Cessna F150J, G-INGR and Yak Aerostar, RA02030

AAIB Bulletin No: 12/2000 Ref: EW/C2000/4/4 Category: 1.3

Aircraft Type and Registration:	(1) Cessna F150J, G-INGR (2) Yak Aerostar, RA02030
No & Type of Engines:	(1) 1 Continental Motors O-200-A piston engine (2) 1 Ivchenko Vedeneyev M-14P piston engine
Year of Manufacture:	(1) 1969 (2) 1999
Date & Time (UTC):	19 April 2000 at 1621 hrs
Location:	2 nm north of North Weald Airfield
Type of Flight:	(1) Private (2) Private
Persons on Board:	(1) Crew - 1 - Passengers - 1 (2) Crew - 1 - Passengers - None
Injuries:	(1) Crew - 1 (Fatal) - Passengers - 1 (Fatal) (2) Crew - 1 (Fatal) - Passengers - None
Nature of Damage:	(1) Aircraft destroyed (2) Aircraft destroyed
Commander's Licence:	(1) Airline Transport Pilot's Licence (2) Private Pilot's Licence
Commander's Age:	(1) 38 years (2) 33 years
Commander's Flying Experience:	(1) 7,987 hours Last 90 days: 114 hours Last 28 days: 40 hours

(2) 539 hours

Last 90 days: 4 hours

Last 28 days: Not known

Information Source: AAIB Field Investigation

History of the flight

The accident occurred when the two aircraft collided in the circuit at North Weald Airfield. The weather at North Weald was observed as 200°/15 kt, few at 3,000 feet with unlimited visibility.

The pilot of a Yak 50 aircraft, callsign Aerostar 4, was a member of a seven aircraft formation aerobatic team operating from North Weald. Following a comprehensive pre-display briefing the team conducted a display rehearsal over the airfield at North Weald. The flight was carried out under an exemption to Rule 5 (1)(e) of Rules of the Air Regulations 1996 and, in accordance with the conditions of the exemption, authorised by the airfield manager. The rehearsal was carried out between 1510 hrs and 1520 hrs. When the display rehearsal was complete the Yak, in company with another departed for Little Gransden, Cambridgeshire, where the second Yak was based, and for the pilot to collect a length of metal braided hose which was required as part of the smoke generator system for the aircraft. The aircraft arrived at Little Gransden, at approximately 1540 hrs. The pilot placed the 2.5 metre length of hose inside his flying suit and departed for North Weald at about 1600 hrs.

The Yak was shown on radar recordings to transit from Little Gransden Airfield near St Neots direct to the west of Harlow and then route around to the south of the town heading east towards North Weald. The altitude for the transit was not known since secondary radar recordings were not available.

The owner of the Cessna had travelled to North Weald with his family and a friend, who was a professional pilot and had also taught him to fly. The intention was for the owner to work on another aircraft and for the friend to carry out a short local flight with family members. Having carried out the pre-flight checks the pilot and one of the owner's children taxied across to the 'Squadron' (a locally based flying organisation) to book out. The Cessna pilot had previously flown from North Weald airfield.

At approximately 1600 hrs the Cessna took-off from North Weald on Runway 20 (right hand circuit) and departed to the south east from the end of the down wind leg. Whilst the aircraft altitude is not known the flight was recorded on radar from primary returns and shows the flight path to the south east which included turns to the left and right. The aircraft then travelled west, passing to the south of North Weald and joined the circuit on the downwind leg at 1619 hrs.

The collision

At 1620 hrs the Yak pilot, approaching the circuit from the west, called North Weald Radio. 'Aerostar initial er break to land'. The radio operator in the tower saw the aircraft at about circuit height and North Weald Radio responded, 'Roger one aircraft late downwind'. The Yak pilot confirmed he had the Cessna in sight by responding, 'Visual with him and er thirty seconds to

initial'. The term initial was used by the formation aerobatic team, of which he was a member, when 1 nm on the extended centreline from the airfield to signify the IP before running in for the break. 'Run and break' is described later in this report.

