the seat belt but not launched the parachute. The bottom of the higher plane was cracked, its steering system was damaged and the canopy was broken. The pilot rescued himself with a parachute.

Both planes had two GPS devices, and their recordings were used in the accident investigation. The planes were also equipped with a FLARM system for collision avoidance. According to the rescued pilot, the FLARM did not alert before the collision, which may have been due to the limited capabilities of the system as described in its instructions manual.

The accident was caused by pilots' insufficient situational awareness leading to the situation, where the planes got above each other and their flight paths intersected in the vertical direction. At the same time the pilots could not see each other. Contributing factor was the fact that the collision warning system did not alert.

Safety Investigation Authority, Finland issued a safety recommendation to the Finnish Aeronautical Association, urging them to hold a safety information session before every gliding contest. In addition, it was proposed that safety issues be addressed in the briefing session for each day of competition.

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ABBREVIATIONS

ADS-B	Automatic Dependent Surveillance – Broadcast
ARC	Airworthiness Review Certificate
ATC	Air Traffic Control
BFU	Bundesstelle Für Flugunfalluntersuchung
FAI	The World Air Sports Federation
FLARM	Flight Alarm (system)
GPS	Global Positioning System
LED	Light-emitting Diode
MHz	Megahertz
SSR	Secondary Surveillance Radar
UTC	Co-ordinated Universal Time
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions

SYNOPSIS

An aircraft accident occurred near lake Renkajärvi in Hattula, southern Finland, on 12 June 2011 at 15:57 Finnish time. Two single-seat sailplanes participating in Finnish Gliding Championships collided each other at a height of approximately 1400 m. The collision occurred in gliding flight in good weather conditions between the turnpoints of Forssa and Syrjäntaka inside Pirkkala Military Control Area (Airspace class D) of which southern part was reserved for the competition.

The aircraft involved were a Ventus 2a sailplane manufactured by Schempp-Hirth Flugzeugbau Gmbh, registration OH-920 and competition sign YX, and an ASW 27-18E sailplane manufactured by Alexander Schleicher GmbH & Co, registration OH-983 and competition sign BO. The pilot of OH-920 was killed in the accident. The pilot of OH-983 rescued himself with a parachute. Both sailplanes were destroyed.

On 4 July 2011, the Safety Investigation Authority, Finland appointed an investigation team to investigate the accident (Decision No. 350/5L). Investigator Jorma Laine was appointed investigator-in-charge, and investigators Ismo Aaltonen and Hannu Halonen as members of the team. The German safety investigation authority (Bundesstelle für Flugunfalluntersuchung) appointed investigator Frank Stahlkopf and the Slovenian safety investigation authority (Sektor za preiskovanje letalskih nesreč in incidentov, Ministrstvo za promet) investigator Roman Rovansek as their representatives.

Comments on the draft final report were requested from the parties concerned, Finavia Corporation, Kanta-Häme Police Department, the Finnish Transport Safety Agency, the Finnish Border Guard, the Area Control Centre Finland, the Finnish Aeronautical Association, Tinttilakki ry, as well as from the German and Slovenian safety investigation authorities and the European Aviation Safety Agency. Their comments were taken into account in the final report.

All times in this investigation report are in Finnish local time (UTC+3 hours).

This investigation report uses the competition signs to refer to the sailplanes.

The material used in the investigation is stored at the Safety Investigation Authority, Finland.

1 FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Events before the flights

The sailplanes YX and BO involved in the collision were participating in the 15-metre class of the Finnish Gliding Championships, which had started on 11 June 2011. The competition centre was at Räyskälä Aviation Centre in the municipality of Loppi.

Safety-related issues were discussed in the first briefing session for the competition. The competitors also received instructions on how to act in case of an accident.

In the morning briefing on the second day of competition 12 June 2011, the competitors were given weather information for the day, and the 15-metre and two-seater classes (21 planes in total) were assigned a 283.2 km course via seven turnpoints. The take-off and landing site was Räyskälä aerodrome (EFRY).

The pilots planned their flights as usual. The water tanks of both aircraft were filled up so that the planes were at their maximum take-off weight of 525 kg. Aero-towing of sailplanes for the competition started at 12:00.

1.1.2 Events during the flights

The course for the flying task went first south-west from Räyskälä to Somerniemi and then via Kanteenmaa and Punkalaidun to Forssa. At the time of the accident, the planes were flying below a line of cumulus clouds in visual meteorological conditions (VMC) from the turnpoint of Forssa towards Syrjäntaka turnpoint, which was located approximately 25 km east-northeast of Hämeenlinna. There were about ten sailplanes flying in the same direction in the same area. Some of the planes were two-seaters, which were proceeding slightly slower.

The flight altitude was about 1400 m above ground and the speed varied between 150–220 km/h. According to eyewitnesses, the other plane climbed from a lower level and hit violently the bottom of the plane flying above it. The GPS recordings showed that the cockpit canopy of YX hit the bottom of BO's front fuselage. The canopy of YX shattered and aircraft parts and water from the wing tanks were scattered in the air in a large area. Other competition planes flying close behind had to change their heading to avoid the aircraft parts.

