Questionnaire Study

Heat Stress in Strike Aircraft : A Questionnaire Study

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Heat stress is an important problem in aviation, especially in a tropical country like India. The problem assumes large magnitude because of the cumbersome flying clothing worn, and operating temperature. This factor, coupled with absence of proper ventilation of the cockpit, raises temperature by several degrees above the ambient, especially from the time the pilot occupies the cockpit till he gets air borne. Though, modern aircraft provide for airconditioning of cockpit, this is ineffective during low level high speed flying, when pilots efficiency has to be at its peak, in the interest of operational performance and flight safety. A questionnaries survey was conducted to evaluate the heat stress in strike aircraft. The study was conducted at squdarons operating both the Jaguar and MiG 27 aircraft (sinch both operate in low level high speed environment). A total of 150 questionnaire were given out of which 111 were received. The data collected is presented and implications on flying performance discussed. Practical solutions are offered for consideration by the operational commander, to ensure optimum utilization of aircraft capability.

Keywords : Heat Stress, high speed low level flying, cockpit air-conditioning.

Heat stress is considered as one of the major problem in aviation specially in a tropical country like India. The problem assumes large magnitude because of the operating temperature which has been observed to rise to uncomfortable levels in cockpit of aircraft parked in sun in most of our operational bases. This factor, coupled with absence of proper ventilation in the cokpit, raises temperature by several degrees above the ambient. During summer operations, more so during low level high speed flying, the cockpit temperature of these high performance aircraft are likely to rise to a level which may compromise flight saftety. Though military aircraft have cabin conditioning systems designed to cater for different sortie profiles, they are often inadequate to meet the requirements of our country because of tropical climate.

In low level military flying, cockpit temperature can often reach to dangerously high level in hot climatic conditions[1,2]. The heat

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stress problem is more severe in high performance strike aircraft, when the climatic heat load is further increased by aircraft factors and the limited capacity of onboard cooling systems, thereby leading to higher cockpit temperature than that of ambient[1]. Also the effectivity of the air-conditioning system is seriously compromised in hot weather conditions, since ram air cooling is an essential part of the overall design requirement of such a system[3, 4].

Malse[5] in his study showed that heat stress was more in low level than medium level sorties, the average rise in mean skin temperature was 3.1 °C during low level sorties as compared to a rise of 2.7 °C during medium level sorties. Also the sweat loss was found to be to the tune of about 1% of body weight in majority of the sorties. Heat problem has also been studied in North - East India where the humidity levels are very high with moderate temperature levels. A considerable amount of heat accumulation has been seen to occur even before the pilot takes-off. Because of humid environment at ground level, recovery from heat stress is either impeded or delayed, limiting the aircrew tolerance further in subsequent sorties.

The strike aircraft has a low level role, hence the pilot flying these aircraft are most affected from heat stress. This problem aggravates because of the cumbersome flying clothing worn by the pilots during flying. Therefore, to analyse the effect of cabin conditioning in such sorties, a questionnaire study was carried out compairing the effect of heat stress on pilots flying the two strike aircraft.

Material and Methods

Assessment of heat stress in strike aircraft was done with the help of the questionnaire survey. The study included all the squadrons operating Jaguar and MiG-27 aircraft. Both of these aircraft operate in low level high speed environment. The questions were framed after extensive discussion with the aircrew and aviation medicine specialists and thus a pilot questionnaire was prepared which was then given to pilots who were not of strike fleet and the response analysed. A part of the final questionnaire prepared was despatched by post to squadrons, and the rest of the questionnaire were taken by hand to remaining squadrons. Out of the total 150 questionnaires, 111 were received back for analysis. 76 of these questionnaires were answered by MiG 27 pilot and 35 by Jaguar pilots.

The feedback so obtained was analysed separately for MiG 27 and Jaguar aircrafts and percentage calculated. The results obtained from both were further compared with each other and assessment of cockpit environment in terms of heat stress was carried out.

