

Case Report

Iskra ejection seat system failure and fatal injury

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ABSTRACT

Escape from a disabled aircraft is one of the basic problems in aviation medicine. Assisted escape is carried out by means of ejection seat fitted both in subsonic and supersonic aircraft. The Iskra seat has modes of auto separation and manual override for ejection. However unlike other modern seats, it does not have a stabilizer drogue, and thus tumbles with erratic and unpredictable ballistics. In such a condition, it may be difficult for the pilot to keep his orientation and recognize a failure of auto separation in time to take further actions. A fatal accident involving an Iskra aircraft clearly brings out this fact. There is a requirement of either changing the seat, or design a simulator where the trainees and instructors can do the emergency drills.

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On 14 Mar 2002 two Iskra aircraft took off from a flying training unit. A trainee pilot was flying the first aircraft and an instructor along with a trainee pilot flew the chase aircraft. It was the first mission of the day for the two trainee pilots and second for the instructor. Visibility on that day was 10 kms. Both aircraft were fully serviceable and the one flown by the instructor had completed four sorties earlier in the day. It had flown 6.35 hrs since completion of 100 hrs servicing 5 days back. There was no history of any repeated major snag on aircraft.

This mission was airborne at 1335 hrs and was uneventful till decision to rejoin was taken in sector approximately after 17 mins of flying while approaching reporting point for rejoin at 1.3 km. The

instructor simulated **U/S** R/T for the trainee to take subsequent actions. This was acknowledged by all concerned and everything was normal till then. The instructor wanted to simulate another emergency along with **U/S** R/T and tried to attract attention of trainee in the lead aircraft. However, the pupil wanted to position himself over the reporting point, opened power, and could not correctly monitor the additional emergency being simulated / indicated by the instructor.

The instructor tried to catch up but suddenly felt that he had flamed out. He communicated his decision to eject and the sequence was correctly followed for ejection at

around 400 m AGL and 270 km/hr. The instructor ejected first, impacted the ground with the seat and suffered fatal injuries. The pupil who was flying in the same aircraft with the instructor came down safely.

Evidence from Crash Site

The distance from canopy and rear seat was found to be 1000 m and distance between rear and front seat about 75 m. Both seats were on a bearing of 260 from the canopy, which corresponds to flight path of aircraft, which was on a course of 240°. After the ejection, aircraft turned right and crashed on a course of 020° approximately 2 km away.

The ground where the seat impacted was firm with bushes and scattered boulders. At the point of impact the ground had a deep impression of about 6" and bushes had been uprooted. The seat was lying on its back. The headrest had broken away, lying about 8' away from the seat. The body of the instructor was lying perpendicular to the right side of the seat, head being closest and left hand touching the seat pan. The parachute D-ring was pulled out by about 37 cms from its housing. The parachute had come out of its pack and was lying to the left of the body. The outer helmet was lying between point of impact and seat. The O₂ mask with a 30 cm piece of hose was found along with the outer helmet. The helmet showed total flattening of dome, crumpling in the posterior portion and antero-posterior disruption in midline and to the left of the midline. The visor was shattered and the chinstrap with fastener area on helmet had broken away. The inner helmet had been torn, and showed antero-posterior disruption of left quadrant. Left ear shell and surrounding leather were torn badly. The O₂ mask hose had torn off. Thumb portions of both gloves had been torn badly. Right thumb portion of

the glove, along with tissue, was found stuck between distorted seat firing handle and hand rest. Both shoes showed damage to leather on the right aspect. Right lace flap of right shoe was torn off from zip attachment. Cloth from right leg of flying overall was torn badly, and from the left leg, it was torn over the thigh and shin. The cloth over trunk portion was torn badly, especially over right half of chest and abdomen. The AD-3 in badly damaged condition was lying towards the top of the seat. The seat harness D-ring was laying outside its sleeve and the harness lock was open. The metal protection guard, which covers the junction of AD-3 cable and D-ring cable connection, was deformed, pulled out with its locking pin, from the hook where it is attached after servicing. The hook itself also was deformed and torn. The canvas, on which this hook is riveted, was also torn. The manual trigger release hook was lying separately.