On impact, the rear fuselage of YX broke off and the right wing broke at about 1 m from the fuselage. The plane turned into a steep dive, and after a while, the left wing also broke off near the fuselage. The fuselage part crashed down at high speed in an almost vertical position, coming to rest in a boggy terrain with sparse trees.

The cockpit part sank almost completely into the soft ground. The pilot was found about five metres from the wreckage. His seat belts were unfastened, but the pilot had not launched the parachute. Aircraft parts had been scattered in a large area around the fuselage.

According to the BO pilot, he suddenly heard a loud bang and the aircraft's plexiglass canopy was shattered. The pilot tried to reduce speed, but the elevator control did not work. After realising this he decided to use the parachute.

The plexiglass of the canopy had almost completely shattered at the impact. For this reason he did not jettison the canopy, and the instrument panel which would normally go up with the canopy was left in the down position. When the pilot got up from his seat, his right shoe fell off. He sat back down and put the shoe back on. After this he rose again from the seat, turned left and braced his hands against the front edge of the wing. He pushed himself downwards away from the plane, waited for a moment and then pulled the parachute deployment handle.

After the parachute opened, the breast strap of the harness went up to the pilot's neck, since the harness was not tight enough. This caused bloody scratches on his neck. The pilot grabbed the breast strap with his hands to keep it down. As the parachute seemed to be drifting towards a nearby GSM mast, he took his other hand off the breast strap, pulled the suspension line and managed to change the direction.

The pilot landed the parachute in a forest, approximately 1 km from his plane. The parachute canopy became entangled in treetops and the pilot was left hanging at a height of about 12 metres. He managed to swing himself so that he got a grip of the tree trunk. After this he released himself of the parachute harness and slid down the tree to the ground. The tree trunk caused significant abrasion sores on his legs.

When the pilot got out of the plane, the nose of the empty plane pitched up and the speed decreased. The plane turned slowly to the left, nose pitching up and down. After about one minute and 50 seconds, the plane hit the trees in a mixed forest, coming to rest in an almost vertical position with the nose and left wing towards the ground.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	-	-
Serious	-	-	-
Minor/None	1	-	-

1.3 Damage to aircraft

Both sailplanes were destroyed.

1.4 Other damage

The accident caused no other damage. To transport the wreckages and the victim out of the forest, a trail was cleared for an excavator and an off-road vehicle.

1.5 Personnel information

YX (OH-920)

Pilot	Age 41 years
Licences	Sailplane pilot licence, valid until 23 September 2012
Medical certificate	National medical certificate class 4, valid until 13 June 2012
Ratings	Radiotelephone operator, Finnish

Flight experience	Last 24 hours	Last 30 days	Last 90 days	Total experience
All types	2 h 57 min	14 h 28 min 9 landings	14 h 28 min 9 landings	1623 h
Type concerned	2 h 57 min	12 h 56 min 5 landings	12 h 56 min 5 landings	105 h 33 landings

BO (OH-983)

Pilot	Age 51 years
Licences	Sailplane pilot licence, valid until 19 June 2012
Medical certificate	National medical certificate class 4, valid until 19 June 2012
Ratings	Radiotelephone operator, English

Flight experience	Last 24 hours	Last 30 days	Last 90 days	Total experience
All types	6 h 00 min 1 landing	22 h 22 min 12 landings	38 h 20 min 21 landings	ca. 1700 h
Type concerned	6 h 00 min 1 landing	12 h 00 min 3 landings	28 h 00 min 8 landings	ca. 350 h

1.6 Aircraft information

1.6.1 Basic information

Both accident aircraft were single-seat sailplanes. YX belonged to the 15-metre class and BO was a self-sustaining glider in the 15/18-metre class.

YX

Type:	Ventus 2a
Registration:	OH-920
Manufacturer:	Schempp-Hirth Flugzeugbau GmbH
Year of manufacture:	2001
Owner/operator:	Private person

BO

Type:	ASW 27-18E
Registration:	OH-983
Manufacturer:	Alexander Schleicher GmbH
Engine:	Solo
Year of manufacture:	2008
Owner/operator:	Private person

1.6.2 Airworthiness

OH-920

Airworthiness review had been performed on 4 October 2010 and the Airworthiness Review Certificate (ARC) was valid until 28 September 2011.

The insurance cover was as required.

OH-983

Airworthiness review had been performed on 19 April 2011 and the ARC was valid until 18 April 2012.

The insurance cover was as required.

1.7 Meteorological information

Based on the weather forecasts given in the morning briefing, wind at the flying area would be between south and west, speed 4–6 m/s. Thermal strength was forecast to be

over 2 m/s and the upper limit about 1600 m. According to the forecast, at least the first part of the course would be blue thermals. There were no visibility impairing factors. The actual weather was as forecast and it was suitable for gliding.

1.8 Aids to navigation

During the competition flight, the pilots used GPS-based chart and route information on palmtop computers or other similar displays. The flights were flown under visual flight rules (VFR).