Results

The result of the questionnaire study pertaining to the magnitude of heat stress in MiG-27 and Jaguar aircrafts has been reflected in Table-1. A comprehensive information pertaining to the activity involved before commencement of sortie and the surroundings that may contribute to heat stress has been reflected in Table-2.

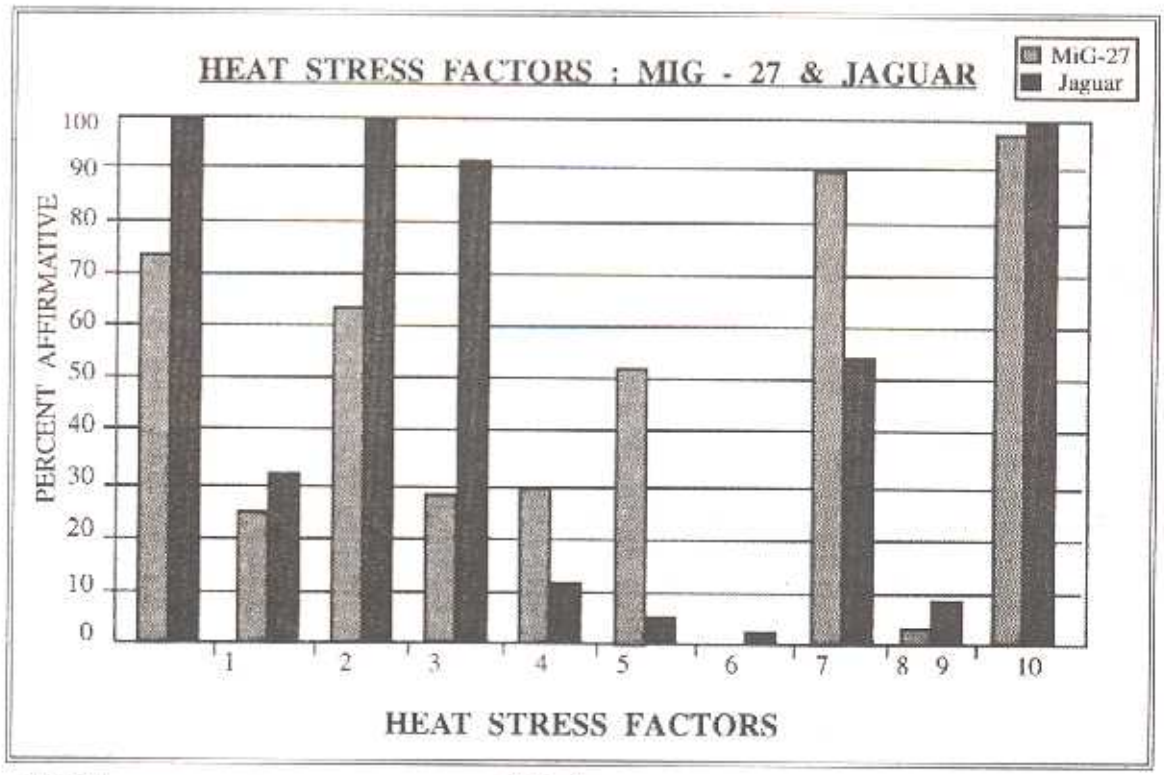
As shown in Table-1 & (fig 1) the heat stress was assessed as very high in low level high speed flying, specially in MiG-27 aircraft. The maximum heat stress was found to be due to delay in wheel roll after carrying out final checks at vital action point. This was mainly due to the delay in clearence given by ATC either due to bird activity or traffic. Second in the list of factors contributing to increase in heat stress was due to long time taken from prestart check to wheel