Autopsy Findings

- (a) Facial tissue. Skull was totally smashed with only pieces of skull bone present. It was empty and brain was missing. Parts of scalp tissue and mandible were only present. Only pinna of the ears could be recognized.
 - (b) Chest. Lungs were collapsed and congested. Ribs had multiple fractures on both sides.
 - (c) Spine. Dislocation of both sacroiliac joints was present.
 - (d) Upper limbs. Left shoulder was dislocated with a laceration of about 3 cm over shoulder. Left forearm showed deformity with fracture. Left thumb was amputated. Left index finger nail bed was crushed. Right shoulder and arm showed marked swelling. Right elbow and right thumb showed fracture with avulsion of skin and muscle.
- Hip joints. Marked dislocation of right hip joint was seen.

(f) Lower limbs. Right thigh showed skin and muscle laceration with crushing and disorganization. Right knee was crushed with fracture dislocation at knee. The tibial condyles were jutting out of the open wound at knee. Right leg was lacerated with compound fracture. There was laceration of left thigh over full length on anterior aspect. Torn muscle and tendon was visible at knee. The ankles were intact.

(g) Abdomen. Right half of abdominal wall was ruptured. Left half was contused and abraded. There was full thickness laceration over inguinal region. Genitalia were intact.

The autopsy and histopathological examination clearly indicated that injuries occurred on landing due to failure of seat man separation and failure of parachute to open up.

Discussion

Ejection injuries may be minor or major. Contusions, abrasions, sub dermal hematomas, superficial burns not more than 5% of the skin surface, etc. are considered as minor injuries. Major injuries include fractures, deep burns, subluxations etc. In spite of constant improvements in ejection seat design and procedures, the risk of sustaining major injuries is high. In a study of 60 ejections in Bulgarian Air Force [1], Milanov found eight fractures of vertebrae, two fractures of upper limbs and two fractures of lower limbs. The percentage of spinal fracture in IAF is 27.5% [2], as compared to 16 % in Bulgaria [1], 18 % in Finland [3] and 25 % in Sweden [4].

Despite the major advances of ejection seat, Iskra aircraft, a fixed wing trainer aircraft is fitted with a primitive ejection seat, which requires lot of action from the operator during the process of ejection. The seat consists of seat pan, seat back, headrest, jettison handles and firing levers. The parachute is placed in the seat pan with the pilot sitting on top of it. There are two canopy jettison levers, one each on the left and right arm rests, which also serve as safety guards against accidental squeezing of the firing handles (i.e., without operating the jettison levers, the firing

handles cannot be squeezed). Thus irrespective of who jettisons the canopy, each of the two pilots has to operate the jettison lever for initiating ejection. Before ejecting, the pilot has to lock the harness and withdraw both his feet from the rudder pedals and place them on the footrest, as there is no leg restraining mechanism in this seat. For ejection the canopy has to be manually jettisoned by moving either of the canopy jettison levers forward (i.e. towards instrument panel). However, as a matter of procedure both the levers are to be used simultaneously. This releases the canopy lock and the canopy flies off with the air stream. A trigger release pin is attached to the canopy frame, which gets pulled out when the canopy flies away and makes the seat live. In case this pin is not pulled out due to any reason, then the seat will not be fired and the pilot has to resort to manual-override.

Squeezing either of the firing handles activates the firing pin and the pyrocartridge is fired. The cartridge produces gases which force the inner tube, along with the seat, to move upwards. When the ejection seats move upward three things happen:-

(a) The connected lanyard of the AD-3 timer, which is secured to the guide rail of aircraft, pulls out the AD-3 safety pin and timer is activated.

(b) The normal supply of O₂ is disconnected and emergency O₂ systems come into operation.

(c) The R/T connection is disconnected.