1.9 Communications

All competitors used the frequency 122.650 MHz in the vicinity of Räyskälä aerodrome before heading for the competition course and when approaching the finish line at the aerodrome. After crossing the start line, they used the frequency 122.065 MHz during the flight.

1.10 Aerodrome information

Räyskälä aerodrome (EFRY) is located in the municipality of Loppi. The coordinates for the aerodrome are 60 44 41 N and 24 06 28E, and the aerodrome elevation is 124 m. The aerodrome has four paved runways and associated taxiways. Aero-tow launches for the gliding competition were carried out on runway 12L.

1.11 Flight recorders

The accident aircraft had no flight recorders. Both planes had two recording GPS devices with a recording interval of four seconds. The GPS recordings were used in the accident investigation.

1.12 Wreckage and impact information

Both wings and fuselage of YX had broken off in the air as a result of the collision. The canopy was also shattered. On ground impact, the front part of the fuselage had cracked and bent to the right. The seat belts were unfastened and intact. The canopy frame was in place. Small pieces of canopy plexiglass and a ventilation hatch were found beside the fuselage. The rear fuselage remained attached to the front fuselage only by cables and push rods. Wing roots were still attached to the fuselage.

The wings were found at about 150–200 m from the fuselage. Some wing skin plates were found at a distance of about 800 m. Pieces of horizontal stabiliser were found in two different places about 200–300 m from the fuselage. Large pieces of canopy plexiglass were found near the pieces of BO's canopy, at about 500 m from the fuselage of YX.

Figure 1. YX in boggy terrain.

BO had crashed into a forest where the terrain was hard. The right wing had been wedged between two trees, so that the plane was in an almost vertical position with the nose and left wing towards the ground. The left wing had broken off on ground impact at a distance of about 2 m from the wing tip. All parts were left in the wreckage, except for the plexiglass of the canopy. The plane was disassembled at the accident site and transported to Konekorhonen Ltd's repair shop hangar at Hyvinkää for further investigation.

The lower side of the fuselage nose section had cracked in a large area. The plexiglass of the canopy had shattered on impact, but the canopy frame was in place. The rear part of the fuselage was intact. The engine was in its place inside the fuselage and undamaged. When testing the elevator control, the investigators found that the rearward movement of the control stick was limited. With the stick in the full aft position, the elevator remained slightly below the neutral position.

The flight control system of BO was checked. The control stick was found attached to a metal tube located between two arches, which were made of 10 mm plywood and covered with glass fibre material. The frontmost of the arches had broken. This had allowed

the front part of the metal tube to be pushed up, which restricted the control stick movement. The crack was partly caused by the battery which was located under the arch. The effect of the forceful impact at the bottom of the fuselage, right where the battery was located, was conveyed by the battery further to the plywood arch, thus breaking it.

Figure 2. BO on the crash site in a forest.

Figure 3. The bottom of BO's front fuselage, damaged in the collision.

1.13 Medical and pathological information

A breath alcohol test was made to the pilot of BO at the accident site, with the result of 0.00 ‰ alcohol. The blood tests made in Kanta-Häme Central Hospital showed no traces of alcohol or narcotic substances.

A full forensic autopsy was performed on the pilot of YX. The pilot had zero blood alcohol, and no narcotic substances were detected. Severe trauma caused by the accident was determined to be the cause of death.

1.14 Fire

There was no fire.

1.15 Survival aspects

Several competitors flying near BO and YX saw the collision, which happened at 15:57. Competition management heard about the accident on the competition frequency, reported by one competitor (GN). The other competitor (VA) reported the collision to Tampere-Pirkkala ATC, which initiated the alerting services. The emergency response centre was alerted by local eyewitness on the ground at 16:00 and sent eight units to the accident site. In addition, a medical helicopter was called in from Vantaa at 16:06. First ground units arrived at the accident area at 16:30.

Finnish Border Guard helicopters from Turku and Malmi were alerted to assist in the search at 16:10. The helicopter from Turku arrived at the site at 16:45 and started the search. The medical helicopter started the search at 16:55. At 17:20, the helicopter from Malmi arrived at the area.

The aeronautical rescue coordination centre located at Area Control Centre Finland directed the search operation from Tampere. The rescue coordination centre did not have the Terrestrial Trunked Radio system *VIRVE* (a network used for communications between rescue authorities in Finland) at their disposal for voice communications with the helicopters and ground units. VHF communications were poor because the helicopters were flying at a low altitude.

At first, several competition planes remained flying above the accident site. Two of the planes stayed above the area for more than one hour. One of the sailplane pilots guided the helicopters and ground units towards the area and relayed messages between the aeronautical rescue coordination centre and the helicopters. The competitor tried to locate BO’s wreckage with the FLARM system, since the FLARM was still operating while the wreckage was in the forest.

BO’s pilot, who had jumped with the parachute, was left hanging in a pine tree at a height of about 12 metres. He managed to slide down the trunk of the tree. When on the ground, the pilot phoned the competition management and told that he would walk to the

nearby GSM-mast. Based on an information plate in the mast, he could report his exact position to the emergency response centre using his mobile phone.