The Cessna at this point was approximately 1.5 nm south of the Yak, which continued on an easterly track to pass in front of the Cessna. Shortly after the last transmission the Yak was seen by the radio operator to enter a dive, levelling at about 100 feet which was held momentarily before entering a climbing turn. This manoeuvre was carried out in the vicinity of to the pilot's house. Due to the distance from the aircraft the radio operator could not determine whether the turn was to the left or right, however a witness close to the aircraft track who also observed the manoeuvre saw the aircraft make a left turn. He then looked away.

At about that time the Cessna made a right turn onto base leg. Using the last seven radar returns and allowing for the prevailing wind speed it was possible to calculate the average ground speed of the Cessna as 87 kt, and that of the Yak as 124 kt. The Yak climbed back up to approximately circuit height and transmitted to North Weald Radio, 'Aerostar 4 is initials for the break and the other traffic is?' Thinking that the Cessna pilot would have heard this call the radio operator waited for him to respond but, on not hearing any transmission, looked up to try and locate both aircraft but could not see them.

An off duty Air Traffic Control Officer saw the Cessna on a constant easterly heading at about circuit height. He watched the Yak initially in straight and level flight on a south westerly heading make a gentle left turn using some 5° to10° of bank as if turning towards North Weald. It was also at about circuit height with engine power sounding as if at a low to medium power setting, with the aircraft nose slightly above the horizon. Just before the two aircraft came together the Cessna made a very rapid roll to the right to a steep bank angle and, about one second later at 1621:44 hrs the two aircraft collided. The tracks of both aircraft, derived from radar recordings and eyewitness evidence, are shown at Figure 1.

The right hand wing of the Cessna detached and the aircraft descended rapidly in a spiral to the right, impacting the ground in an open field. The Yak also made a steep descent, impacting in another field 150 metres south of the Cessna. The occupants of both aircraft received fatal injuries in the impacts.

Communications

Air traffic communications at North Weald comprise an Aerodrome Air/Ground Service with licensed radio operators passing information to, but not controlling aircraft. Although there is no requirement to record RT traffic, such a recording was routinely carried out. At about this time the tape in the recording system was changed and the joining call from the Cessna was not recorded, but the call was made and acknowledged by the radio operator.

Wreckage examination

The two aircraft impacted the ground relatively close together. The Cessna's right wing, virtually complete from root to tip and with the strut still attached, was found 185 metres to the north of the remainder of the wreckage. Pieces of windscreen and some loose items from the Cessna were also found in the vicinity. The fuselage, empennage and left wing had impacted the ground in a steep nose-down attitude with a force sufficient to buckle the rear fuselage through almost 180°

The Yak had struck the ground, in a steep nose-down attitude beyond the vertical, at high speed. This meant that the wreckage was effectively inverted with the engine and nose forward of the cockpit buried in the earth. Severe damage to the right tailplane and elevator, which did not appear to be consistent with ground impact, was noted. There was also an obvious propeller slash on the inboard right wing. Apart from the missing parts of the tailplane and fabric-covered elevator (which were located in the same debris field, which contained the Cessna windscreen), the Yak appeared to have been structurally complete at ground impact.

The propeller slash in the right wing of the Yak also showed that it had been generated from the underside. A black mark on the underside wing skin, in the centre of the slash, appeared to come from the black painted spinner of the Cessna (confirmed when a piece of the spinner was found with rivet witness marks matching the pattern of those used in the Yak wing at that location).

On the Cessna there was only one area of damage severe enough to account for failure of the right wing attachments and that was on the strut and the underside skin of the leading edge adjacent to the strut attachment. The skin had been crushed from underneath by an object which had left a smear of black material on the sheet metal. The strut itself had received a heavy blow from behind by object(s), which had left faint but positive traces of blue and yellow paint on the strut.

