Case Report

Low Level Ejection Experience with KM-1M Ejection Seat

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Three low level ejections from aircraft fitted with KM-1M seat are analysed. Two were successful while the third was fatal. Flight conditions at the time of ejection in each case vis-a-vis relevant safe envelope are discussed. Reasons for the outcome have been analysed with a view to validate the limits of safe envelope.

Key words: Aircrew escape system, safe ejection envelope

The large MiG fleet of the Indian Air Force (IAF) is equipped by KM-1M ejection seat. It is fitted in Trishul, Vikram, Vijay, Rakshak, Bahadur and Garud aircraft. During the past eight years, the KM-1M ejection seat was involved in nearly 50% of the total ejections in IAF. For tactical reasons, more and more flying is being undertaken at lower and lower altitudes and any ejection at low altitudes becomes particularly hazardous.

The Seat

The KM-1M is a fully automatic rocket boosted seat weighing 135 kg. It has three modes of operation with automatic mode selection based on the aircraft altitude and speed at the time of ejection. It is capable of providing successful escape at altitudes of zero to 20 km above ground level and at speeds of 130 kmph to 1200 kmph. Or, stated simply, it is a ground level ejection seat with minimum aircraft speed requirement of 130 kmph. Hence theoretically, the seat can provide successful escape capability to the pilot in practically every conceivable flight situation.

But then there are factors that complicate this apparently simple scenario and affect the outcome of an ejection attempt. Aircraft speed at the time of ejection is one such factor. High speed at low altitudes can be a boon or a disadvantage depending on whether or not the pilot is in a position to barter his speed for altitude. In case of dire emergencies at low altitudes with high aircraft speed and with no time available to convert the speed into height, an ejection under the circumstances would expose the pilot to the vagaries of wind blast and high drag deceleration. On the other hand, if the pilot does have time to trade in his speed for altitude, he might be able to eject from a safe and convenient height.

Aircraft altitude at the time of ejection is another factor. All low level ejections are potentially hazardous. Attitude of the aircraft is one more decisive factor. Any ejection from an aircraft with unusual attitude can be dangerous. For instance, from an inverted aircraft, the minimum safe ejection altitude (MSEA) is 100 m less than for a banked aircraft. Rate of descent is also an important factor. Any rate of descent adds to the MSEA.

Case Reports

To illustrate the performance of the KM-1M seat at low altitudes, three cases of ejection have been selected - one each from Vijay, Vikram and Garud aircraft. All ejections took place at the so called edge of the safe envelope.

Case I

An experienced pilot was flying a Vijay aircraft on a range sortie for live bombing. While running in for a safety run with a speed of 920 kmph at 95% engine RPM, 260 m AGL and descending, the pilot flew into a flock of birds. He heard a loud noise followed by winding down of engine RPM. The pilot eased up the nose of the aircraft, swept his wings forward from 70 deg to 16 deg and attempted a relight which was unsuccessful. He decided to eject, gave a call to this effect and initiated ejection mechanism at an altitude of 1.4 km and speed of 410 kmph. The aircraft was flying level, with negligible rate of descent.

The ejection process was uneventful. The pilot escaped apparently unhurt. About three hours after the ejection he felt some backache. X-ray examination of the spine, however, did not reveal any bony injury and he was treated symptomatically for contusion of the back. Six weeks after the accident, one of the review X-rays revealed mild compression fracture of the 7th dorsal vertebra. The pilot recovered uneventfully and was returned to full flying status after a year’s observation in restricted medical category.

Case II

A young pilot of modest experience took off in a Vikram aircraft for a range sortie. He heard a loud
bang a short time after take off at a height of about 800 m AGL and a speed of about 700 kmph. The engine RPM started winding down. The pilot attempted relight twice without success. He then decided to eject and attempted to pull the ejection firing handle with one hand, while trying to control the aircraft with the other. He did not succeed in this attempt. Finally he let go of the stick and successfully initiated ejection mechanism at a height of about 150 m with the speed being 450 kmph. The rate of descent at this time was about 30 m/sec, with wings level. The ejection mechanism functioned satisfactorily and the pilot landed almost next to the burning aircraft wreckage. As a matter of fact, his parachute was partially singed in the post-crash fire. The pilot's landing was rather harsh and he sustained fracture of the left femur due to impact with the ground. He also sustained mild compression fracture of the first lumbar vertebra. He was treated with internal nail fixation of the femoral neck and has since made good recovery. He is still under observation in a non-flying category, but appears to have good chance of being returned to full flying status.