One of the Border Guard helicopters found the wreckage of YX at 17:28 and the wreckage of BO at 17:34. At 18:01 it was confirmed that the YX pilot had been killed.

1.16 Test and research

1.16.1 GPS recorders

According to the competition rules, every sailplane was required to use at least one GPS recorder for the documentation of competition flights. The maximum recording interval was 10 seconds. The recording interval of the devices used in the accident sailplanes was four seconds, which proved useful for investigation purposes.

Both sailplanes involved had two GPS recorders. The recorder primarily used by YX had been damaged. The device was sent to the manufacturer for downloading the data, but it turned out that the damage was so extensive that the flight track data could not be downloaded. However, the owner of the sailplane informed the investigators that there was another GPS recorder in the aircraft above the landing gear well. From this recorder the investigation team, assisted by an expert, managed to download the flight track data. The recording ended a few seconds after the collision. BO's recorders remained intact and the flight track data could be downloaded up to the ground impact.

1.16.2 Sequence of events based on GPS recordings

The sailplanes arrived at the turnpoint of Forssa about 15 minutes before the collision. Until then, YX and BO had followed slightly different routes. YX came to the turnpoint at an altitude of 1050 m and BO about one minute later at 950 m. Soon after the turnpoint YX remained circling in a thermal. BO arrived at the same thermal about 100 m lower. Both planes climbed to about 1800 m. YX continued first towards the course and BO followed about half a minute later.

Five minutes before the collision BO flew past YX from the left side at the same altitude. The planes were gliding at a speed of about 220 km/h. In this situation, BO's pilot told having seen YX for the last time. The planes continued gliding almost along the same route, BO in front and YX behind it slightly to the right.

Three minutes before the collision BO came to an area of lift at 1450 m reducing speed and started turning to the left. YX was about 600 m behind BO at the same altitude, gliding at a speed of almost 200 km/h. When YX reached the same lift, it started a left turn. It reduced speed and climbed to 1540 m. At this stage, BO had turned about 180° and was on YX's front left side at a distance of about 450 m, slightly higher. YX did not continue circling, but continued to the right towards the course. BO continued to the same direction slightly higher, 400 m behind YX and 250 m to the right.

Figure 4. Flight tracks of the sailplanes during the last 20 minutes. BO's flight track and symbol are depicted in blue colour and YX's in red. Picture taken from SeeYou analysis software.

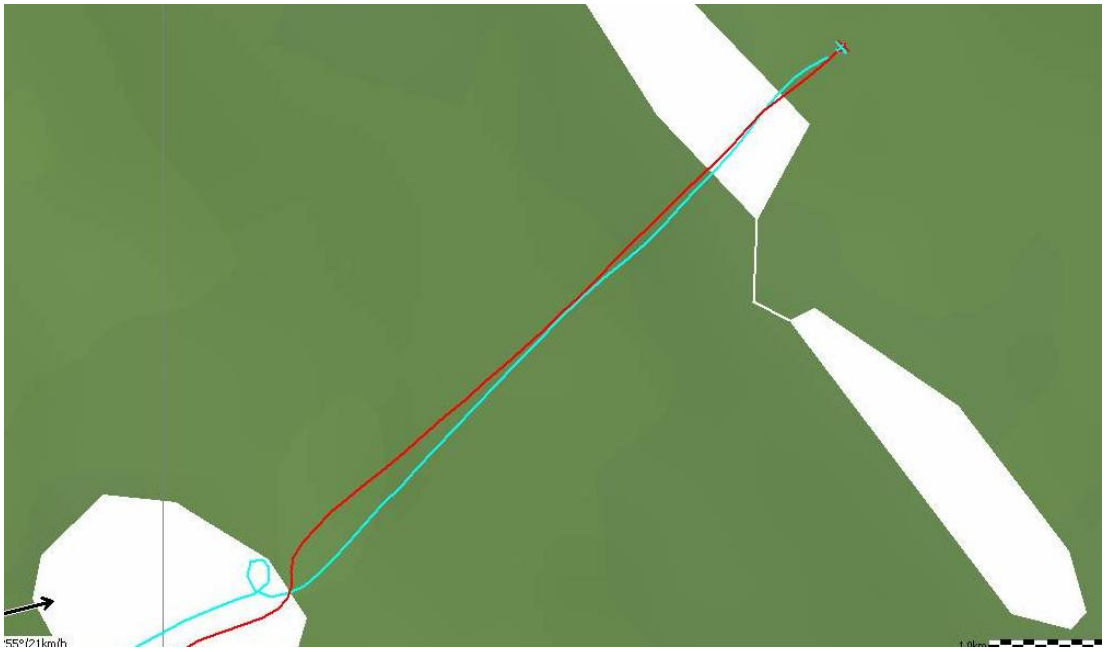

Figure 5. Flight tracks of the sailplanes during the last 2.5 minutes. BO is depicted in blue and YX in red. Picture taken from SeeYou analysis software.

