



Aviation Accident near Eura Aerodrome on May 17, 2025



L2025-01

SYNOPSIS

Pursuant to the second subsection of section 2 of the Safety Investigation Act (525/2011), the Safety Investigation Authority Finland (SIAF) decided to investigate an aviation accident that occurred near Eura aerodrome on May 17, 2025 when two helicopters were involved in a mid-air collision resulting in fatal injuries to five persons.

The purpose of a safety investigation is to promote general safety, the prevention of accidents and incidents, and the prevention of losses resulting from accidents. A safety investigation is not conducted in order to allocate legal liability.

The appointed investigation team leader was subject matter expert Kalle Brusi. The team members were subject matter experts Jari Hjerppe and Krista Oinonen, senior safety investigator Juho Posio and subject matter expert Mikko Raatikainen. The investigator-in-charge was Chief Air Safety Investigator Janne Kotiranta.

The National Transportation Safety Board (NTSB) of the United States, the Estonian Safety Investigation Bureau (OJK) and the Austrian civil aviation accident investigation authority (SUB) appointed accredited representatives for the investigation. The European Union Aviation Safety Agency (EASA) appointed a technical advisor.

The safety investigation examines the course of events of the incident, its causes and consequences, and the search and rescue actions as well as any actions taken by the authorities. The investigation specifically examines whether safety had adequately been taken into consideration in the activity leading up to the accident and in the planning, manufacture, construction and use of the equipment and structures that caused the accident or incident or at which the accident or incident was directed. The investigation also examines whether the management, supervision and inspection activity had been appropriately arranged and managed. Where necessary the investigation is also expected to examine possible shortcomings in the provisions and orders regarding safety and the authorities' activities.

The investigation report includes an account of the course of events of the accident, the factors leading to the accident and its consequences, as well as safety recommendations addressed to the appropriate authorities and other instances regarding measures that are necessary in order to promote general safety, the prevention of further accidents and incidents, the prevention of loss and the improvement of the effectiveness of the operations of search and rescue and other authorities.

An opportunity is reserved to those involved in the accident and to the authorities responsible for supervision in the field of the accident to comment on the draft investigation report. These comments have been taken into consideration during the preparation of the final report. A summary of the comments is at the end of the report. Pursuant to the Safety Investigation Act, no comments given by private individuals may be included in the investigation report.

The investigation report was translated into English by TK Translations.

The investigation report and its summary were published on the SIAF's internet website at www.sia.fi on October 6, 2026.

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1 SYNOPSIS

1.1 History of Flight

On Saturday May 17, 2025 at 1117¹ a party of five individuals departed Linnahall heliport (EECL), Tallinn, Estonia, on two Robinson R44 Raven I helicopters with destination Piikajärvi aerodrome (EFPI), Finland. The helicopters were registered to private entities as ES-ETR and OE-XOS and carried three and two occupants, respectively. After 1 h 16 min from departure, they approached Eura aerodrome (EFEU), Finland, with ES-ETR positioned to the left of OE-XOS as seen in the direction of flight. When overhead the aerodrome, ES-ETR made a right turn to the north while OE-XOS continued to track northwest. The helicopters collided at 1234 northeast of the aerodrome about 200 m above ground level sustaining substantial damage and fell to the ground. Debris was scattered over a large area in a forested terrain north of the aerodrome, and the main fuselage of ES-ETR was destroyed by fire. All occupants sustained fatal injuries.

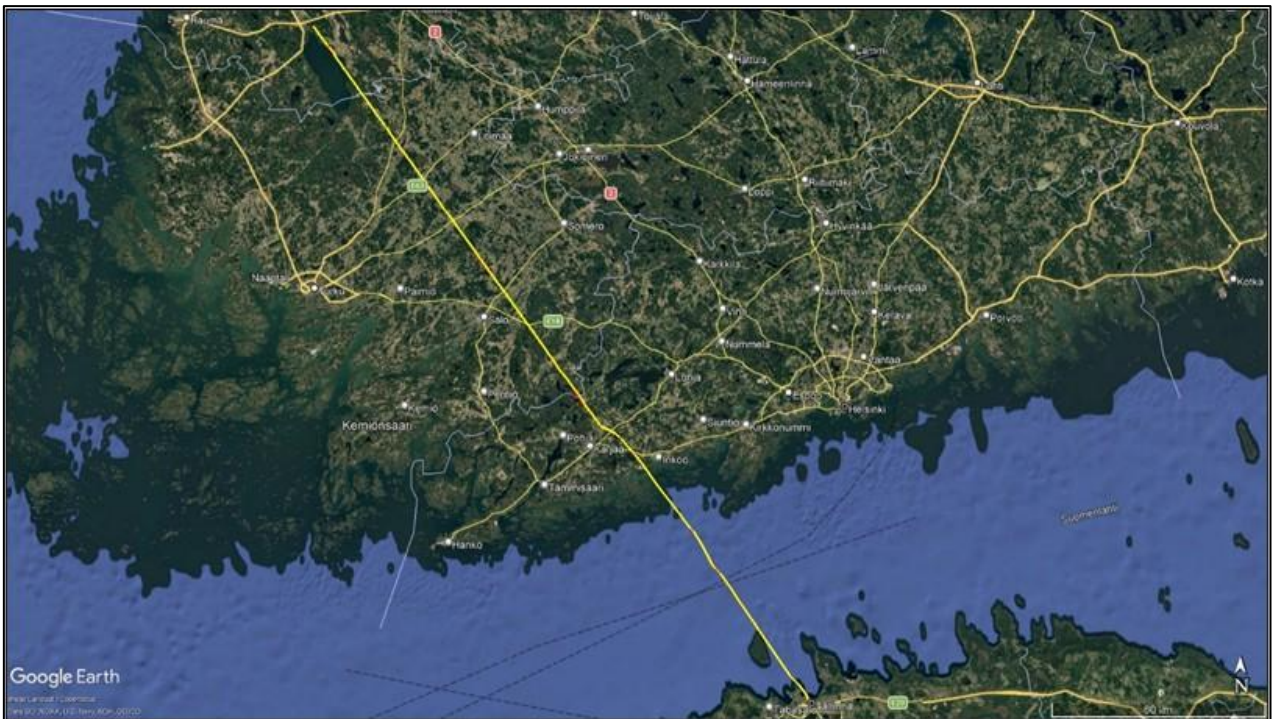


Figure 1. Helicopter flight paths. (Image: Google©, annotations: SIAF)

¹ Finnish daylight saving time (UTC + 3 h). All subsequent times given are Finnish daylight saving time.

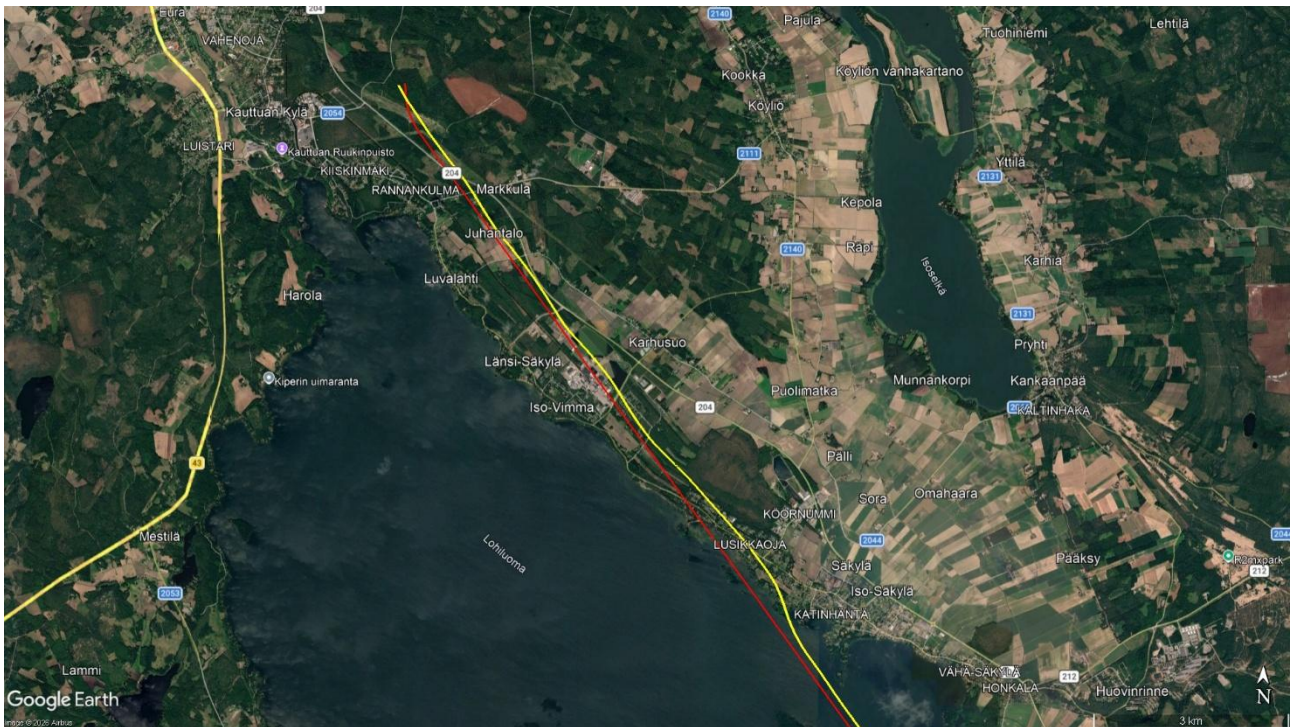


Figure 2. The final phase of the helicopters' flight and the collision north of Eura airfield. (Image: Google©, annotations: SIAF)

1.2 Alerting and Rescue

The emergency rescue center (ERC) received several calls related to the accident. One of these was an automatic call from a mobile phone on board one of the helicopters. The first actual call, which triggered emergency response, was made by a functionary at Eura aerodrome at 1235.14, indicating that two small helicopters had collided in flight about one kilometer north of the aerodrome. The caller explained that they were manned and had partially disintegrated while still in the air. Subsequent calls supported this information.

Based on a risk assessment, the ERC alerted rescue department, paramedic and police units to respond to a serious air traffic accident (task code 232A). The initial alert was given at 1236.42, and at 1241 the ERC notified the Aeronautical Rescue Coordination Center (ARCC) of the event. The first units to reach the aerodrome were the incident commander (P32) at 1240.35 and a rescue unit at 1245.50, followed by several rescue department, paramedic and police units. Some rescue department units conducted ground search in the aerodrome's vicinity.

Personnel at the aerodrome supported the authorities in search and rescue, while a private pilot took off on aerial search in an airplane owned by Kauttua Flying Club. Among other assets to locate the crash sites, the authorities employed a drone and a fire spotter airplane. Kauttua Flying Club assigned altitude blocks for deconfliction between aircraft and drone movement. The Border Guard and Finnish Army dispatched helicopters to assist in the search effort, the Army helicopter being retasked to the scene from an ongoing mission.

The on-duty fire officer (P33) supported the rescue operation remotely from the situation center and contacted the ARCC to inquire about the types and the flight plans of the accident aircraft.

The fire spotter airplane located one of the crash sites at 1258, and the first rescue department units reached the location at 1313. The second wreckage was located at 1324. The wreckages were about 100 m apart some 150 m from the nearest logging trail in dense fir-tree forest. After paramedics and a physician on board an emergency medical services helicopter confirmed that all occupants of the accident helicopters had sustained fatal injuries, rescue service units focused on securing the crash sites and providing assistance to investigators.

Social and crisis emergency services teams were dispatched to the facility of Kauttua Flying Club and to Piikajärvi aerodrome to provide crisis counseling.

1.3 Injuries to Persons and Damage to Aircraft

All five helicopter occupants sustained fatal injuries, and the helicopters were destroyed. Fuel and oil leaking from the wreckages contaminated the soil, and one of the helicopters caught fire on impact. The authorities and landowners were notified of the accident.