In this case, the pilot probably touched down moments after the parachute was deployed because of low level ejection. There was not enough time for reducing his rate of descent after chute deployment. That would explain the hard touch down, and the fracture femur sustained by him.

Case III

An experienced pilot was making an approach for landing in a Garud aircraft. At a distance of about 4-5 km from the landing dumbell, at a height of about 350 m AGL and a speed of about 400 kmph, the pilot appeared to have encountered some problem. Though the exact nature of the problem could not be determined, the pilot seemed to have lost control of the aircraft. He initiated the ejection mechanism at a height of about 300 m AGL. The aircraft attitude was almost level and it was descending rapidly with a speed of about 350 kmph. The estimated rate of descent of the aircraft was about 50 m/sec.

The ejection sequence functioned normally upto the stage of seat separation at which point it hit the ground. The pilot parachute did not deploy because of insufficient height. The pilot landed on the ground fully separated from the seat, but with parachute undeployed. He sustained severe multiple internal and external injuries including fractures of all bones, rupture of heart and liver and telescoping of cervical spine into the skull. He was killed instantaneously on impact.

Discussion

When these three cases of ejection are compared (Table I), some very interesting points are noticeable. First of all, when the emergency occurred, case II seems to have been best positioned in terms of height and speed. But he squandered away these advantages by unnecessarily delaying the initiation of ejection. Ultimately he ejected at the lowest altitude of all the three cases - about 150 m. The pilot escaped with survivable injuries probably because of his lower rate of descent, 30 m/s, at the time of ejection, which he probably achieved by last minute zooming up. Even a slight increase in his rate of descent would have pushed him irretrievably into the unsafe zone. He probably saved himself by last minute arrest of rate of descent by trimming the aircraft nose up.

Case I, though placed at a disadvantage as compared to Case II in terms of height and speed, turned the situation to his advantage by converting his speed to height and then taking an early decision to eject. He ejected at an altitude of 1400 m - well out of unsafe zone. His case is worthy of emulation.

Case III was in a hopeless position right from the beginning. At the time of occurrence of the emergency he was on approach path with reduced engine power and at low altitude and low speed. In addition he had the undercarriage and flaps down. However, he reacted quickly and ejected without loss of time. There was no way he could have gained any height whatsoever, since he had

<table>
<thead>
<tr>
<th>Case No</th>
<th>Aircraft Type</th>
<th>At Emergency Height (m)</th>
<th>At Emergency Speed (kmph)</th>
<th>At Initiation of Ejection Height (m)</th>
<th>At Initiation of Ejection Speed (kmph)</th>
<th>At Initiation of Ejection Attitude Bank (deg)</th>
<th>Rate of Descent (m/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Vijay</td>
<td>260</td>
<td>970</td>
<td>1400</td>
<td>410</td>
<td>Level</td>
<td>40</td>
</tr>
<tr>
<td>II</td>
<td>Vikram</td>
<td>800</td>
<td>700</td>
<td>150</td>
<td>450</td>
<td>? Nose up</td>
<td>&lt;10Lt</td>
</tr>
<tr>
<td>III</td>
<td>Garud</td>
<td>350</td>
<td>350</td>
<td>300</td>
<td>350</td>
<td>? Nose down</td>
<td>?</td>
</tr>
</tbody>
</table>

Table - I Comparison of Flying Parameters
no speed to trade-in to begin with. Thus when he ejected, he was already well into the unsafe zone, but one thing is immediately noticeable, that he ejected at an altitude which was higher than that of Case II. But what did him in, was his rate of descent, which in his aircraft was inherently very high, aircraft configuration at the time of ejection making it worse.

It is thus seen that success or failure of an ejection can be predicted fairly accurately from the safety envelope, provided one knows the aircraft parameters at the time of ejection. Three cases of ejection just described fully validate the limits of this safety envelope. But what is important is the time between occurrence of the emergency and initiation of the ejection. As we have just seen one pilot encountered emergency almost at the edge of safety envelope, but managed to climb out of trouble and ejected at a safe height, whereas another pilot who was relatively well placed when the emergency occurred, made his position worse by delaying ejection and ultimately scraped the surface of safety envelope, escaping by the skin of his teeth injuring himself in the process.