The close proximity of the two main wreckages suggested that both aircraft had immediately become uncontrollable after the collision. With the loss of the complete right wing this was an unavoidable consequence for the Cessna. The major collision damage to the Yak appeared to be confined to the right tailplane and elevator. Whether this would render the aircraft totally uncontrollable is not known but it appears likely. Although the propeller slash in its right wing continued into the aft fuselage, it was a shallow cut and was positioned aft of the pilot's seat and hence pilot incapacitation as a result does not appear likely. Given the low altitude at which the collision occurred there was little time for the pilot to abandon the aircraft by using his parachute and no such attempt appeared to have been made.

The two aircraft, whilst sustaining major damage, had struck each other in a relatively 'glancing' manner inasmuch as a more positive impact could reasonably be expected to have resulted in much more airborne fragmentation than actually occurred. Although most witnesses described the Yak striking the left wing of the Cessna there was no evidence of impact on that area. The damage to the right wing and strut, which caused it to detach, came from below and behind. Macroscopic and forensic examination of all the witness marks left by one aircraft contacting the other strongly suggest that the aircraft were effectively 'belly-to-belly' and generally heading in the same direction at the moment of impact. Marks on the Cessna right wing and strut were matched with the tailwheel and lower rudder of the Yak: black marks on the Yak elevator lower surface fabric were matched to Cessna tyre rubber and, as mentioned previously, the propeller slash on the underside of the Yak right wing. It is concluded that the relative attitudes of the two aircraft were as depicted in the illustration at Figure 2 and suggests that the Yak pilot also tried to take avoiding action by banking very rapidly to the left, even though this was not recalled by the eye-witnesses.

Airfield joining procedures

North Weald Airfield is an unlicensed aerodrome, operated by the local authority. It is situated to the south of Stansted (197°T°/10.2 nm), beneath the Stansted Control Area (CTA) [1,500 feet to 2,500 feet altitude] and some 2 nm outside the Control Zone (CTR) [Surface to 3,500 feet]. Flying activity on the airfield includes model aircraft, light aircraft and ex military jet types as well as

parascending and gliding. Procedures included in the North Weald Airfield Operations Manual (AOM) set out the method by which the activities should be carried out.

Of relevance to the accident are the Airfield Joining Procedures as set out in the AOM. These are:

'Section 4.3. Airfield Joining Procedures

1. The following procedures apply to all powered fixed wing aircraft arriving at North Weald Airfield and are published in UK Air Pilot and Jeppesen, Bottlang Airfield Manual.
2. Aircraft are only permitted to join North Weald airfield with prior permission and when Visual Meteorological Conditions (VMC) prevail. The VMC conditions vary dependent on aircraft speed and whether passengers are being carried or not. The absolute minimum being in sight of the ground and 1 nautical mile visibility.
3. At 5 nautical miles from the airfield, aircraft, which are radio equipped, are to contact the airfield on 123.525 megahertz. When 2-way communications are established, pilots are to pass their estimated time of arrival (ETA), aircraft type, number of persons on board (POB) and intentions. Pilots must obtain details of air and ground activity at North Weald. Joining under these circumstances should be in the downwind position of the duty runway.
4. In the event that communication is not established as in paragraph 3, the arriving aircraft is not radio equipped or is arriving without prior permission, then the aircraft should remain clear of the overhead, establish the duty runway from either of the signals squares and join in the downwind position of the duty runway.'

General Flight Rules are contained in Section IV of The Rules of the Air Regulations 1996. For flight in the vicinity of an aerodrome Rule 17 (5) states that an aircraft shall:

'(a) conform to the pattern of traffic formed by other aircraft intending to land at that aerodrome, or keep clear of the airspace in which the pattern is formed; and

(b) make all turns to the left unless ground signals otherwise indicate.'

[**Note**. On the day of the accident the circuit direction at North Weald was right handed]

Run and break manoeuvre

When considering the compliance of both aircraft with these procedures it is important to be familiar with the terms 'initial' or 'initials' and 'break' as transmitted by the Yak pilot.