2 BACKGROUND INFORMATION

2.1 Environment, Equipment and Systems

2.1.1 Accident Flight

During the morning of the day of the accident, the pilot of ES-ETR had flown from Tõutsi aerodrome (EETI) in southern Estonia to Tallinn's Linnahall heliport. The helicopter departed from Tõutsi at about 0815 and landed in Tallinn at 1024, carrying the pilot and two passengers. The original point of departure of OE-XOS was Tallinn. The pilots had agreed to meet in Tallinn and then proceed to Piikajärvi aerodrome to attend an aviation event.

They had filed separate flight plans for a non-formation flight from Tallinn to Piikajärvi, giving departure times at 1100 and 1115 for ES-ETR and OE-XOS, respectively. There was a minor difference between the flight planned routes in that the flight plan of OE-XOS called for proceeding via reporting point ROLIF² direct to Piikajärvi, whereas the pilot of ES-ETR had given Eura aerodrome as a turning point. On the other hand, it was found from the onboard navigation system of OE-XOS that the pilot had selected Eura aerodrome as a waypoint.

The sole passenger of OE-XOS occupied one of the front seats, and the passengers of ES-ETR were seated one in the front and one in the rear. The pilots reported departure to air traffic control (ATC) at 1117, which was indicative of a short time interval between the takeoffs.

ATC radar data and information derived from the navigation system of OE-XOS revealed that the helicopters tracked an identical route from Tallinn toward Eura. Separation between the helicopters varied and was at its minimum slightly less than 100 m. Because separation was less than one kilometer for most of the flight, characteristics of formation flying³ were evident. However, the relative position of the helicopters varied, with each helicopter alternating between the right and left wing position and taking turns as the lead or trail aircraft. At about 1220, ES-ETR established constant heading, altitude and speed with only minor apparent variations, which suggests flight on autopilot. However, investigation was unable to determine whether autopilot was engaged in either one of the helicopters. Neither could the engaged or disengaged status of one or more autopilot modes be verified from the recordings.

At 1231, before passing overhead Eura aerodrome and with less than 150 m separation between the helicopters, the pilot of OE-XOS called ATC to close both flight plans⁴. This took about 2 min, and within this timespan the pilot of OE-XOS increased separation and reduced airspeed, which resulted in OE-XOS lagging behind and to the right of ES-ETR, thereby increasing separation to more than 600 m. After closing the flight plans, the pilot of OE-XOS accelerated to gain on ES-ETR until the helicopters were in a line abreast position with less than 100 m separation at 1233.

By 1234, OE-XOS had again dropped behind ES-ETR and was about 25 m above the latter on the right-hand side, while separation had increased to about 125 m. At the same time ES-ETR, which was slightly in front of and below OE-XOS, initiated a right-hand turn toward Piikajärvi aerodrome and continued this turn while OE-XOS maintained the original north-westerly heading. At 1234.16, OE-XOS banked right while remaining behind and to the right of ES-ETR and about 15 m higher with about 80 m separation. The helicopters collided at 1234.21. By

² ROLIF is a reporting point in the northwestern corner of Tallinn control zone.

³ Aviation regulations define formation flight as an action by two or more aircraft with separation between aircraft not exceeding 1 km.

⁴ Closing the flight plan is common due to possible weakness of VHF signal at ground level. A potential risk is that air traffic control following may terminate upon receipt of the announcement.

this time, ES-ETR had turned about 30° to the right and was now positioned behind OE-XOS prior to the impact. The helicopters were substantially damaged and fell to the ground.

2.1.2 Accident site

The accident occurred over forested terrain to the north of Eura aerodrome. The helicopters impacted ground a few hundred meters from the runway at the locations shown in figure 3.

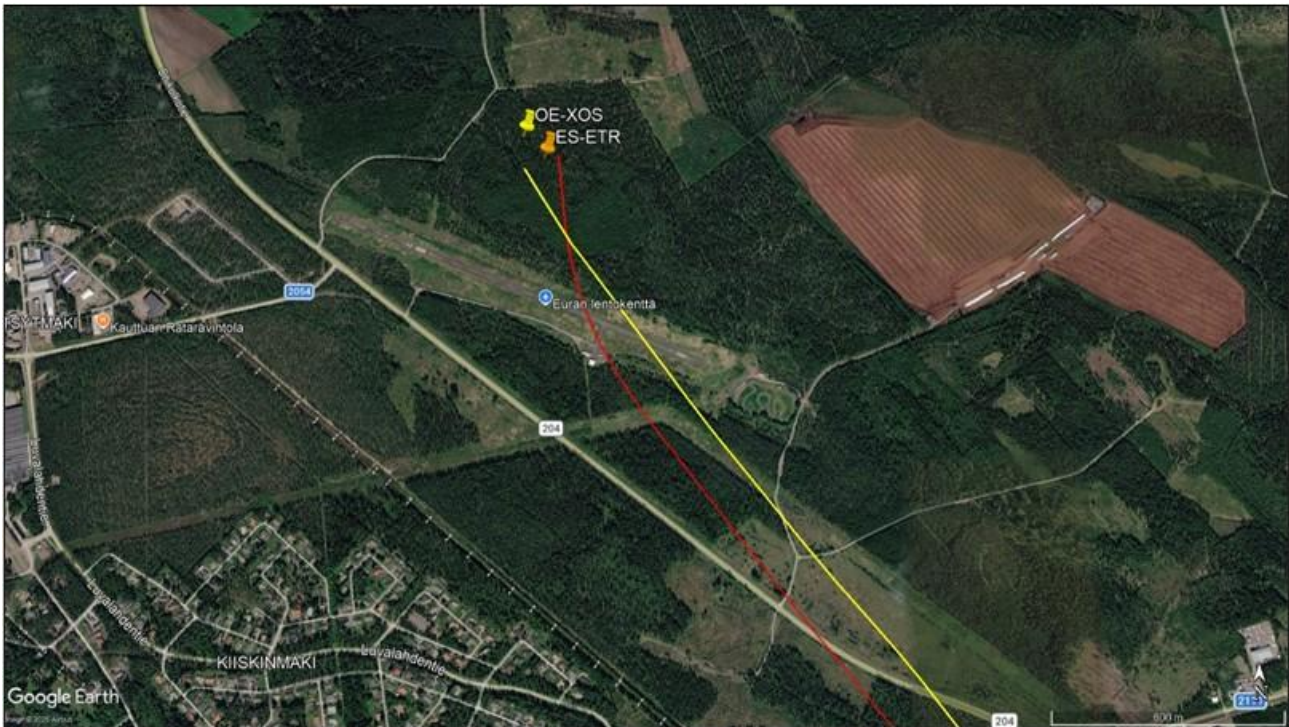


Figure 3. The accident site. The points where the aircraft fell are marked on the image. The runway at Eura aerodrome is also visible in the image. (Image: Google©, annotations: SIAF)

2.1.3 Aircraft

The Robinson R44 Raven I is a type-certified four-seat light helicopter powered by a piston engine that drives a main rotor and a tail rotor. The main fuselage is a welded steel tube structure covered with riveted aluminum skin, and the tailboom is of aluminum monocoque construction. The front and rear cabin doors, internal furnishing and some external fairings are of composite material.



Figure 4. A Robinson R44. The helicopter shown was not involved in the accident. (Photo: Finnish Aviation Academy)

The six-cylinder air-cooled Lycoming O-540 engine rated at 225 hp at takeoff power drives via a sheave and belt system the main gearbox that is mounted above the cabin to step down engine speed to a manageable rotor speed.

Aircraft Systems

The main gearbox drives the 10.06 m diameter two-blade main rotor via a shaft. The hub of the semi-rigid teetering rotor is mounted to the drive shaft with a teeter hinge that allows seesaw-like up-and-down rotor disc movement and a coning hinge for each blade that allows blade flapping. Each blade is attached to the hub with a feathering hinge that allows the blade to rotate about its span, changing its pitch angle. The rotor rotates counterclockwise when viewed from above.

Each all-metal blade consists of a load-bearing steel spar forming the leading edge to which is attached an aluminum alloy composite structure that gives the blade its airfoil shape. The maximum rotational speed of the rotor system is about 408 r/min.

A drive shaft inside the tailboom transmits engine power from the main gearbox to the tail rotor gearbox, which steps up rotational speed to an efficient tail rotor speed. The tail rotor is a two-blade teetering rotor of metal construction with a diameter of 1.47 m.

The main rotor is controlled via a hydraulically boosted mechanical system that transmits control stick and collective lever inputs via push-pull tubes to three hydraulic servos that adjust the plane of rotation and blade pitch of the rotor. The tail rotor control system is mechanical with no hydraulic boost, and it is controlled by operating anti-torque pedals.

The helicopter can be equipped with dual flight controls to enable control from both the left and right seat if this is required for instructional use. The pilot normally occupies the right

seat. A quick-release cyclic stick and collective lever together with a second set of anti-torque pedals can be installed for operation by the left seat occupant. The T-bar cyclic stick is mounted on the cabin centerline and pivoted to allow control from both seating positions. The collective lever used by the right seat occupant is mounted to the left of the seat and has a twist-grip throttle and switches for engine control, whereas the removable left-hand collective is equipped with a twist-grip only.

Both helicopters were fitted with a comprehensive flight management and radio navigation suite. The primary display was Garmin GDU 700L which shows flight parameters such as speed, altitude, heading and attitude, and navigation data including a moving map, waypoints and track lines. The primary radio navigation system was Garmin GTN 650Xi, and both helicopters were fitted with a stability augmentation system, which is described below.

The helicopters were not equipped with a traffic collision avoidance system (TCAS)⁵, nor was the system required. A TCAS would also be of little use during formation flying because it would issue constant alerts of other aircraft of the formation.

Genesys HeliSAS Stability Augmentation System

The Genesys HeliSAS is designed to augment the stability of a helicopter, thereby reducing pilot workload. It also functions as a two-axis autopilot and is integrated with the Garmin flight management and navigation system. The system uses its integral flight control computer to monitor helicopter motion, acceleration, flight parameter changes and Garmin-derived data to adjust cyclic stick position in the desired direction via two independently operating servos. The system provides only roll and pitch stabilization and is not connected to the collective lever, engine control system or anti-torque pedals.

⁵ The traffic collision avoidance system uses transponder signals to alert pilots of potential collision threats with other transponder-equipped aircraft or to assist pilots for collision avoidance.



Figure 5. The Genesys HeliSAS control panel. (Photo: SIAF)

The system has several pilot-selectable operating modes. When the system is engaged, the stability augmentation system (SAS) provides attitude stabilization. The pilot can select, for example, the heading hold (HDG), altitude hold (ALT) or navigation (NAV) mode or any

combination thereof. For example, with ALT and NAV selected, the system strives to maintain the selected altitude and track the helicopter along the course line selected with the navigation system. The system is disengaged by operating a switch on the cyclic stick or a button on the HeliSAS control panel. The pilot can adjust the helicopter's attitude with manual control inputs without disengaging the system, and when the controls are released, the previously selected flight parameters are re-established.

Emergency Locator Transmitters

Both helicopters were equipped with a Kannad AF Integra emergency locator transmitter (ELT), which, when activated in an accident, transmits a homing signal to facilitate search and rescue on 121.5 MHz and 406 MHz. Signals transmitted on 121.5 MHz can be heard on the international VHF emergency frequency and can be used to locate the accident site over short distances, but it does not identify the aircraft in distress.

Signals transmitted on 406 MHz are received and processed by Cospas-Sarsat system satellites that relay information of the accident and accident site to ground-based receivers. Transmissions may carry data that identifies the active ELT and its more precise position provided the ELT has an internal global positioning system (GPS).

The ELT is designed to activate automatically on impact, and it can also be activated manually by a switch in a remote control panel or on the ELT. ELTs and their installations are designed to operate in survivable accidents only and are not expected to be robust to fire or excessive accelerations.

Emergency Locator Transmitter Activation

The ELT system is integrated on the airframe. In the R44, it is in the rear of the main fuselage above the engine. The assembly consists of a mounting bracket strapped on the tubular fuselage framework, and an ELT that is attached to the bracket with a velcro band. The ELT shall be correctly aligned with direction of flight to ensure correct operation.