About one minute before the collision BO flew past YX from the right side. About half a minute before the collision YX was almost at the same line, 60 m behind BO and about 70 m lower. BO came to an area of lift reducing speed. YX was flying about 20 km/h faster than BO. After this, YX's flight path intersected BO's flight path from left to right,

and YX flew past BO from the right side at a distance of 35 m and about 90 m lower. At the time of passing, YX was flying about 30 km/h faster than BO. Soon after passing YX reduced speed.

About five seconds before the collision YX was on BO's front right side at a distance of 44 m and about 40 m lower. Just before the collision YX was 25 m ahead of BO and still about 40 m lower. At impact, YX's flight speed was 160 km/h and rate of climb about 7 m/s. BO was flying almost level at 168 km/h.

Before the collision, three other competition planes were flying in front of BO and YX at a distance of 100–300 m and about 100 m higher. In addition, BO and YX had flown past three two-seater sailplanes a moment earlier.

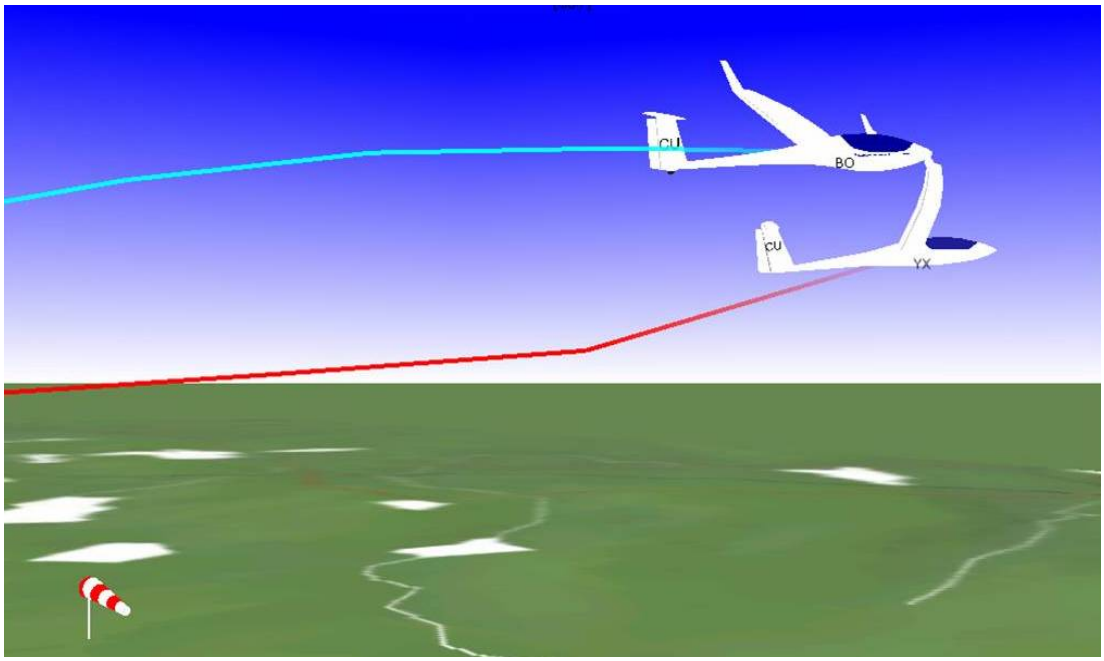

Figure 6. The collision situation. Picture from SeeYou analysis software.

1.17 Organizational and management information

The Finnish Gliding Championships are raced every year in five different classes. The central organisation for sport aviation, the Finnish Aeronautical Association, grants the right for organising the competition to an individual aviation club or association on application. The Finnish Aeronautical Association has published the general rules for Finnish championships, which require a competition director, a vice competition director and sufficient assisting staff to be nominated. The competition director, together with his/her staff, is responsible for ensuring that the championships rules, specific rules for sailplane competitions and the World Air Sports Federation (FAI) Sporting Code are followed.

In the case now under investigation, the responsible competition organiser was Tinttilakki ry. A competition director, a vice competition director and sufficient assisting staff

had been nominated according to the Finnish Aeronautical Association's rules. The competition was organised in accordance with the requirements.

1.18 Additional information

1.18.1 Flying the competition task

The competition usually lasts from seven to nine days. A flying task is assigned each day, if the weather is suitable for flying. In gliding competitions, the aim is to fly the given course as quickly as possible, i.e. they are speed races. Courses are determined in the morning of the competition day based on the weather forecast.

Before heading for the flying course, all sailplanes in the same class are towed into the air and the start line is opened. The pilots may decide themselves when to depart for the course. The decision to depart depends on many different factors, such as the weather forecast, the development of actual weather, the length of the course and other pilots' decisions. Most competitors often depart for the course almost at the same time.

Competition gliding, as well as other sailplane flying, involves circling in thermals and gliding. The choice of route is critical for proceeding fast around the course. The pilot must be able to choose a route with as many thermals as possible, preferably in successive lines. This allows the sailplane to glide long distances at high speed so that the flight altitude only varies by a few hundred metres. In such conditions, the pilots reduce speed in areas of rising air to gain more height. When the thermal ends, flight speed is increased, and the height in turn decreases.