The run and break manoeuvre was adopted by the armed forces in wartime as a means of permitting high speed aircraft to land at an airfield with the minimum of delay for both tactical and operating reasons. The aircraft would maintain its high speed, flying down the dead side of the duty runway at a pre determined height until at a certain point the pilot entered a climbing turn reducing speed and joining the circuit pattern downwind for landing. Associated with the manoeuvre was an Initial Point (IP) at a specific distance from a position on the airfield or a time which the pilot reported to ATC commencing the break in order that other pilots or ATC were aware of the aircraft position and intended flight path. The procedure and any reporting points as well as any heights to be flown were promulgated in the relevant airfield documentation made available to those involved in flight operations. Visiting pilots could either establish prior to departure the procedure to be adopted when carrying out a run and break at an airfield or on the RT prior to arrival. The call of 'initials' or '30 seconds to initials', informed ATC and other traffic that the aircraft was at the IP or

had 30 seconds to run to the IP. Visual acquisition of the approaching traffic was therefore assisted by the geographical position reported. The term 'initial' or 'initials has no defined meaning in civilian RT phraseology. Such a call can only convey a specific position if it is promulgated in documents available to pilots and ATC or communicated on the RT. This was not the case at North Weald.

Medical and pathological information

A post-mortem and toxicological examination was carried out of all three victims, all of whom received fatal injuries at ground impact. In no case was there any evidence of pre-existing disease, alcohol, drugs or any toxic substance which may have caused or contributed to the cause of the accident. There was no evidence of injury or incapacitation resulting from the airborne collision.

The Yak pilot was required to wear glasses or contact lenses to correct short-sighted vision. Whilst it was not possible to confirm that corrective lenses were being worn at the time of the accident, a video taken of the pilot during the earlier pre aerobatic briefing showed him wearing the glasses. A colleague confirmed that the pilot wore glasses in preference to contact lenses for flying when carrying out aerobatics. Damaged spectacles were recovered from the wreckage with the pilot. It was concluded that he was most probably wearing the glasses and that his uncorrected eyesight was not a factor in the accident.

Conspicuity

The ability to see another aircraft depends largely upon distance, movement and contrast. The Cessna was predominantly white whilst the Yak 50 had a two-tone pale grey camouflage design on its upper surfaces and pale blue lower surfaces with a yellow engine cowling and rudder. The day was sunny with a small amount of cloud in the area and unlimited visibility. From the radar plots the distance between the two aircraft from the time that the Yak was believed to have been passed the 'late downwind' position of the Cessna to the point of collision was never greater than 2 nm. From the RT recording, the pilot of the Yak, on receiving the 'late downwind' position of the Cessna, responded immediately that he was 'visual with him'. The Yak then passed from left to right approximately 0.75 nm in front of the Cessna. It is not known if the Cessna pilot had seen the Yak as no transmission to that effect was received. However, it is probable that within the circuit he was monitoring the radio and, if looking in the correct direction, the range and fast movement across in front of him would have made the Yak visible. This was despite any poor contrast in colour between the Yak and the sky or surface background.

Analysis

The Cessna pilot, having completed his flight to the south east of North Weald, had rejoined the established right hand circuit for Runway 20. This he had done from the up wind end of the downwind leg in accordance with the recommended airfield joining procedures.

The Yak pilot having arrived from the west had declared his intention to break to land and prefixed this with the word 'initial'. The term initial was used by the formation aerobatic team, of which he was a member, when 1 nm on the extended centreline from the airfield to signify the IP before running in for the break. This location is not laid down in the North Weald AOM. Whilst it is not known if the Cessna pilot was familiar with the significance of the term 'initial' as applied to North Weald, it is probable that he understood the term 'break' as being the manoeuvre previously

described. There are two main possibilities of why the Cessna pilot did not see the Yak until just before the collision.