The waterproof ELT has an internal battery to enable operation without external electrical power. It is connected to an external antenna, but in the event of antenna damage or a faulty cable an internal antenna allows continued transmission. An internal acceleration sensor activates the ELT when a preset acceleration force is exceeded.

ELT operating modes are preselected by a three-position latched switch located on the unit itself, or from the remote control panel. With the switch in ARM, the unit is in standby mode and is automatically activated on receiving an input from the acceleration sensor. The unit can also be activated via the remote control panel. When the switch is OFF, the ELT is fully deactivated and will not begin to transmit on impact. Neither can it be activated via the remote control panel. With the switch set to ON, the ELT will transmit an emergency signal.

2.1.4 On-site Investigation

ES-ETR

The helicopter, serial number 2805, had entered service in May 2025. It had undergone last maintenance check two days before the accident on May 15, 2025, at the last recorded running time of 10.16 h. Total hours at the time of the accident are not known because the helicopter's journey log was destroyed by fire. All required documents were valid, and the helicopter was airworthy before departure.

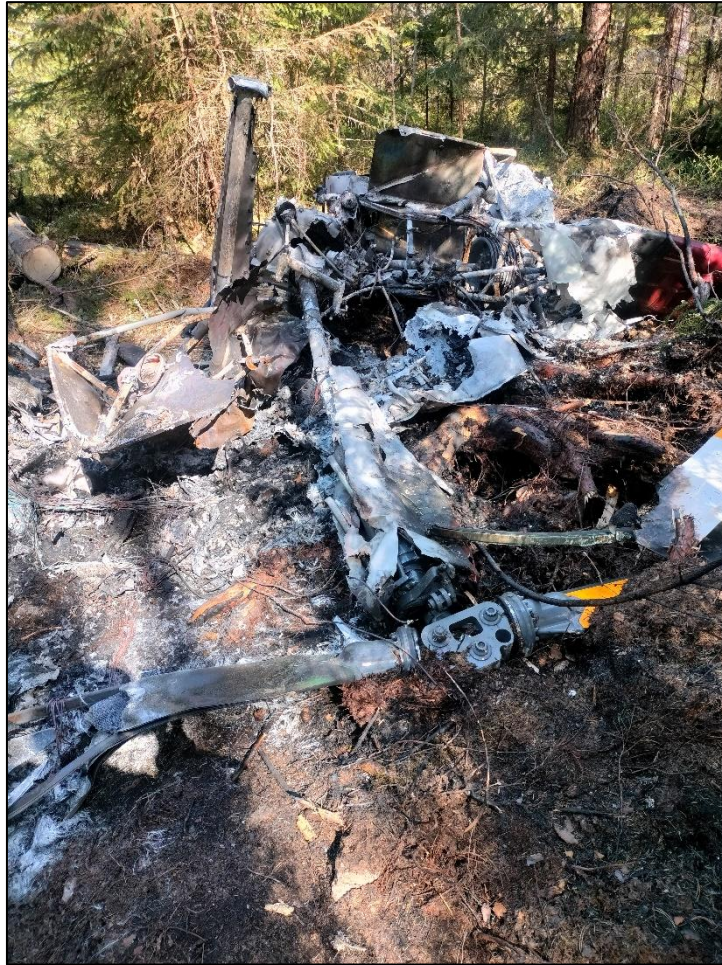


Figure 6. ES-ETR main fuselage and main rotor after completion of rescue operation. (Photo: SIAF)

The main fuselage was consumed by fire. The engine and the main gearbox remained attached to the airframe, the main rotor remained connected to the gearbox and rotor control system continuity was established. The hydraulic servos remained attached but were melted by fire. The main rotor blades, which were disintegrated and partially consumed by fire, remained attached to the rotor hub at the roots. Examination of components remaining after the impact and fire showed no evidence of damage that could have contributed to the accident.

The collective stick of the dual control system was found fitted to the left of the left seat, while the left cyclic stick and left anti-torque pedals were recovered from the vicinity of the crash site. The end fittings of the flight control system push-pull tubes remained in place although the tubes were destroyed by fire. The hydraulic servos were in place but severely fire-damaged. Examination of components remaining after the impact and fire showed no evidence of defects or damage that could have contributed to the accident.



Figure 7. ES-ETR collective lever. (Photo: SIAF)

The instruments and avionics equipment exhibited extensive damage and were mostly destroyed by fire. Navigation system components were sent for further examination and retrieval of flight route data to the Bureau of Enquiry and Analysis for Civil Aviation Safety of France (BEA). Some navigation data could be recovered from the fire-damaged components. The destroyed onboard recording camera was found separated and yielded no useful information.

The tailboom, which had separated at a point 95 cm aft of its attachments to the main fuselage, was located some distance away from the main fuselage, to which its front section remained attached. The tailboom was undamaged except for slight bending of the vertical stabilizer, and the tail rotor drive shaft, the tail rotor gearbox and the tail rotor were in place and free to rotate. The rotor control system between the point of boom separation and the rotor remained intact. While the point of separation showed no signs of an external impact, stretching and tearing of the aluminum skin in the area were apparent.



Figure 8. The tailboom of ES-ETR separated during the collision sequence. (Photo: SIAF)

Both main rotor blades remained attached to the hub at the roots. One blade was severely fire-damaged between the root and mid-span, although the leading edge structure was continuous all the way to the blade tip, and no impact marks were noted on the leading edge of the outer blade section. The other blade had bent aft prior to breaking into four sections that were located near the main wreckage.



Figure 9. The main rotor blades of ES-ETR. One blade was destroyed between the root and mid-span, while the other broke into four sections. (Photo: SIAF)

Two major impact marks were found on the leading edge of the outermost section of the blade. A 20 mm diameter mark was located at a distance of 2 cm from the blade tip, and a 50 mm diameter indentation was evident at the point of breakage. The blade had bent slightly aft before disintegration. The impact signatures were consistent with damage found in a main rotor servo piston, the aft strut and right skid on OE-XOS.

OE-XOS

The helicopter, serial number 2702, was manufactured in 2023. Its total running time as indicated by the Hobbs meter retrieved from the wreckage was 407.41 h. The helicopter had undergone the most recent maintenance on April 23, 2025, at 396.95 h. All required documents were valid and the helicopter was airworthy.

The fuselage impacted ground inverted and tail first and remained relatively intact. The fuel tank ruptured allowing fuel to escape to environment, but there was no fire.



Figure 10. OE-XOS fuselage. (Photo: SIAF)

The rear section of the cabin aft of the rear seats was crushed, and the structure below the front seats exhibited deformation. The seat harness remained intact, and cockpit controls and switches were in a position corresponding to cruise flight. Although the ELT mode switch was in “armed” position⁶, the unit did not activate on impact.

⁶ The switch has three positions: ON, ARM (on the ELT unit) and ARMED (on the remote control panel), and RESET/TEST. With the switch in ON, the ELT transmits a continuous emergency signal. The “armed” position is for normal operation, and when this mode is selected, the ELT will activate on impact. RESET/TEST position is for functional tests.

Altimeter setting was 1016 hPa. Analysis of the navigation systems at BEA facilities provided extensive data of the accident flight. The onboard recording camera was found in the wreckage, but it had failed to retain information of the accident flight due to a malfunction.

The cabin-mounted flight control system components remained in place and operated correctly when manipulated. The dual control system was not installed, and its components were found in the baggage compartment.

The engine and the main gearbox remained attached but exhibited damage caused by main fuselage deformation during ground impact. The main rotor mast was bent forward and fractured about 40 cm above the gearbox. An impact mark and traces of yellow paint consistent with the finish of the rotor blades were apparent on the rear face of the mast at the fracture point, while the flight control servo located behind the mast was bent and fractured at the piston root because of an external impact. The impact marks were consistent with damage to the tip of one main rotor blade on ES-ETR.



Figure 11. The main rotor mast of OE-XOS was fractured about 40 cm above the main gearbox.
(Photo: SIAF)

The main rotor blades, which remained attached to the hub at the root, were fragmented into sections that were located around and underneath the main fuselage and showed signs of impact with trees surrounding the accident site.

The tailboom was sheared off. Traces of yellow paint from a main rotor blade were apparent in a cut mark that began on the lower surface of the boom near its midpoint and continued to the junction of the boom and the main fuselage, indicating that the damage had progressed at an upward angle from aft to front toward the upper fuselage. The tail rotor gearbox and the tail rotor remained in place and operated correctly. The horizontal stabilizer and the lower section of the vertical stabilizers were cut off due to an impact in aft-to-front direction, and their fragments were located around the accident site. The cut marks exhibited traces of yellow paint consistent with the finish of a main rotor blade.

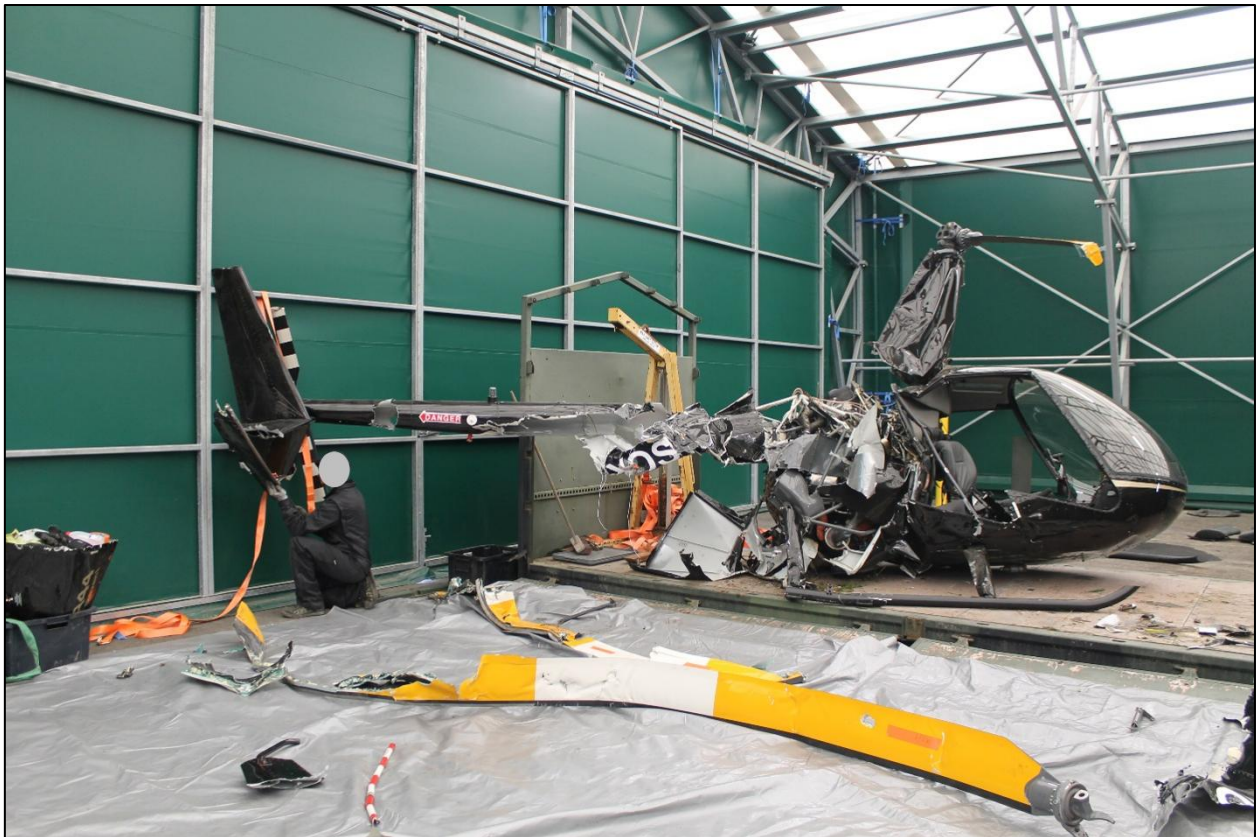


Figure 12. The tailboom of OE-XOS, which was cut off near midpoint, was lifted to its original position for reconstruction purposes. (Photo: SIAF)

The aft end of the right skid had fracture-separated and was recovered next to the main fuselage. Traces at the fracture point matched the damage sustained by a main rotor blade of ES-ETR.



