

A comprehensive review of problems associated with long duration flying and some suggested remedies

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ABSTRACT

Deep penetration strike aircraft of the IAF have been involved with long duration flying for nearly half a decade now. Some problems associated with long duration sorties had been anticipated and catered for over the past half decade; however a review of still unsolved problems is required. This paper comprehensively updates problems associated with long duration flight. A validated questionnaire with high test-retest reliability was used to study problems associated with long duration flying. Forty pilots participated in the study. Problems pertaining to the lack of autopilot as related to inflight meals have been brought out. Problems related to harness design interfering with inflight urination and those related to fatigue and boredom have been discussed. Based on the above, a different definition of long duration sorties has been attempted. A few remedies have been suggested. Long duration sorties are still new to the IAF. After about half a decade's experience, a better understanding of long duration flying and its related problems has emerged. The authors have shared this understanding and have attempted to suggest some remedies.

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Evolution in aircraft design has contributed to continuous improvement in their efficiency and endurance. With the advent of air-to-air refuelling (AAR), strike aircraft have accumulated many long duration flying records. The first non-stop round-the-world flight was flown by a B-50 bomber in 94 h with the help of four aerial re-fuelings [1]. During Operation Linebacker II, B-52's based in Guam routinely flew 14-15 h round trip combat missions over North Vietnam [2]. The longest air combat mission in history, lasting 36 h, was flown by seven B-52's launched from Barksdale AFB, LA, to attack targets in Iraq [3] during operation Desert Storm. Since the introduction of AAR in the Indian Air Force (IAF), the IAF too has been flying many long duration missions. During Ex Cope-Thunder, Jaguar aircraft of the IAF flew from Jamnagar to Eilson Air Base Alaska in 180 h, averaging single sorties of approximately 6 hours duration, a first for single seat aircraft not equipped with autopilot [4]. Currently fighter sorties lasting more than four hours

are classified as long duration flights [5]. At present no distinction is made between the type of aircraft, type of sortie, number of crew, cockpit activity etc. It is the authors' contention that all these issues affect the fatigue involved with long duration flying and need to be considered comprehensively for a better understanding of problems associated with long duration flying.

There are three classes of aircraft used in the IAF for long duration fighter sorties. Of these the Jaguar was designed in the 1960s. The other two aircraft were designed in the 1970s and 1990s respectively. Understandably, there are design differences between these three aircraft types. Some of these design differences, which may be largely overlooked in a conventional sortie, tend to become important during long duration sorties. There is thus a need to study aircraft specific

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problems associated with long duration flying. The Jaguar being of the oldest design serves as the best platform to study some of these differences. Once these are understood, a comparative study would help us understand how should aircraft designers tackle these problems in this future aircraft. The designing of indigenous fighter aircraft has now become a reality. Thus it is important for us to study the effect of various design features on the capability of an aircraft vis-à-vis long duration flying. This study would highlight some such issues.

Hence, the aim of this study is twofold: Firstly to review the problems related to long duration flying in the IAF, The second is to understand the effect of various design features and man-machine interfaces on problems related to long duration flying, with a view to making such data available for future aircraft design.

Material and Methods

The study was carried out as a questionnaire study. In our literature survey we could not find any validated questionnaire for bringing out aircraft design characteristics vis-à-vis pilot fatigue. A questionnaire had to be developed anew for this study. This was done in three phases.

In the first phase, a set of questions was formulated based on preliminary discussions with pilots on problems associated with long duration flying. In phase two these preliminary questions were vetted by a panel consisting of one aviation medicine specialist, one experimental test pilot and two qualified flying instructors with a vast instructional experience with the view to ascertaining five qualities:-

- (a) Comprehensiveness
- (b) Absence of any leading questions.
- (c) Absence of double-barrelled questions ie two queries in a single question which might

vitate the answer.

- (d) Unambiguous questions.
- (e) No personally offensive questions.

The final questionnaire was made after incorporating inputs from the vetting panel. Subsequently, the questionnaire was subjected to a test-retest cycle to assess test-retest reliability and split half reliability. The questionnaire was administered to all fighter aircrew on base without bias to age, rank or experience. The questionnaire was kept anonymous, without any column for the name of the respondent. The final questionnaire consisted of 56 questions covering nine areas of concern.