If he had not seen the Yak crossing in front from left to right, he would have looked to the right in order to try and locate the other aircraft in the area of the extended centreline of Runway 20. He might have assumed that he had missed seeing it and its break was complete with the Yak downwind behind him. As he made the turn onto base leg, adjusting his position in relation to the runway, most of his attention would have been directed looking out to the front or to the right. It is unlikely that he would have seen the Yak make the low level left turn and climb from below as he was seated on the left side of the aircraft and the manoeuvre was probably obscured by the nose and right side of his aircraft.

Alternatively, if he had seen the Yak pass from left to right, he might have seen it make the dive and adopt a flight path, which would take him on a base leg to run in for the break. Again, concentrating on positioning and configuring his aircraft for landing, he would not have expected the Yak to appear from his left.

The Yak pilot, on completing the left climbing turn at the end of his dive, made a steep climb, taking him quickly to the height at which the collision occurred. The long nose of this aircraft does limit forward visibility significantly in a climbing attitude, although the pilot was able to maintain a lookout either side of the nose and clear the airspace in front by turning from side to side. The cockpit support structure and the position of the sun may further have degraded his ability to locate the other traffic. The call, 'Aerostar 4 is initials for the break and the other traffic is?' indicates that he had lost sight of the Cessna and the speed and gentle left turn of his aircraft, as described by the witnesses, suggest he was looking for the other traffic to his left before commencing his restated intention to perform the break manoeuvre. Furthermore, he could not afford to fly too far eastwards without encountering the gliding activity on the dead side of the airfield. The Cessna at this point was to his right and slightly below.

The Cessna had regained a level wing attitude on the base leg and the pilot was probably still looking out to the right with the Yak approaching from the left. The high wing of the Cessna limiting the pilot's visibility above the aircraft further exacerbated the situation.

The rapid roll to the right by the Cessna just prior to the collision suggests that it's pilot saw the Yak and made an attempt to turn away from it. The Yak pilot probably saw the upward movement of the Cessna left wing and his reaction to make a large control input to turn to the left would have been instinctive. The rate of roll of the Yak at the airspeed given would have been approximately 300° a second. To achieve the underside to underside mode of the aircraft damage would have taken 0.43 seconds at that rate of roll. This would be reduced if the Cessna had continued to roll to the right. The Cessna propeller made the initial impact with the underside of the right wing trailing edge of the Yak.

Conclusion

The Aerodrome Air/Ground Communications Service which was provided at the airfield meant that aircraft joining or in the circuit were not positively controlled but were responsible for their own separation and sequencing. This should have been in accordance with the Rules of the Air Regulations and the instructions laid down in the AOM quoted earlier in this report.

The Yak pilot declared his intention to carry out a 'run and break' with a time frame of 'thirty seconds to initial'. It was thus possible for others listening on the frequency to be aware of his intended flight path, which was to descend and make a right turn in order to align his aircraft with the runway before carrying out the run down the runway and then break right to join the circuit downwind. By making the left turn and descending to such a low height, he deviated from that flight path and placed his aircraft in a position relative to the Cessna, which was not expected by the Cessna pilot or by the radio operator.

The last seven radar sweeps, at intervals of four seconds between returns, showed the relative bearing between the two aircraft changing by only 5° in five sweeps. This presented a virtually stationary view of the other aircraft to each pilot. Relative movement, so useful in detecting other traffic would not have been present. In the last two radar sweeps the relative bearing increased by 13° on the sixth return and a further 13° on the seventh return. This increase would have given a small amount of relative movement but by that stage the respective aircraft structures, combined with the direction in which the pilots were probably looking, would have made detection unlikely.

The collision occurred because the pilots of both aircraft did not see the other aircraft in sufficient time to take effective avoiding action.

Safety action

The airfield operator had commissioned a safety review by an external consultant in January 1998. They have indicated their intention to undertake a further review, which will include 'consideration of the operating procedures, the Airfield Operating Manual, levels of Air Traffic Service and ways in which in conjunction with our tenants safety and good airmanship can be positivley encouraged and maintained.'