Figure 13. The rear section of the right skid and strut of OE-XOS and a main rotor blade of ES-ETR. Matching damage is apparent. (Photo: SIAF)



Figure 14. Estimated attitude of the helicopters on impact, based on damage described in this paragraph. (Figure: SIAF)

Emergency Locator Transmitters

No emergency signals were received from the helicopters.

The ELT of **ES-ETR** was destroyed by post-impact fire and was not recovered, which precluded functional testing.

The ELT of **OE-XOS** remained in place despite deformation of its attachments. While the ELT casing was intact and showed no signs of an external impact, the antenna cable was found severed. The mode selector switches on the ELT and in the remote control panel were in “armed” position. Technical examination found no anomalies in the ELT, that had not activated during its service life.

2.2 Conditions

Meteorological conditions did not contribute to the accident. Weather was ideal for flying with unrestricted visibility,⁷ practically clear skies and almost calm winds. The sun was to the left and behind of the helicopters and therefore did not cause direct glare to the pilots. Atmospheric pressure was 1015 hPa, and temperature and dew point were 15 °C and 5 °C, respectively.⁸

2.3 Recordings

Investigators had access to ATC radio communication recordings, secondary surveillance radar data track data, and video footage captured by an eyewitness immediately after the collision. These were supported by navigation system data from the helicopters. No cockpit voice and flight data recorders were installed, nor were they required to be carried.

Onboard cameras yielded no useful information because the camera retrieved from the wreckage of OE-XOS was inoperative due to a technical reason, and the camera fitted in ES-ETR was destroyed in the accident.

Recorded ATC communications, which covered the entire flight from takeoff to the collision, indicated nothing abnormal. Shared frequency transmissions, such as pilot-to-pilot communications, were not available for investigation.

OE-XOS Navigation System Data

Data from the Garmin GTN 650Xi navigation system of OE-XOS was downloaded in a BEA facility. This data covered the entire flight from takeoff to the collision and contained flight parameters, navigation data and information of the operation and function of aircraft systems.

Data remained continuous up to timestamp 1134.20, after which it became partially or completely interrupted until the final recorded data at 1134.30.

2.4 Organizational and Management Information. Safety Management

The helicopters were registered to private entities that were not involved in aviation business. Available information suggests that neither helicopter had been operated for aerial work.⁹

The pilots had not received specific formation flying training, which is rarely given in general aviation community. Interviews indicated that they had no previous experience of actual formation flying, and for them cross-country flights at a close distance from another aircraft were not a norm.

⁷ In aviation, unrestricted visibility means a condition where horizontal visibility is more than 9,999 m.

⁸ Finnish Meteorological Institute. Eura weather on August 17, 2025, at 12-13 h.

⁹ Aerial work is defined as any operation where the aircraft is used for specialized activities such as agriculture, construction, photography, surveying, observation, patrol, search and rescue and aerial advertising.

2.4.1 Pilot of OE-XOS

The pilot of OE-XOS held a valid pilot's license and an aeromedical certificate. His most recent PPL(H) (private pilot license for helicopters) included an SEP(land) (single-engine piston land) and Night(H) (night rating for helicopters) ratings for the R44. He had acquired an R44 type rating in 2011 and held a PPL(A) (private pilot license for airplanes) issued in April 2025.

His flying experience in terms of flight hours is shown in Table 1 as derived from the helicopter's logbook and the pilot's personal flight log. The available sources did not indicate the division of flight hours between helicopter types, e.g., between the R22 and R44.

Table 1. Flight experience of OE-XOS pilot.

Flight experience	Last 24 h	Last 30 d	Last 90 d	Total
All aircraft types (mostly helicopters)	1 h 17 min	15 h 12 min	37 h	About 1,670 h
Accident aircraft type	1 h 17 min	15 h 12 min	37 h	402 h minimum ¹⁰

The hours shown were flown predominantly in helicopters. Collating data from the pilot's flight log, the helicopter's journey log and the airborne time on the accident flight suggests that the pilot had a total of about 1,670 h, of which about 402 h in the accident helicopter. The last flight log entry was from March 1, 2025. After this date, the journey log contained 23 entries that were not made in the flight log. Information of the pilot's flight hours in airplanes could not be determined, but airplane time had by necessity been relatively modest because he had received the required license only about one month prior to the accident.

The pilot, who had several years of experience in helicopters and was the owner of the accident helicopter, exercised his privileges primarily for personal cross-country flights.

2.4.2 Pilot of ES-ETR

The pilot of ES-ETR held a valid pilot's license and an aeromedical certificate. His PPL(H) was issued in October 2024 after undergoing flight training in the R22. He had acquired an R44 type rating in November 2024 and held a valid CPL(A) (commercial pilot license for airplanes) issued in 2023.

Because the pilot's flight logs and the helicopter's journey log were destroyed in the accident, the flight hours given are based on interviews and on information from a commercial operator in which the pilot had exercised his CPL privileges. Of the total number of hours, about 580 h were in airplanes and the remaining approximately 70 h in helicopters.

¹⁰ Although the exact amount of R44 hours is unavailable, the journey log of OE-XOS revealed that he had accrued about 402 h in the accident aircraft.

Table 2. Flight experience of ES-ETR pilot.

Flight experience	Last 24 h	Last 30 d	Last 90 d	Total
All aircraft types	About 4 h	Not known	Not known	About 650 h
Accident aircraft type	About 4 h	Not known	Not known	About 16 h

The pilot had relatively little experience in rotary-wing aircraft general and in the accident helicopter type in particular, but he was an experienced fixed-wing pilot and had exercised both his PPL and CPL privileges. It was learned that he had little problems in embracing the topics of helicopter training, and he was described as an experienced pilot owing to his previous experience.

2.5 Preventive Actions of Authorities

Safety management in general aviation¹¹ is based on international and national regulations that cover areas such as airworthiness requirements of aircraft, pilot qualifications, training requirements, contents of training and common flight rules. A flight safety authority oversees compliance with regulations, monitors the level of flight safety and undertakes actions with the aim of improving flight safety in general. Apart from the foregoing, responsibility for safety management rests predominantly with the aircraft pilot. Essential regulatory framework related to the accident is described in para. 2.7 while some previous mid-air collisions are discussed in para. 2.8.2.

2.6 Rescue Services and Their Preparedness

Satakunta Rescue Department is one of Finland's 21 rescue departments. It is functionally integrated with Satakunta Wellbeing Service County to provide rescue and paramedic services in accordance with the provisions of a decision on the standard of services.

The department's area of operations covers all 16 municipalities of the province of Satakunta, and the department is the lead organization for contract fire brigades in its assigned area. It has in round-the-clock readiness about 35 personnel manning seven permanent rescue stations located in Kanta-Pori, Rauma, Meri-Pori, Kankaanpää, Huittinen, Harjavalta and Ulvila.

The department employs about 300 full-time persons to provide regulatory accident prevention, rescue and emergency preparedness services. Its area of operations is further divided into Karhukunnat, Lower Satakunta and Northern Satakunta operational sectors. An on-duty fire officer, who will exercise rescue command and control, is assigned to Kanta-Pori,

¹¹ General aviation is defined as all aviation other than air transport operations for remuneration or hire, state aerial operations and aerial work.

Eura and Kankaanpää, but no on-duty fire chief is designated. Rescue operations are supported by the department's 24/7 situation center.

A total of 49 contract fire brigades is operational in the department's area to assist in rescue operations and in safety communication and reporting under a contractual arrangement with the department. The fire brigades have a total of 900 persons available on call.

Satakunta Wellbeing Service County uses several paramedic service providers as required by the Health Care Act, the Decree on Emergency Medical Services and by other regulations. A paramedic service standard decision outlines requirements for paramedic services within the county's area of responsibility and for paramedic care for which the county is responsible.

An emergency medical service unit is maintained in readiness according to a predetermined schedule, or round-the-clock if this is required. FinnHEMS emergency medical services helicopters can be deployed from Seinäjoki, Turku and Tampere to support paramedic services in responding to incidents that fall under specific task categories.

2.7 Regulatory Framework

2.7.1 Formation Flights

The Standardised European Rules of the Air (SERA) series of regulations published by the European Union Aviation Safety Agency (EASA) prescribe procedures for formation flight by civil aircraft.¹²

According to the rules, aircraft shall not be flown in formation except by pre-arrangement and planning among the pilots-in-command of the aircraft taking part in the flight. When flying in controlled airspace, regulations published by the competent authority with regard to the flight leader, navigation, position reporting, collision avoidance and maximum separation between aircraft in the flight shall be complied with.

One of the pilots-in-command shall be designated as the flight leader. The formation operates as a single aircraft with regard to navigation and position reporting.

Separation between aircraft in the flight shall be the responsibility of the flight leader and the pilots-in-command of the other aircraft in the flight. Distance between each aircraft and the flight leader shall not exceed 1 km laterally and a distance of 30 m vertically from the flight leader. Regulations do not prescribe minimum separation during formation flight.

Flight rules -related learning materials or training are not readily available for civil aviation purposes, and civil aviation stakeholders do not typically provide formation flight training or instruction on related safe procedures. Some training organizations have instructed students on formation flight techniques, but this practise has been discontinued, partly because formation flight skills are not needed in commercial air transport. On the other hand, formation flight is a norm in military aviation, and safe formation flight is an integral part of pilot training syllabi. The competent authority does not require the inclusion of formation flight training into training for a civilian pilot's license since this would entail an increased risk of accidents during training.

2.7.2 Right-of-Way

SERA regulations also prescribe the following rules related to right-of-way in civil aviation.¹³

¹² SERA.3135 Formation flight

¹³ SERA.3210 Right-of-way

Converging: When two aircraft are converging at approximately the same level, the aircraft that has the other on its right shall give way.

Overtaking: An overtaking aircraft is an aircraft that approaches another from the rear on a line forming an angle of less than 70° with the plane of symmetry of latter, i.e. is in such a position with reference to the other aircraft that at night it should be unable to see either of the other aircraft's left or right navigation lights. An aircraft that is being overtaken has the right-of-way and the overtaking aircraft, whether climbing, descending or in horizontal flight, shall keep out of the way of the other aircraft by altering its heading to the right, and no subsequent change in the relative positions of the two aircraft shall absolve the overtaking aircraft from this obligation until it is entirely past and clear.

2.7.3 Standards for Emergency Locator Transmitters

Both Aircrafts were flying under NCO rule NCO.IDE.H.170, which requires for helicopter that it is equipped with an ELT(S) or a personal locator beacon (PLB), carried by a crew member or a passenger.

Minimum requirements for aircraft ELTs involved in this accident are published in European Organisation for Civil Aviation Equipment (EUROCAE) document ED-62A that contains regulations governing the structure and operation of ELTs and establishes parameters for automatic ELT activation. According to the document, an ELT shall activate automatically within a specified timespan on sensing acceleration of a sufficient magnitude. The manufacturer of the ELTs mounted on the accident helicopters stated that the units met the specified requirements. There is a more recent EUROCAE document AD-62B¹⁴, where cross axis inputs and crash accelerations are more efficiently taken into account compared to earlier standard.

2.8 Other Investigations

2.8.1 Accident Flights

Although the flights from Tallinn to Piikajärvi were planned and conducted as flights by individual aircraft, characteristics of formation flying were evident practically during the entire en-route portion of the flight. Altitude as well as separation between the helicopters varied, but separation remained predominantly at less than one kilometer. While the helicopters were nearly co-altitude with a few hundred meters of separation in other directions for most of the flight, stacking increased occasionally to more than 30 m. Although the flight planned routes diverged, they followed an identical track. Most radio transmissions were made by individual pilots and were related to the particular aircraft. However, the pilot of OE-XOS closed the flight plans for both helicopters.