Results

As has been mentioned above, the questionnaire had 56 questions addressing nine areas of concern which have been brought out in table-1.

Table-1: Nine areas of concern addressed in questionnaire survey

Sl No	Categories
1.	Rules vs Workload
2.	Lack of Autopilot
3.	Cockpit Geometry and comfort
4.	Physical fitness
5.	Aircraft Systems
6.	Ground support
7.	Boredom
8.	Urine disposal
9.	Choice of food and beverages

The questionnaire was returned by a total of 30 pilots. Their mean age was 30 years. Their mean flying experience was 1362 h. They had flown an average of seven long duration sorties. The maximum number of long duration sorties flown by a single individual were 23. All respondents were male, as the IAF has only male fighter pilots.

Table - 2: Incidence of various factors: Questionnaire feed back

Categories	Percentage
Rules vs Workload: Four Hour rule	
The specified time of four hours is too long.	100%
Majority felt 3 h is also long duration	
With increased workload, a shorter sortie should also be classified as long duration.	100%
Lack of Autopilot	
Interferes with in-flight meals	25%
Interferes with type of meal which can be had	75%
Increases fatigue	100%
Cockpit Geometry and Comfort	
Lack of cockpit space increases fatigue	30%
Better seat comfort would reduce fatigue	100%
Physical fitness	
Equal Number of pilots suggested stretching before, during and after the sortie	30%
Physical fitness reduces fatigue	100%
Most pilots considered themselves quite fit	75%
Average time spent per week on physical fitness	3-4 h
Aircraft Systems	
Pilots strongly agreed that better aircraft systems would reduce fatigue, namely, mission planning, health monitoring, nav systems, recovery aids, SA systems, self protection, Long range surveillance radars, AWACS	100%
Ground Support	
Better living conditions both residential and at Squadron would reduce fatigue	100%
Better administrative facilities would reduce fatigue	100%
Better GCA, ILS would reduce fatigue	90%
Boredom	
Boredom is a major issue with low workload long duration sorties	100%
Boredom alleviation is necessary if IAF plans to become a Strategic Air Force	85%
Pilots use boredom alleviation strategies in the cockpit	60%
Urine Disposal	
Diaper was considered an unsatisfactory method for urine disposal	80%
Better research is needed for urine disposal	100%
Pilots do not use the diaper	95%
Prefer condom drainage	66%
Choice of Meals/beverages	
For a 4 hour or less sortie chocolates and sandwiches.	
Preferred plain water and fruit juices. Suggested addition of Energy drinks (Red Bull) and electrolyte replacement (Gatorade)	85%
For >4 h preferred sandwiches and parantha rolls	75%
200 g (2 sandwiches) every 4 h	80%

The raw data for this questionnaire was quite extensive hence it has condensed into the nine areas as mentioned in Table 1 for the sake of clarity. The condensed results for each of these categories are given at table-2.

The test-retest reliability coefficient of the questionnaire was 0.89 and the split half reliability coefficient was 0.93. 100% pilots felt that the stipulated duration of 4 hours to classify a sortie as a long duration sortie was too long. 70% of the pilots felt that the duration of a long duration sortie should be different for day and night sorties. Pilots universally agreed that introduction of autopilot would reduce fatigue to a large extent. In addition, it would also allow ease during in-flight eating (75%) as well as urination(70%), as the former requires loosening of mask and the latter loosening of QRB.

100% pilots believed that a more comfortable seat would reduce fatigue, while 30% respondents brought out that a more spacious cockpit with more comfortable cockpit geometry would also reduce fatigue. It was felt by 100% respondents that better ground and cockpit systems would reduce the workload and hence fatigue. The pilots specified improvement in navigations systems, recovery systems, aircraft health monitoring systems, situational awareness systems, GCA and ILS as systems which would reduce fatigue. Another issue brought out by all pilots was better living conditions at home and work. These included a reliable electrical supply, water supply, better quality furniture etc. It also included easier procurement of spares, flying clothing etc. A mention was also made of better administrative services by 100% respondents.

All the respondents placed a large emphasis on physical fitness. Most respondents considered themselves quite physically fit. On the other hand, the total time devoted to physical activity was only

3-4 h per week. Boredom as an important issue in long duration sorties was brought out by 100% of the respondents. Most pilots felt the need for boredom alleviation strategies. Nearly 60% of pilots use some sort a boredom alleviation strategy in the cockpit.