In favourable conditions, sailplanes may glide at speeds over 200 km/h. They do not necessarily glide in straight lines, but may also move sideward as the pilots are trying to find the best thermals. The competitors make their decisions based on assessment of the weather ahead, clouds and rain areas, weather fronts and also the decisions of other competitors. Due to all these factors, experienced gliding competitors often choose the same routes, which means that the planes are flying close to each other at times.

1.18.2 System for collision avoidance

The cockpits of sailplanes used for cross-country and competition flights are equipped with calculator-type displays in addition to the usual flight instruments. Palmtop computers and other similar displays are also used to show the chart and route information.

Both accident planes were equipped with a FLARM (Flight Alarm) system for collision avoidance. The system has been in use for some years, but since the beginning of year 2011 it is a mandatory piece of equipment in Finnish Gliding Championships. The system gives an alert of another aircraft equipped with the same device, if it is on a conflicting flight path. The alerts are shown on the FLARM display with LED lights, and the device also gives an audible beep alert.

FLARM systems have several manufacturers. In those devices manufactured by the original developer of the system, any alerts given can be saved. The devices made by other manufacturers do not have this facility. The devices used in the accident planes were not capable of saving the alerts.

The FLARM Operating Manual states that the main task for FLARM is to support the pilot while he scans the airspace ahead with his own eyes. FLARM is designed and built as an auxiliary device intended only to support the pilot's situational awareness, and it cannot always provide reliable warnings. It is specifically highlighted that FLARM does not give any guidance on avoiding action, and the pilot should not under any circumstances adopt non-standard procedures or deviate from the normal principles of safe airmanship.

According to the Operating Manual, the technical capabilities of the FLARM system are limited. The field intensity of its antenna is significantly restricted by any other antennas installed too close (e.g. GPS antenna), the magnetic compass, metal parts and carbon fibre in the cockpit structures. Even the pilot's own body may restrict the propagation of antenna signals.

Practical experience has shown that FLARM does not alert on traffic close below or above. Reception of alerts from other directions is limited by other obstacles as explained above. According to the pilot of BO, FLARM did not give an alert of the other aircraft before collision.

2 ANALYSIS

2.1 Events leading to the collision

Five minutes before the collision BO flew past YX from the left side at the same altitude. In this situation, BO's pilot told having seen YX for the last time. After flying past YX he had the impression that he was proceeding faster and the distance to YX was increasing.

The planes continued gliding at high speed along a line of clouds, under which there was a line of rising air. BO and YX followed almost the same route and had practically no difference in altitude. During the glide, they passed some planes in the two-seater class flying the same course.

Three minutes before the collision BO came to an area of lift and started turning to the left. The pilot of YX probably saw BO starting to circle, as he initiated a turn towards the same area. However, he did not continue circling but went straight ahead towards the course. BO's pilot flew a full circle and then straightened to the course direction. He did not see YX flying past him. In this situation, the pilot of YX may have got the impression that BO was left clearly behind him, circling in the thermal. BO's pilot was still under the impression that YX was behind him. (Figure 5)

The planes were gliding towards the next turnpoint at high speed. There were several planes in the vicinity which had to be considered to maintain the traffic picture. Both BO and YX flew past three competition planes in the two-seater class at a relatively short distance.

During the glide, BO and YX came to a position where neither of the pilots were able to see each other. BO's pilot could not see the plane below and slightly ahead of him, and YX's pilot could not see the plane behind and above him. Neither pilot had situational awareness of the other sailplane close by. In this situation, FLARM did not alert, since the antenna fields of the devices were limited and they had no contact with each other. The antenna field was probably also limited by carbon fibre in BO's cockpit structure and by metal structures behind the instrument panel. (Figure 6)

YX then came to an area of lift, and the pilot started to reduce speed rapidly. The plane hit the bottom of BO's cockpit with great force, so that YX's fuselage and right wing broke off immediately.

Before the collision, three other competition sailplanes were flying ahead of BO and YX slightly higher. The need to monitor those planes may have contributed to the fact that one aircraft flying close by was left outside the traffic picture.

2.2 Events after the collision

2.2.1 Sequence of events for YX

The canopy of YX was shattered on impact. Pieces of plexiglass from both sailplane canopies were found in the same areas on the ground. The impact was so violent that the plane's fuselage and right wing broke off. The plane went into a steep dive, and after a while, also the left wing broke off. At this stage, the pilot was probably subjected to high G forces, which may have made it difficult to get out of the aircraft. The pilot may also have sustained injuries in the collision and was therefore not fully capable of functioning.

The pilot's seat belts were unfastened. Considering the seat belt locking mechanism, the investigation team finds it probable that the pilot unfastened the belt himself. The investigation team concluded that the collision could not have caused the seat belts to open.