2.8.2 Previous Mid-air Collisions

The annual EASA safety review for 2025¹⁵ concludes that the annual occurrence rate of serious incidents and accidents in general aviation surpasses the number of such occurrences in commercial aviation measured in terms of accident numbers and relative to accumulated flight hours. A total of 21 serious incidents and 10 accidents were reported in commercial

¹⁴ Adopted by EASA in ETSO-C126c

¹⁵ EASA Annual Safety Review 2025. September 1, 2025. <https://www.easa.europa.eu/en/document-library/general-publications/annual-safety-review-2025>

helicopter operations during 2024, while for non-commercial helicopter operations the numbers were 12 and 27, respectively.

The European Co-ordination Centre for Accident and Incident Reporting Systems (ECCAIRS 2) database contains seven mid-air collisions in which at least one aircraft was a helicopter occurred during 2015–2024. A list of helicopter accidents that were examined is in table 3, which also includes two collisions reported by the Australian safety investigation authority.

The conditions and underlying factors of the listed accidents show several similarities. To start with, they occurred in visual meteorological conditions in good visibility, most pilots were experienced aviators, and most collisions happened in uncontrolled airspace or at an uncontrolled aerodrome. The aircraft were not flying in formation, and in only one accident, which occurred on a photography flight, did the pilots fly intentionally in close proximity. Contributing factors included inadequate radio communication, which deprived the pilots of awareness of the proximity of the other aircraft or its pilot's intentions when a pilot was preoccupied with managing the flight or addressing a safety-related issue. Underlying factors also included restricted visibility due to sun glare, or difficulty to acquire the other aircraft visually against the terrain below. Finally, in several accidents the aircraft were closing from directions in which they were partially or completely obscured by aircraft structures.

Table 3. Mid-air collisions in which at least one aircraft was a helicopter 2015–2024.

Year	Accident description
2023	Two Eurocopter EC130 B4s collided in Australia. One helicopter sustained major damage and impacted ground, while the pilot of the other helicopter made a controlled landing. Four occupants perished, six were seriously injured and three received minor injuries.
2020	An Extra EA-300 airplane and a Guimbal Cabri G2 collided on the runway in Australia. The impact occurred while the helicopter was in hover and the airplane on the landing run and caused significant damage to both aircraft but did not result in injuries.
2019	A Bell 206L3 and an Aeroprakt A22L airplane collided in Spain, sustained major damage and impacted ground. All seven aircraft occupants perished.
2019	A Bell 206L3 and a Jodel D.140E airplane collided in Italy, sustained major damage and impacted ground. Seven aircraft occupants perished and two received serious injuries.
2018	An Eurocopter EC135 P2+ and a Piper PA-28RT airplane collided in Germany, sustained major damage and impacted ground. All four aircraft occupants perished.
2017	A Bell 412SP and a CASA 1131 airplane collided in Spain. The airplane impacted ground after loss of control, and its pilot perished, while the helicopter force-landed resulting in minor injury to two of the ten occupants.
2017	A Cessna 152 airplane and Guimbal Cabri G2 collided in Britain, sustained major damage and impacted ground. All four aircraft occupants perished.
2016	A Robinson R44 and a Supermarine Spitfire airplane collided on runway in Britain when the helicopter was crossing the runway in hover and the airplane was on landing run and its propeller contacted the helicopter's tail. The accident did not result in injuries.
2015	Two Eurocopter AS350 B3s collided in Argentina. Both aircraft impacted ground and were destroyed, and all ten occupants perished.

EASA safety reviews look not only at the number of occurrences but also at the seriousness of their actual or potential consequences. Total risk is also assessed against the effectiveness of so-called safety barriers that are in place for accident prevention. Based on this risk assessment EASA identifies mid-air collisions as an important risk area during helicopter operations in particular and has raised a need to improved safety procedures for collision risk mitigation.

Investigation reports into accidents listed in table 3 have suggested, among other means, utilization of traffic advisory systems ensuring their continuous operating condition. EASA has in its part made active efforts to expedite the development and fielding of systems that facilitate the observation of nearby aircraft and are particularly suitable for installation in general aviation aircraft, which would contribute to further reduction of collision risks.¹⁶ In addition to the foregoing, reports have highlighted the need for better communication between pilots, combined with improved safety risk recognition and assessment especially when operating in uncontrolled airspace.

2.8.3 Assessment on Hazardous Situation in 2024

Mid-air collisions are extremely rare in Finland. In 2024, SIAF issued an assessment¹⁷ on evasive action that the pilot of a medical service helicopter conducted on detecting a collision hazard with a light airplane in uncontrolled airspace. The aircraft were flying in uncontrolled airspace. At the time of the occurrence, the helicopter pilot was focused on changing the flight plan and on related radio communication. The helicopter crew had not spotted the airplane earlier because the aircraft were closing at different altitudes and from different directions, and visibility was obstructed by aircraft structures. The helicopter pilot assumed that the helicopter had not been spotted from the airplane. The helicopter was fitted with a traffic advisory system (TAS) which, however, will not detect aircraft that are not fitted with a transponder, or if the transponder is switched off.

2.8.4 Limitations of Human Visual System

See-and-avoid is a fundamental aviation principle where pilots actively scan the sky for other aircraft in the vicinity when flying under visual flight rules and use this information to maintain safe separation without external guidance. They can also use the radio to report their position and intentions to other pilots.

In order to observe nearby traffic, the pilot must establish positive visual contact of another aircraft or use any other means to maintain awareness of its position and intentions. Positive visual contact assumes that the pilot can perceive an aircraft against its background and focus his or her eyes and attention to the detected aircraft. However, there are significant limitations related to human visual system, perception and attention both to the ability of the human eye to see an object and to the pilot's attentiveness. Studies have indicated that the see-and-avoid principle alone is insufficient for mid-air collision prevention.¹⁸

¹⁶ EASA. October 15, 2025. <https://www.easa.europa.eu/en/newsroom-and-events/press-releases/easa-launches-new-initiatives-prevent-mid-air-collisions-general#group-easa-extra>

EASA. January 1, 2026. https://www.easa.europa.eu/en/document-library/general-publications/european-plan-aviation-safety-epas-2026?check_logged_in=1

EASA. October 15, 2025. <https://www.easa.europa.eu/en/domains/general-aviation/%21conspicuity>

¹⁷ Safety Investigation Authority Finland. October 15, 2025.

<https://www.turvallisuustutkinta.fi/en/assessments/assessment-on-evasive-action-near-muhos-on-july-20-2024/>

¹⁸ See, e.g., Hodds, A. Limitations of the See and Avoid Principle. ATSB. September 1, 2025.

https://www.atsb.gov.au/sites/default/files/media/4050593/see_and_avoid_report_print.pdf

The human visual field spans about 200° horizontally and 135° vertically. However, visual acuity and object detection differ across the visual field in which the central, focal point covers a sector of no more than about 1° to 2°. Outside this small area of sharp vision in the center the eye, visual acuity degrades gradually until at an angle of about 30°, degradation is significant. The area outside this sector is referred to as the area of peripheral vision in which the visual system can detect primarily broad shapes and objects that are sufficiently high-contrast, i.e., stand out from the background, while most details are not distinguished.¹⁹

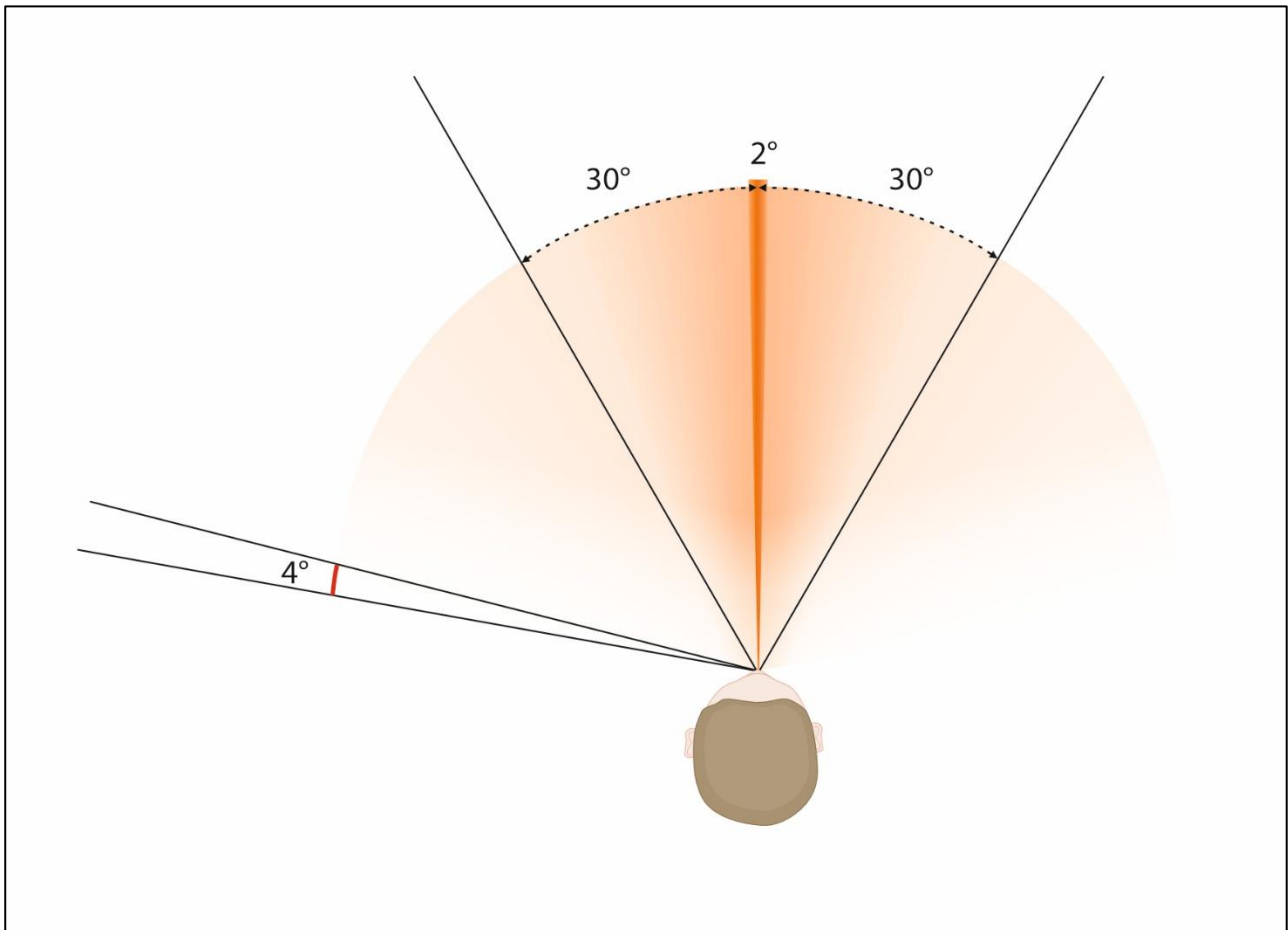


Figure 15. Extent of human visual field. Details can only be seen of objects within the focal point covering a narrow arc of about 1° to 2° on either side of the center of the eye. Outside this sector, visual acuity degrades gradually until within the area of peripheral vision at an angle of about 30° straddling the focal point degradation is significant. This area is referred to as the area of peripheral vision. The figure shows the apparent size (about 4° of line-of-sight angle) of an R44 at a distance of some 125 m from the viewer. (Figure: SIAF)

¹⁹ Strasburger, H., Rentschler, I., & Jüttner, M. (2011). Peripheral vision and pattern recognition: A review. *Journal of Vision*, 11(5):13, 1-84.