Discussion

Majority of pilots felt that four hours was too long a duration for a sortie to be called long duration. This is noteworthy, because it is different from world literature. For the F-16 the USAF has determined an 8-hour period as a long duration sortie [6]. On the other hand, the Jaguar is the only single seat aircraft involved in long-duration flying which does not have an autopilot. Another issue brought out by the respondents was about the difficulty of a particular sortie. It was brought out that while for a ferry sortie a 4 hour sortie may be quite comfortable, for a sortie with multiple aerial refuellings and combat situations even 2-3 hours is quite fatiguing. It has been established that disruption of circadian rhythm is much more fatiguing [7]. This finding was confirmed in the present study where a majority of the pilots felt that a night sortie of the same duration is more fatiguing. Another factor that may have contributed to this is that a night long duration sortie also involves night aerial refuelling, which is a tough exercise in itself, especially in the Jaguar.

The conjecture made above was substantiated by pilots who brought out universally that the fatigue would be reduced by introduction of an autopilot in the aircraft. The lack of autopilot also hampered other activities which are considered routine in other aircraft. Loosening the mask and eating an inflight meal is an uphill task without an autopilot, especially if the food is elaborate or messy. A majority of pilots agreed that they would be willing to compromise on taste and quality of rations provided

it was easy to eat. For this reason, most pilots preferred chocolates to a more substantial meal for sorties lasting for less than 4 hours. However, for sorties of a longer duration, they said they preferred different and more wholesome rations like a sandwich or 'parantha' roll. Despite this a large number of pilots asserted that they would prefer not to eat in the absence of an autopilot as it may be a flight safety hazard.

Pilots were questioned about their preferred method of in-flight urine disposal. Most pilots agreed that the adult diaper suggested by some authors [7] is not an appropriate method for urine disposal. Most respondents brought out that they had never used the diaper for in-flight urination. In the aircraft in question, the negative-G strap is a thick flat strap that presses on the crotch. Thus urination requires loosening of the QRB, which in the absence of an autopilot, is difficult if not impossible. The respondents felt that a better designed and comfortable cockpit, better seat, arm rests etc. would go a long way to reduce fatigue due to long duration flying. Again, reduction in cockpit workload using better displays, fail-safe systems, ground and air base navigational aids, GPS and ILS would reduce fatigue. It is noteworthy, that most modern aircraft tasked with long duration sorties have all these features.

Pilots brought out that adequate infra-structure facilities both at home and at work reduce fatigue and this is transferred to the cockpit. Thus, when the infrastructure is adequate long-duration sorties are tolerated better. All respondents emphasized the importance of physical fitness in combating the stresses of long duration flying. Most respondents also felt that they were adequately physically fit. Surprisingly, the average duration of time spent by pilots on physical fitness turned out to be only 3-4 hours per week. This indicates that though the pilots felt that they may be physically fit, their average

level of fitness could not have been high.

Boredom appears to be an important and hitherto un-addressed issue in long-duration flying. Most pilots felt that if long duration flying is to be the norm then active measures are required to be taken to alleviate boredom. It is interesting that our literature search did not indicate that any other Air Force is doing active research into boredom alleviation. 60% pilots mentioned that they use some strategy for boredom alleviation in the cockpit, like singing, talking to oneself, talking on R/T. There is, however, no teaching/discussion in the squadrons about how to alleviate boredom. In addition to the points brought out above, other factors contribute to the fatigue resulting from long duration flying. Thomas et al have concluded that eastward 'back of clock' flights induce much more fatigue than westward flights [8]. Gowron et al [9] have brought out the importance of a good night's rest prior to long haul operations for reducing the amount of fatigue. They advise at least 12 hours rest of which 7-8 hours must be spent in uninterrupted sleep. Pharmaceutical countermeasures have also been suggested by some authors [6].

Conclusion

Long duration flying poses various problems, which increase with increasing number of exercises and increase in duration. However, a large amount of problems and associated fatigue may result from the man-machine interface or the lack of it. The Jaguar being an older aircraft, these problems are more and varied. This study thus provides an insight into two areas. One is to be able to help reduce problems with long duration flying in the Jaguar aircraft. The second equally important idea is to help create a database of problems associated with various aspects of man-machine interface, which would help in future aircraft design.

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