After the left wing broke off, the fuselage went into a near vertical dive. The pilot then either managed to get out or fell out of the cockpit. However, the dive speed was so high that there was no time to use the parachute.

2.2.2 Sequence of events for BO

BO's elevator control system had been damaged in the collision. After realizing this, the pilot decided to rescue himself with the parachute. Since the canopy had shattered at impact, the pilot did not need to jettison the canopy. For this reason, the instrument panel which would normally go up with the canopy frame was left in the down position. This made it more difficult for the pilot to get out, and his other shoe fell off when he got up from the seat. He managed to put the shoe back in his foot and jumped off the plane.

The pilot's parachute harness was not tight enough. As the parachute opened, the breast strap was pulled upward, causing bruises on his neck. While descending with the parachute he had to hold the breast strap with both hands to prevent it from going too far up. To prevent the parachute from drifting against a nearby GSM mast, the pilot had to take one hand off the strap to be able to steer the parachute. By pulling on the suspension line he managed to change the direction and landed in a forest, where the parachute became entangled in tree tops. If the harness had been tight enough, the pilot would have been better able to steer the parachute.

The pilot was left hanging from the parachute harness at a height of about 12 metres, but managed to slide to the ground down the tree trunk. When sliding down, he got bloody scratches on his legs from the trunk. This was partly because he was wearing shorts; long trousers or flying overalls would have protected his legs better.

The pilot's decision to swing himself to get a grip of the tree trunk, to release himself of the harness in the tree and to slide down the trunk involved a risk of falling. The pilot's good physical condition helped him to succeed.

When on the ground, the pilot walked to a nearby GSM mast. Because the location was written on a sign in the mast, he could report his exact position to the emergency response centre. This was a good decision, since assistance could then be sent quickly to the site. The pilot had kept his mobile phone and wallet in his pocket during the flight, which also made it easier to get assistance - it may not have been possible to take those items from the plane's side locker or luggage compartment when jumping.

The pilot acted in a calm and reasonable manner throughout the emergency.

2.2.3 Actions of the competition organisation and other competitors

The pilots of several competition sailplanes flying nearby saw the accident, and some of them remained circling above the accident area. Competition management was informed about the accident on the competition radio frequency. One of the planes, competition sign VA, switched over to Tampere-Pirkkala approach control frequency and reported the accident.

BO's FLARM system was still operative after the plane crashed down. VA's pilot was able to locate the FLARM signal by flying towards it from different directions. He managed to determine the place where the plane had crashed and relayed the coordinates to rescue services.

VA remained above the accident site and guided the rescue vehicles and Border Guard helicopters towards the right area. This was of significant assistance in finding the wreckages and the pilot who had jumped with the parachute.

The competitors followed the instructions given for accident situations in the first briefing session. Radio communications and the transfer of information via air traffic control to rescue authorities functioned very well.

The competition organisation acted efficiently and according the instructions after the accident.

2.3 Factors affecting pilots' lookout

The cockpits of sailplanes used for cross-country and competition flights are equipped with calculator-type displays in addition to the usual flight instruments. Palmtop computers and other similar displays are also used to show the chart and route information.

The increased number of displays in the cockpit may make the pilot spend too much time scanning the cockpit instruments and less time looking out. Depending on where the devices are located, the auxiliary devices and displays may also restrict visibility out of the cockpit.

In gliding competitions, there are often situations where several planes are flying in the same area close to each other. Some of the planes may occasionally be left in a blind spot outside the pilot's field of vision. For this reason, the pilot should maintain a con-

stant lookout and keep himself aware of any traffic close by, which may not be visible. From time to time, the pilot has to change the flight path or the attitude of the plane to see better and to determine the positions of other planes nearby.

In an investigation report (Statens haverikommission Rapport RL 2007:01) of a collision between two sailplanes in Sweden in 2006, it was concluded that the pilot's field of vision in a modern sailplane is limited by 15º to the front and down, and by about 45º down to both sides.

2.4 FLARM system

In recent years, the use of FLARM collision warning devices has become more and more common, and in this competition it was mandatory in all planes. It is possible that the warning system creates a false sense of security, which makes the pilots less careful with their lookout.

Pilots should be aware that because of technical limitations of the FLARM system, it may not always give an alert on all traffic and the competition organisers should also remind the pilots of this. The only way to avoid a collision is to maintain constant lookout and create a mental picture of the traffic based on one's own observations, using FLARM to assist in this task. When several planes are flying close to each other in a thermal or during a glide, forming a correct picture of the surrounding traffic and avoiding collisions is completely dependent on the pilot's lookout.

The manufacturer of the FLARM system has also developed a new device called Power FLARM. Power FLARM can be equipped with two antennas, which helps to reduce blind areas. Moreover, the device gives warnings on those aircraft with an SSR transponder or ADS-B.

2.5 Effect of weather

The weather in the area was favourable for sailplane flying and for the flying task on the accident day. There were plenty of thermals, which made it possible to proceed fast. Flight altitudes varied between 1300–1800 m. Visibility was good and the planes were gliding below lines of cloud, so that the pilots were not dazzled by the sun. Weather conditions had no effect on the accident.