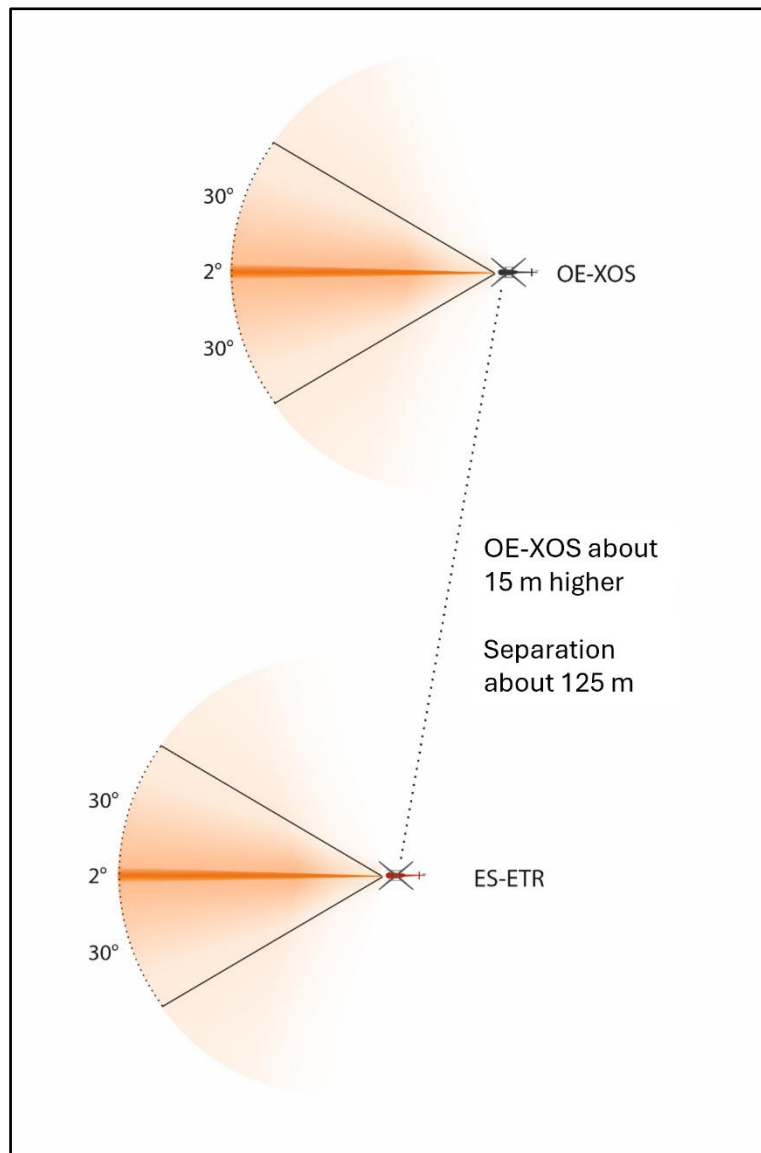


Figure 16. The extent of the pilots' visual field when looking straight ahead. The figure shows the helicopters' relative position just before ES-ETR initiated the turn. (Figure: SIAF)

Peripheral vision plays an important role in **motion detection**. The human eye detects motion when an object that stands out from its background moves relative to the viewer and causes the vision system to respond to a stimulus moving across the retina. However, when two aircraft are on a collision course at co-speed, the relative position of the other aircraft within the visual field remains practically unchanged, and peripheral vision will not respond to its movement.

The accident helicopters were flying practically at the same speed. After ES-ETR had initiated a shallow right-hand turn over Eura aerodrome it also kept tracking to the original direction at only slightly reduced velocity; in other words, the relative size, attitude or relative position of the helicopters were essentially unchanged, and therefore the motion of ES-ETR was not conspicuous from the other pilot's point of view.

While the relative size of an oncoming aircraft increases gradually within the viewer's visual field as the range closes, this increase is not immediately significant in situations where an aircraft approaches from a long range at high speed. Figure 17 shows the angular size of an

R44 at various ranges within the viewer's visual field, indicated as degrees of the line of sight angle to visualize the extent of coverage of the aircraft in the viewer's visual field. When seen from the side, the R44 is about 9 m long, and the area of its main fuselage is about 4 x 4 m. When ES-ETR initiated the shallow right-hand turn, separation between the helicopters was about 125 m. At this distance, the angular size of each helicopter within the pilot's visual field was no more than about 4° (see figure 15), and less than 2° with the tailboom excluded.

In order to distinguish details of an object of this size, the viewer must look directly at the object. Relative size does not begin to increase until during the final seconds before collision. As shown in the figure, still 3 seconds before the impact the angular size of the helicopter was no more than about 10°, and only about 5° with the tailboom excluded.

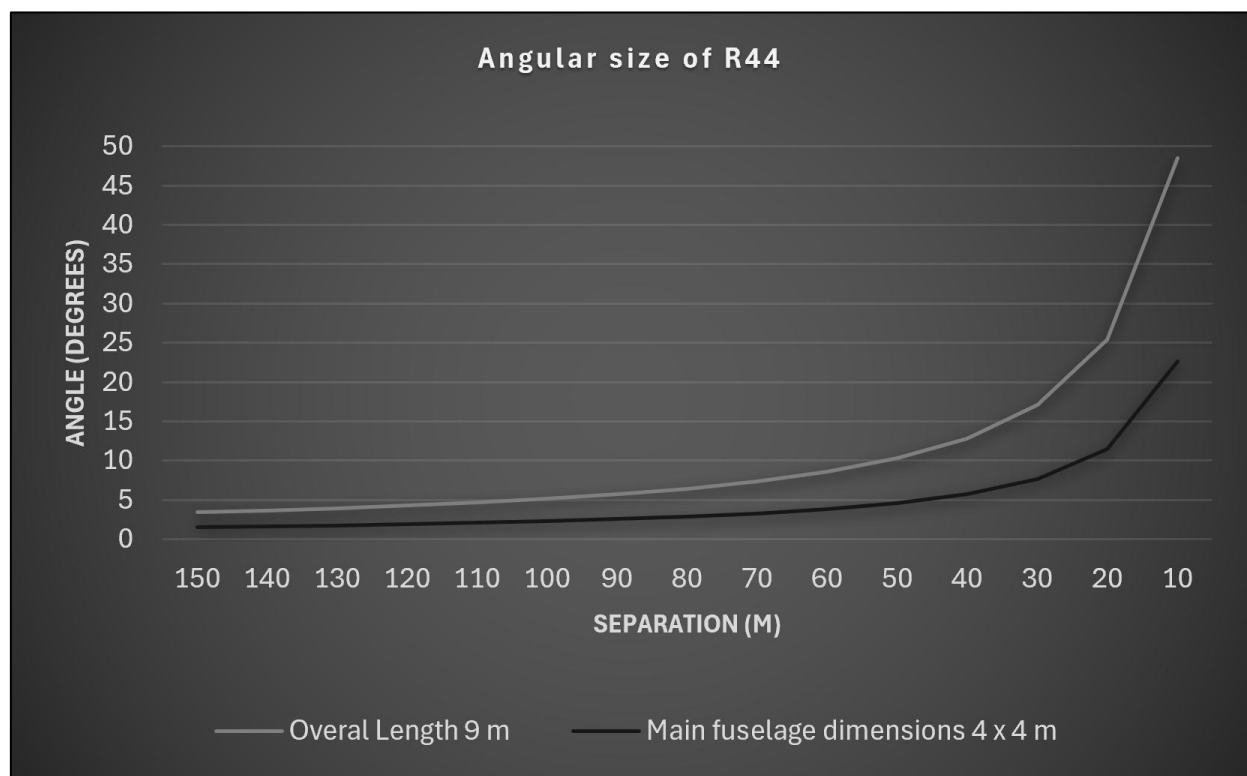


Figure 17. Angular size of the R44 versus range in degrees of visual field. (Figure: SIAF)

After sighting an approaching aircraft, the pilot will not immediately initiate avoidance response. He or she must first identify the aircraft as a collision threat, then select and execute an evasive maneuver. Various maneuverability-related factors determine how fast the aircraft will respond to control inputs for, say, heading change, while time from threat detection to the response movement depends on conditions and existing situation. In situations requiring immediate action, time from detection to aircraft response is typically from 4 to 6 seconds.²⁰ However, a converging aircraft may remain undetected if the pilot is looking at another direction or his or her selective attention is focused on other tasks.

Selective attention is an inherent feature of attentional functions and allows people to concentrate on selected items or tasks in their surroundings or information processes while filtering out distractions from the environment either completely or partially. This is related to what is called inattention blindness, a phenomenon in which an object may remain

²⁰ ATSB (2002). July 2, 2025. https://www.atsb.gov.au/sites/default/files/investigation-reports/aair200201846_001.pdf

unnoticed because the observer's attention and concentration are focused elsewhere. This may even occur in the central visual field, i.e., in the area of eye fixation. Change blindness, on the other hand, is an attentional phenomenon where the observer fails to notice a change in a visual environment if it happens during a brief visual disruption. Two broad categories of selective attention are identified. Selective attention is drawn to an object that is unexpected or distinctive from the environment, or an individual may control and focus attention to selected objects based on an internal assumption, goal or mental model.^{21,22}

Prior to the investigated collision, the pilots' attention may have shifted from monitoring the other helicopter's position and maneuvers to onboard systems, to conversation with a passenger or to any external objects such as events, people or possible other traffic at the aerodrome, or to preparations and conduct of approach to the destination. A study on aviation accidents and serious incidents has shown that the majority of distraction sources could be grouped into categories of flight management tasks, external objects, and people on board the aircraft.²³

By the time of the collision, the pilots had been flying in what appeared as a formation for about one hour. Decrement of alertness or vigilance is an inherent characteristic of attentional functions. It is suggested that in a task that requires constant vigilance an individual's ability to maintain the required alertness level begins to degrade in less than half an hour.²⁴ Therefore, during a one-hour flight in close proximity of another aircraft, vigilance will degrade to such an extent that the pilot's capacity to actively monitor the aircraft and environment will reduce or at least vary as the flight progresses.

Investigators were unable to determine whether the helicopters were flying on autopilot. However, at some points during the flight they maintained practically constant altitude. For example, the track of ES-ETR remained almost unchanged for ten minutes preceding the collision, which suggests that the autopilot was engaged.

Autopilot is an automated system that assists the pilot in navigation and control of the aircraft, developed to make the pilot's work easier, reduce workload and improve flight safety. Yet autopilot presents challenges to human functional capacity that may also degrade safety and affect safety management, such as causing the pilot's role to change from an active doer to a passive observer of aircraft systems.^{25,26} With autopilot engaged, the pilot may also scan airspace less actively, for example in the direction of a turn, because there is no need to prepare for and execute the maneuver.

Attempts to manage collisions risks during **formation flying** include a requirement that pilots-in-command shall agree on required arrangements before the flight, and one of the pilots-in-command shall be designated as the flight leader.²⁷ Formation flying is much more common in military aviation where the leader usually flies the point aircraft, and the pilots-in-command of trailing aircraft maintain visual contact with the leader. Military pilots undergo

²¹ Wickens, C., Hollands, J., Banbury, S. & Parasuraman, R. (2016). *Engineering Psychology and Human Performance* (fourth edition). Selective Visual attention, p. 50-64. London/New York: Taylor & Francis.

²² Wickens, C. & McCarley, S. (2008). *Applied Attention Theory*. Boca Raton: Taylor & Francis.

²³ ATSB (2006). March 1, 2026. <https://www.atsb.gov.au/publications/research-and-analysis-report/2022/aviation/dangerous-distraction-examination-accidents>.

²⁴ Warm, J. S., Parasuraman, R. & Matthews, G. (2008). Vigilance Requires Hard Mental Work and Is Stressful. *Human Factors The Journal of the Human Factors and Ergonomics Society*, 50(3), 433-41

²⁵ Billings, C.E. (1996). *Human-Centered Aviation Automation*. Technical Memorandum, no. 110381. NASA, California.

²⁶ Lee, J. D. & Seppelt B. D. (2012). *Human Factors and Ergonomics in Automation Design*. In: *Human Factors and Ergonomics* (fourth edition). Salvendy, G. (ed.). p. 1615–1642. John Wiley & Sons, Inc.

²⁷ SERA.3135 Formation flight

extensive formation flight training, and commonly agreed procedures that are honed during training serve as a basis on internal mental model that is used to focus attention and enable anticipation of and assumptions on the other pilots' actions. Common understanding and anticipation are supported by mutual communication between formation members. A common operating model obtained and assimilated during training and practising enhances safety management, and training also gives comprehensive awareness of safety risks involved in formation flying and of risk mitigation procedures.