The seat takes approximately 0.2 sec to clear the cockpit. At 0.9 m upward travel, the lanyard pulls out the safety pin of the AD-3 and it starts its operation. 1.5 sees later, the seat harness is released and the pilot separates from the seat along with the parachute. Before separation, however, the seat has a tendency of tumbling as it has no seat-stabilizing drogue. This has also been mentioned in earlier ejection accounts. Another lanyard with a clip is attached to a ring on the left frame of the ejection seat pan and connected to the safety pin of a barostatic time release unit, KAP-3, which is housed along with the parachute. The KAP-3 is set for a time of 2 sec and an altitude of 4 km. Once the pilot separates from the seat, the lanyard connected to

the seat pan pulls out the safety pin of the KAP-3, thereby activating it. It operates as per its setting, which is a time of 2 sec or an altitude of 4 km, whichever is later, and pulls out the end of the cable which otherwise keeps the parachute flaps closed. This opens the parachute pack and the small drogue chute snaps out which pulls out the main parachute sleeve automatically for the parachute to deploy.

In case of failure of canopy to jettison, the pilot has to resort to manually opening the canopy with the normal canopy-operating lever. In case the canopy still fails to jettison, the pilot has to resort to a through canopy ejection. He first has to withdraw the trigger release pin by a finger grip provided on the right side of the headrest and thereafter squeeze the ejection grips. Canopy breaking prongs are provided on both seats above the head rests for this purpose.

In case the seat fails to fire, the pilot has to resort to manual bailout by jettisoning the canopy, disconnecting the KAP-3 clip (attached to the seat), inverting the aircraft and falling out by releasing the seat straps. In such a contingency, as the KAP-3 clip is disconnected, the parachute will not open automatically and the pilot has to pull the parachute D-ring manually.

In this fatal aircraft accident it was apparent that the pilot was holding on to the seat handles when the seat impacted the ground. The amputation of right thumb and pieces of thumb portion of right glove along with human tissues stuck between deformed hand rest and seat firing handle have corroborated this. The seat impacted a rock amidst bushes in position, with canopy breaker hitting first, with a tilt to the right. This has been corroborated with acute bending of tubular structure of canopy breaker and breaking away of right corner of cushioned metal plate. In all probability, in quick succession after the massive first impact, right handle of seat bounced up and went to the left by about 8 ft over the bushes. On this path, the flattened broken helmet along with oxygen mask fell from the body. The seat harness opened just before the seat came to rest on ground. As a result, the body fell out to the right side of the seat with head closer to it. A 20 cm piece of right side frame of the seat pan broke and consequently the right side strap, which is anchored to this portion of the frame, also became free from the seat. At the same time, the left hand rest got bent acutely to the left, breaking the metal fixation points at several places. During impact, the right leg

was crushed and mutilated. Similarly the left leg sustained injuries on thigh due to compression against left hand rest. The posterior aspect of trunk and thighs were free from injuries indicating that these portions were in contact with the seat till separation till the last phase of tumbling. A case is understood to have occurred in Poland wherein a similar ejection caused fatal injuries to the rear pilot. The pilot was holding on to the hand grips so tight after ejection, that the pilot did not separate from the seat though the

harness was open, and the parachute deployment could not take place. However in this case the D-ring was operated manually and the reason for parachute not opening up could not be explained.

Conclusion

The fatal air crash clearly brings out some of the problems of Iskra ejection seat. The seat gains a maximum 13.04 m height in 1.63 sec from the point of ejection and separates in 1.5 sec after ejection, taking the initial firing velocity as 16 m/s. This means that the automatic separation takes place while still in upward travel, assuming the ejection has been in level flight with no rate of descent. The Iskra seat, unlike other modern seats, does not have a stabilizer drogue, and thus tumbles with erratic and unpredictable ballistics. In such a condition, it may be difficult for the pilot to keep his orientation and recognize a failure of auto separation in time to take further actions. Therefore, the pilot must immediately resort to manual override after ejecting, i.e. pull the seat harness D-ring, push the seat firmly away from body and pull the parachute D-ring. Ideally there should be a simulator installed where the trainees and instructors can do the emergency drills.

References

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