3 CONCLUSIONS

3.1 Findings

1. Both pilots had valid licences with the required privileges and valid medical certificates.

2. The airworthiness review certificates for both aircraft were valid. The insurance cover was as required.

3. The accident happened during the flying task for the second day of the Finnish Gliding Championships.

4. Safety-related issues were discussed in the first briefing session for the competition. Instructions on how to act in case of an accident were also given.

5. The weather was suitable for the flying task assigned.

6. The accident happened when the planes were gliding at an altitude of about 1400 m. Their flight paths intersected in vertical direction.

7. The front fuselage of YX hit the bottom of BO's front fuselage from below.

8. The fuselage and right wing of YX broke off on impact, and the left wing a moment later during the dive.

9. The pilot of YX was found, fatally injured, at a distance of about five metres from the wreckage.

10. The pilot of YX had unfastened his seat belts but not launched the parachute.

11. The elevator control system of BO was damaged in the collision. The pilot rescued himself with the parachute.

12. BO's pilot sustained minor injuries during the parachute jump and when sliding down the tree.

13. Both pilots were experienced sailplane pilots and competitors.

14. Both accident planes were equipped with GPS recorders, and the investigators could use the recordings. The recording interval was four seconds.

15. YX's flight track recording ended a few seconds after the impact. BO's recording continued until the ground.

16. After the accident, other competitors flying nearby followed the instructions they had received. One of the competitors (GN) reported the accident on the competition radio frequency.

17. One of the competitors (VA) reported the accident and the coordinates of the accident site to Tampere-Pirkkala approach control, and relayed messages between the aeronautical rescue coordination centre and the helicopters.

18. The competition organisation acted efficiently and according the instructions after the accident.

19. In accordance with the rules of the Finnish Gliding Championships, all competition planes had to be equipped with a FLARM device for collision avoidance. BO's pilot told that FLARM had not alerted before the collision.

20. According to the FLARM Operating Manual, there are significant limitations in the antenna field, which may hinder the operation of the system.

21. VA was able to locate BO's wreckage based on its FLARM signal.

22. The aeronautical rescue coordination centre did not have the Terrestrial Trunked Radio system *VIRVE* at their disposal, which hampered communications during the search operation.

3.2 Probable causes and contributing factors

The accident was caused by pilots' insufficient situational awareness leading to the situation, where the planes got above each other and their flight paths intersected in the vertical direction. At the same time the pilots could not see each other.

Contributing factor was the fact that the collision warning system did not alert.

4 SAFETY RECOMMENDATIONS

4.1 Safety actions already implemented

During the investigation, the aeronautical rescue coordination centre of Finland made a decision to acquire the *VIRVE* system by 1 June 2012.

4.2 Safety recommendations

1. In gliding competitions, flying activity is busier than usual. Due to the competitive nature of the event, the risk level is also higher.

   To increase and maintain safety awareness, the Safety Investigation Authority, Finland recommends the Finnish Aeronautical Association to organise a safety information session before every gliding contest and to address safety issues in the briefing session for each day of competition.

4.3 Other remarks

In sailplane operations, several planes are often flying in the same area either in a thermal or in gliding flight. It is then vitally important to be aware of all traffic nearby. In addition to the general rules for traffic avoidance contained in the Rules of the Air, instructions for thermal flying are given in the basic training material for sailplane flying.

The Safety Investigation Authority, Finland suggests that the Finnish Aeronautical Association should check the instructions concerning thermal flying and supplement them where necessary. The Safety Investigation Authority, Finland also suggests that information on safety factors related to gliding flight be added to the basic training material.

In accordance with national aviation regulations, it is mandatory to use a rescue parachute in sailplane operations. Wearing and using the parachute in accordance with instructions is particularly important to avoid injuries in case of an emergency.

Helsinki, 30 May 2012

Jorma Laine Ismo Aaltonen

Hannu Halonen

Summary of Comments

Finnish Transport Safety Agency (Trafi)

Finnish Transport Safety Agency had nothing to comment on the investigation report.

Finavia Corporation

Finavia Corporation presented two comments on the investigation report. In the first one Finavia Corporation proposed that the airspace class in which the collision occurred would be mentioned in the report. In the second comment Finavia Corporation specified the section in the report concerning the management of the search operation.

Finnish Aeronautical Association

The Gliding Commission of the Finnish Aeronautical Association presented two comments on the investigation report. According to their perception pilots' insufficient situational awareness was one of the actual causes of the accident rather than a contributing factor. In addition, the Gliding Commission of the Finnish Aeronautical Association suggests a proposal for safety to the investigation report concerning the Finnish Communications Regulatory Authority's (FICORA) regulation 15W/2006, which forbids keeping mobile phone turned on in an aircraft. A mobile phone turned on could speed up the finding of the pilot after an accident.

European Aviation Safety Agency (EASA)

European Aviation Safety Agency had nothing to comment on the investigation report.

The Finnish Border Guard

The Finnish Border Guard had nothing to comment on the investigation report.