Investigation was unable to determine whether the pilots had agreed on common procedures before departure, and because the helicopters were not fitted with cockpit voice recorders, information of pilot-to-pilot communication was not available. Assessment of different phases of the flight suggests that the pilots had not fully agreed on their roles and procedures. They were not trained on formation flight techniques and possessed no experience-based formation flying skills. They proceeded in what appeared a formation and were exposed to safety risks involved in formation flying, but without mastering required risk management procedures.

Human ability to assess safety risks is affected by various bias that are characteristic of human deduction processes. One of them is to base risk identification and assessment primarily on previously obtained subjective experience. Individuals commonly tend to overestimate their capabilities; and conversely, they show a tendency toward underestimating the likelihood of occurrences and risks of which they have no first-hand experience or awareness obtained by other means.^{28,29} From this follows that an experienced pilot may subconsciously overestimate his or her ability to control the aircraft, and on the other hand, due to lack of experience, underestimate risks associated with formation flying or other similar actions.

2.8.5 Obstructions Due to Aircraft Structure

The R44 pilot has a wide available visual field that is, however, restricted by cabin structures, the instrument panel and other people on board.

When ES-ETR entered the shallow right-hand turn it was in front of OE-XOS on the left side and slightly below (see figure 16). The pilot and passenger of OE-XOS occupied the right and left front seat, respectively. It is possible that the cabin roof and door frames obstructed the view from ES-ETR's cabin in the direction of OE-XOS, while in OE-XOS, view to the left toward the position of ES-ETR could have been limited by the front seat passenger and door frames. As the turn continued, ES-ETR moved aft as seen from OE-XOS, and as a result the left seat passenger would have obscured the view significantly.

²⁸ Wickens, C., Hollands, J., Banbury, S. & Parasuraman, R. (2016). *Engineering Psychology and Human Performance* (fourth edition). Decision making, p. 245-283. London/New York: Taylor & Francis.

²⁹ Kahneman, D. & Klein, G. A. (2009). Conditions for intuitive expertise. A failure to disagree. *American Psychologist*, 64, 515-524

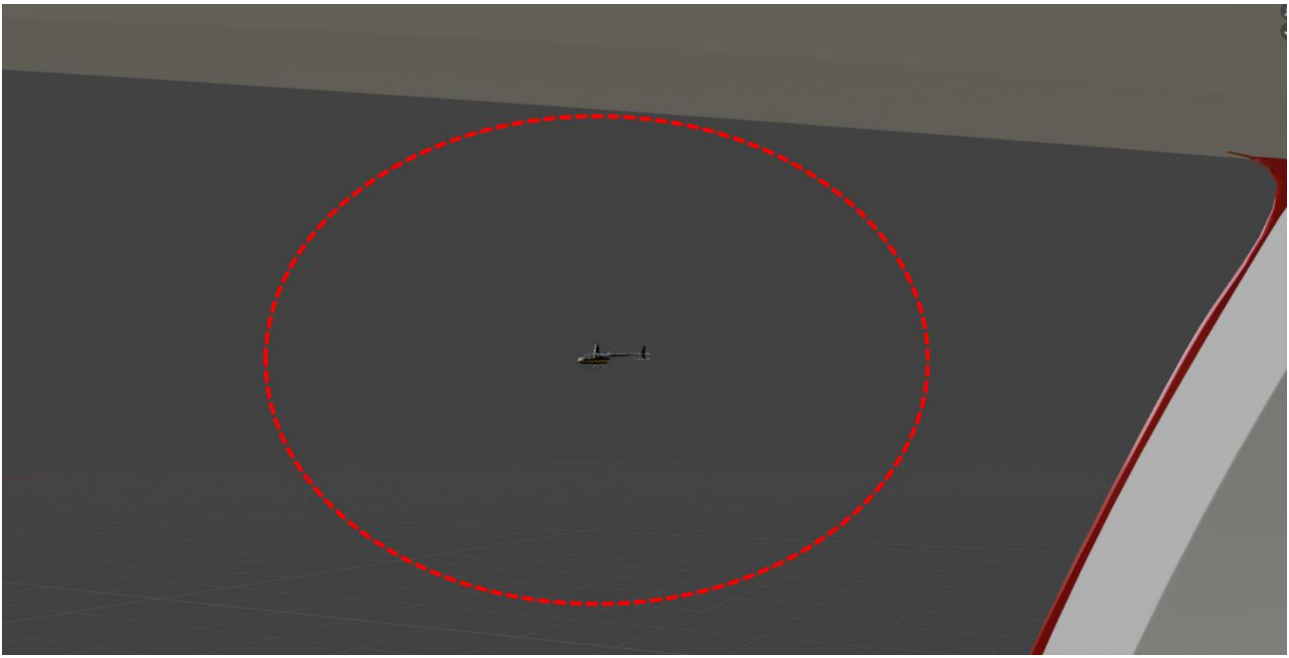


Figure 18. The upper rear corner of the right-hand cabin door is shown in the figure, which illustrates the visual field of the ES-ETR pilot in the direction of OE-XOS immediately before turn initiation, supposing that the pilot was scanning the area behind and to the right of his helicopter. The line of sight extends to the right and slightly behind at an angle of about 100° , and 6° up. The position of OE-XOS is approximate because only inaccurate information was available. This “circle of ambiguity” is shown by the red dashed line. (Figure: SIAF)

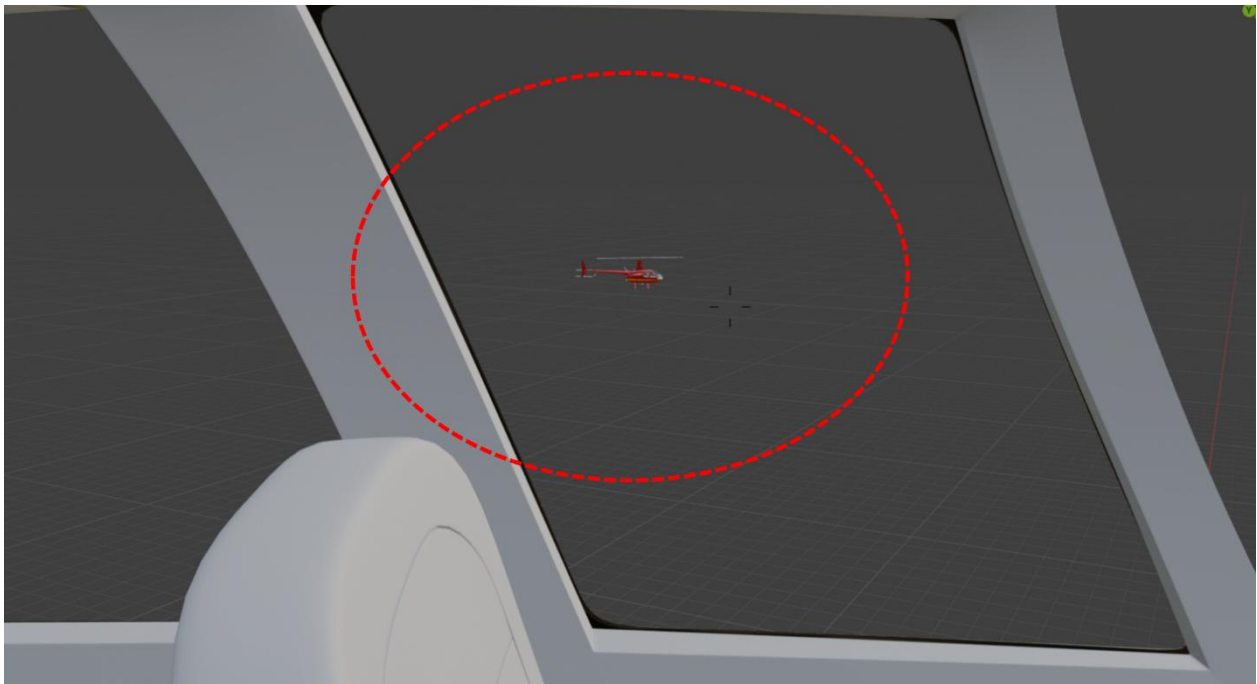


Figure 19. The left-hand cabin door and the left windshield are shown the figure, which illustrates the visual field of the OE-XOS pilot in the direction of ES-ETR immediately before turn initiation, supposing that the pilot was scanning the area to the left of his helicopter. The left seat occupant is not shown. The line of sight extends to the left at an angle of about 80° relative to the helicopter’s longitudinal axis, and 6° down. The position of ES-ETR is approximate because only inaccurate information was available. This “circle of ambiguity” is shown by the red dashed line. (Figure: SIAF)

3 ANALYSIS

A SIAF-developed format of the AcciMap approach³⁰ was used to support the analysis of the occurrence. The following text is arranged in accordance with an AcciMap diagram created during the investigation. The occurrence is depicted as a chain of events along the bottom of the diagram. Contributing factors at various levels can be examined by moving up and down the diagram.

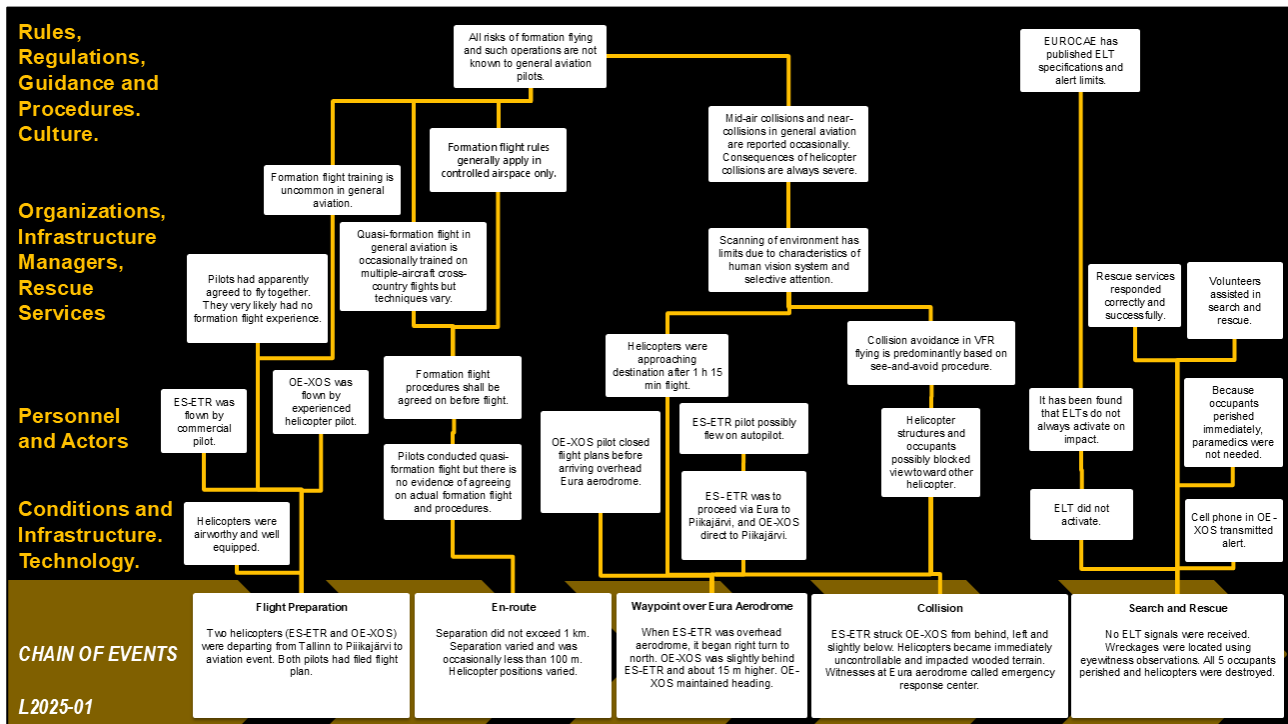


Figure 20. AcciMap diagram, investigation L2025-01. (Figure: SIAF)

3.1 Flight Preparation

Two helicopters, registered ES-ETR and OE-XOS were preparing for a flight from Tallinn to Piikajärvi, where the occupants had planned to attend an aviation event. The pilots had filed separate flight plans in which the times of departure and flight routes given were slightly different in that the route of ES-ETR was via Eura aerodrome, while OE-XOS was to proceed direct to Piikajärvi. Considering that the pilots knew each other it is likely that they agreed before departure to conduct the flight together, which was indicated by the fact that they reported departure to air traffic control (ATC) nearly simultaneously, and the helicopters followed an identical track toward the destination in a close vicinity.

The helicopters were airworthy and well equipped with an autopilot and modern navigation and flight management systems. Judging from accumulated flight hours, the pilots could be described as experienced aviators. The pilot of OE-XOS was an experienced helicopter pilot, while the pilot of ES-ETR had a considerable number of airplane hours, and he had also exercised the privileges of his commercial pilot license, but on the other hand, he had relatively little experience on helicopters. Although operating onboard systems of an unfamiliar aircraft may detract the pilot from effective visual scanning, the accident pilot was

³⁰ Rasmussen, J. & Svedung, I. (2000) *Proactive Risk Management in a Dynamic Society*. Karlstad, Sweden. Swedish Rescue Services Agency.

familiar with the use of autopilot and modern navigation systems, and there is little difference in the architecture and management of these systems between airplanes and helicopters. In addition to this, transition from an airplane to a helicopter causes no significant changes from the pilot's perspective during the en-route phase of a flight, and the investigated accident occurred en route. Because the techniques of flying an airplane and a helicopter during the en-route phase are essentially similar, limited helicopter experience of one of the accident pilots had no direct effect on the accident sequence.

Neither pilot was trained on formation flight, and they had, as far as could be established, no previous experience in this mode of flying.

3.2 En-route

The helicopters departed Tallinn almost simultaneously. Although the pilots conducted the en-route phase of the flight in a coordinated manner, there is no evidence that they undertook formation flight in the sense of the definition contained in the applicable rules of the air. The helicopters proceeded toward Piikajärvi at about 300 m altitude with separation not exceeding 1 km. Separation reduced momentarily to less than 100 m, and the relative position of the helicopters varied, which may indicate that the pilots had not agreed which one of them was a designated flight leader.

Formation-like flying refers to an arrangement in which aircraft proceed in close proximity, but their pilots have not agreed on procedures, aircraft positions and the pilots' roles is particularly prone to collisions and entails major problems in visual observation of other aircraft and in anticipating their maneuvers. Human ability to observe objects in immediate surroundings is restricted both by the inherent limitations of the human vision system and by selective attention, especially when the objects are moving in a changing environment, due to the fact the human being can focus and perceive only a fraction of the field of vision at any one time. Agreed procedures, such as those related to communication between aircraft, help build mental model that the pilot can use to anticipate other pilots' actions and to decide where to focus his attention. Communication between aircraft shall be one these procedures.

Formation-like flying is occasionally practised in the general aviation community during cross-country flights by more than one aircraft, but most general aviation pilots are unfamiliar with risks and procedures related to this mode of flight. Although rules of the air contain general provisions for formation flight, their purpose is not to establish detailed procedures. They prescribe, for example, that pilots-in-command shall agree on arrangements before the flight but give neither detailed instruction on items to be agreed on nor provide guidance for pilots' actions during the flight.

Human ability to assess operational risks is largely based on personal experience, on information and knowledge assimilated by other means, and on awareness of any risks involved. Still, formation flight training is generally not included in civil aviation training, and formation flying is uncommon to say the least, from which follows that knowledge of formation flight techniques and safe procedures may vary and be generally insufficient. Even though formation flight is allowed in civil aviation, formation-like flying may turn into a situation where flight involves all risks inherent in formation flight but excludes required risk management procedures. Furthermore, awareness of safety risks may differ between actual formation flight, which is conducted by a mutual agreement by the pilots involved, and situations where aircraft proceed along the same route in what appears to be a formation.

3.3 Waypoint over Eura Aerodrome

The relative position of the helicopters changed just prior to their reaching the final waypoint for a heading change toward the destination. Almost immediately after the pilot of OE-XOS had closed the flight plans of both aircraft, ES-ETR initiated a right-hand turn toward Piikajärvi with OE-XOS positioned to the right of and behind ES-ETR with some vertical separation.

Although weather and visibility did not hamper visual acquisition, the helicopters closed on each other at an angle where the structure of OE-XOS and the right-seat passenger possibly obstructed the view in the direction of ES-ETR. On the other hand, to see OE-XOS, it would have been necessary for the pilot of ES-ETR to scan an area behind and above his aircraft, and the possibility that the door frame and cabin roof structure restricted visibility during the right-hand turn in particular cannot be excluded. It can also be assumed that the pilot's attention before the impact was focused on aircraft systems, conversation with the passenger or passengers, or external objects, or on preparations for approach.

Although investigation of aircraft systems could not determine whether autopilot was used, a possibility remains that the pilots engaged autopilot at some points during the flight. When the autopilot is engaged, the pilot does not need to actively anticipate and execute a planned turn on reaching a waypoint and may therefore be less attentive in scanning the airspace in the direction of the turn.

Because data of communication between the pilots was unavailable, it was not possible to determine whether the pilots reported their intentions during the flight. It was considered possible that when the pilot of OE-XOS started closing the flight plans before reaching the waypoint, he did not perform scans in the direction of ES-ETR, and then concentrated on own navigation at the waypoint and on execution of the turn that he commenced only seconds before the collision.

3.4 Collision

The factors explained in the previous paragraphs contributed to a situation where the pilots were unaware of each other's intentions and did not acquire the other helicopters visually, which led to the collision. The collision rendered the helicopters uncontrollable, and no recovery action was possible. The investigation found no technical reason that would have been a factor in the collision.

Accidents and hazardous situations are more common in general aviation than in commercial aviation, and also mid-air collisions occur, albeit occasionally. Although collisions between helicopters are relatively rare, their consequences are almost invariably severe. Because of this, the European Union Aviation Safety Agency is striving to boost the development of technical solutions that would be installable in general aviation aircraft to facilitate detection of traffic in immediate vicinity.

Even though collision avoidance systems had been fitted in the accident helicopters, they would have been practically ineffective because the helicopters flew in close proximity during the entire flight, and the systems would therefore have issued an unbroken series of warnings.

Several safety investigation reports on collisions in which at least one aircraft was a helicopter have brought up similarities with the investigated accident. Common contributing factors have been, among others, human and structural limitations to visual detection as well as deficient communications.

3.5 Search and Rescue

The accident was non-survivable. The emergency locator transmitter (ELT) of ES-ETR was destroyed by ground impact and fire. The antenna cable of the ELT onboard OE-XOS was found severed, but the unit remained operational. However, it did not activate, likely due to the direction of acceleration on impact. Judging from the fact that all helicopter occupants perished, acceleration forces were considerable, but the helicopter's attitude on impact most likely prevented activation. However, one of the mobile phones on board initiated an automatic emergency call to the emergency response center.

ELT operation was not a factor in location of wreckages. Eyewitnesses to the collision initiated an effort to locate the wreckages. As a rule, ELT reliability is essential for successful search and rescue, and ELT specifications and alerting limits are detailed in a European Organisation for Civil Aviation Equipment document. The Safety Investigation Authority Finland has discovered that ELTs have failed to activate in a number of accidents.

An airborne NH90 helicopter of the Finnish Defense Forces was retasked to assist in search and rescue, and its crew responded immediately. In addition to the NH90, pilots of Kauttua Flying Club took off almost immediately on an aerial search. Rescue services responded correctly, and search and rescue were conducted without difficulty.

4 CONCLUSIONS

Conclusions encompass the causes of an accident or a serious incident. Cause means the different factors leading to an occurrence as well as relevant direct and indirect circumstances.

1. The pilots of the accident helicopters conducted a flight similar to formation flight toward a common destination.

Conclusion: *Formation-like flying involves risks typical of formation flight but is not supported by required safety procedures.*

2. General aviation pilots are as a rule not trained in formation flight techniques and related safe procedures, and formation flight is a relatively rare mode of flight.

Conclusion: *All risks and safe procedures related to formation flight are not necessarily known to general aviation pilots.*

3. The helicopters' relative position and separation varied during the flight, suggesting that the pilots-in-command had not agreed on formation flying procedures.

Conclusion: *Formation flights should be carried out in a coordinated manner. Without a common agreement on procedures and aircraft positions, anticipating other aircraft's maneuvers will be extremely difficult, which in turn increases collision risk.*

4. The pilots were unaware of each other's intentions and did not detect the other helicopter before the collision. Aviation accidents in which visual perception and its limitations have been cited as possible contributing factors have been reported previously.

Conclusion: *Human ability to scan his or her operating environment visually is not alone sufficient to avoid mid-air collisions.*

5. An emergency locator transmitter did not activate during a high-energy impact. Similar occurrences have been reported previously.

Conclusion: *Failure of an emergency locator transmitter to activate during impact can cause delays in a search and rescue operation and hamper delivery of assistance to injured aircraft occupants.*

5 SAFETY RECOMMENDATIONS

The Safety Investigation Authority Finland reminds pilots of the risks that are encountered during formation flying and other such flight modes. Aircraft in a formation proceed on an identical track with separation between the leader and other aircraft being no more than one kilometer. A recommended practice is to familiarize with formation flight procedures before departure. It is extremely important to agree on procedures before flight and stick to these procedures in order to prevent collision.

5.1 Collision Risk during Formation-like Flying

Formation-like flying involves safety risks encountered during proper formation flying but without required risk management procedures. Risk awareness among pilots varies.

The Safety Investigation Authority Finland recommends that

the European Union Aviation Safety Authority undertakes safety promotion activities to increase the knowledge and awareness of formation flying in general aviation, and its related accident risks as well as collision prevention procedures. [2026-S13]

5.2 Emergency Locator Transmitter

An emergency locator transmitter did not activate although the helicopter was subjected to high acceleration.

The Safety Investigation Authority Finland recommends that

the European Union Aviation Safety Agency ensures that new emergency locator transmitters meet the requirements of ETSO-C126c at the minimum. [2026-S14]

Emergency locator transmitters that meet the new standard are more reliable in helicopter accidents.

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Investigation Material

- 1) Photographs, diagrams, and other material produced during on-site investigation
- 2) Meteorological data
- 3) Police department investigation notice
- 4) On-site police photographs
- 5) Emergency response center authority alert log and accident report

- 6) Radar Data
- 7) Interviews
- 8) Documents of OE-XOS and ES-ETR
- 9) Pilots' licenses and aeromedical certificates
- 10) Emergency response center recordings

SUMMARY OF COMMENTS TO DRAFT FINAL REPORT

The draft final report was submitted for comments to the European Union Aviation Safety Agency (EASA), the National Transportation Safety Board (NTSB) of the United States, the Estonian Safety Investigation Bureau (OJK), the Austrian civil aviation accident investigation authority (SUB), Satakunta Wellbeing Services County, Finnish Transport and Communications Agency Traficom, and the helicopter manufacturer (Robinson Helicopter Company). Pursuant to the Safety Investigation Act, no comments given by private individuals are published.

Robinson Helicopter Company provided amendments to names of helicopter components and the phrasing of the report. The company also requested clarifying information of the timing of the closing of the flight plans during the flight.

The European Union Aviation Safety Agency commented on terms related to formation-like flying and explained what safety actions the agency could promote within the current legal framework. These could include increasing awareness of risks of flying in close proximity and of related flight preparation and agreed procedures among general aviation community. Safety and situational awareness could also be improved by installing various warning and flight following systems in aircraft. The agency provided specifying information of requirements, characteristics, activation, and standards related to emergency locator transmitters carried in general aviation aircraft, and proposed the application of a more recent issue of the related standard in general aviation.

Satakunta Wellbeing Services County commented on the names of rescue units and personnel's duties.

The National Transportation Safety Board of the United States, the Estonian Safety Investigation Bureau, the Austrian civil aviation accident investigation authority (SUB), and Finnish Transport and Communications Agency Traficom did not comment on the report.