Table 1 : Pilot Response to Heat Stress MiG-27 & Jaguar Aircraft

Heat Stress Factors		Percent of Respondents			
		Affirmative		Negative	
		MiG-27	Jaguar	MiG-27	Jaguar
Pre-cooling		75	100	25	0
Transport provided		25	33	75	67
Canopy Open during taxying		62	100	38	0
Ventilation is Adequate during taxying of Ac		29	91	71	9
Heat Stress as a casuse to abandon sortie		30	12	70	88
Affects concentration in LL sortie		53	6	47	94
Switch off air-conditioner prior to landing		NA	3	NA	97
Flying overall drenched in sweat, after sortie		100	54	0	46
Trainer is more comforable		4	9	96	91
Maximum discomfort during afternoon		97	100	3	0
Heat stress on closing canopy	Comfortable	5	31	95	69
	Uncomfortable	74	66	26	34
	Extremely uncomfortable	21	3	79	97
Maximum discomfort in a LL sortie with respect to heat	Taxi-out	29	17	71	83
	Line-up point	47	63	53	37
	After landing	24	6	76	94
	No discomfort	0	14	100	86
Maximum discomfort due to Heat is felt in the form of	Irritability	18	11	82	89
	Lack of concentration	13	3	87	97
	Sweating	49	63	51	37
	Fatigue	20	23	80	77

Table 2 : Major causes of Heat stress MiG-27 & Jaguar Aircraft

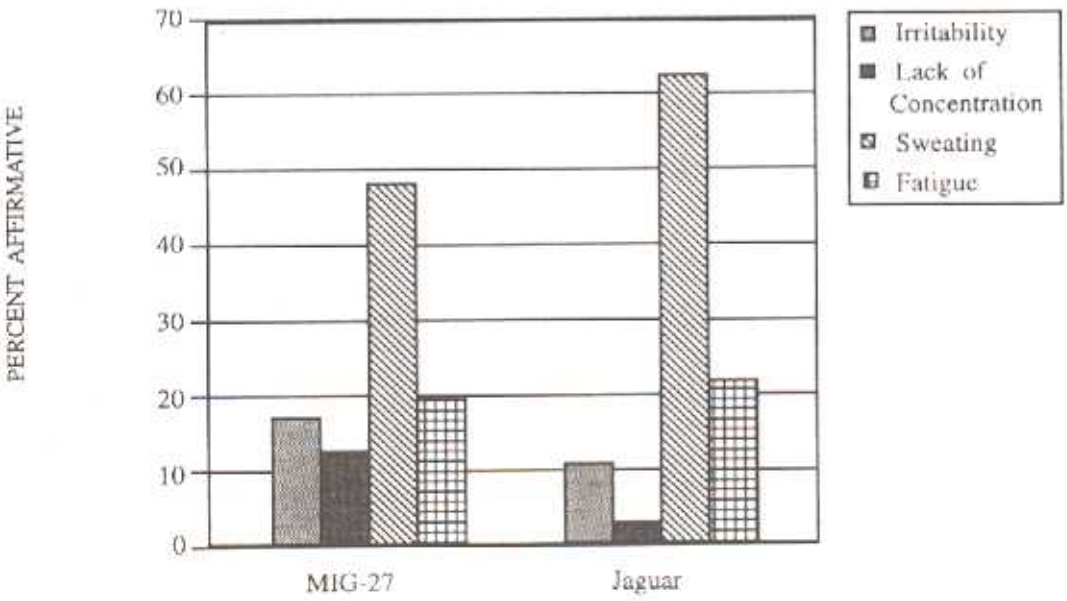
Heat stress factor	Duration (range in minutes)	
Flight preparation time	30-45	25-45
Time taken to reach the aircraft	8-10	5-15
Average time for start-up	5-10	10-15
Time for taxying to VA point	7-12	10-12
Time for VAPoint to wheels-roll	3-20	2-10
LL sortie	35-40	45-60
Cockpit cooling is effective after	8-20	2-10



Legend (Fig 1)

1. Pre-cooling 2. Transport Provided 3. Canopy Open During Taxying. 4. Ventilation Adequate During Taxying Ac. 5. Heat Stress as a Cause to Abandon Sortie. 6. Affects concentration in LL Sortie. 7. Switch Off Air-conditioner Prior to Landing. 8. Flying Overall Drenched in Sweat After Sortie. 9. Trainer is More Comfortable. 10. Maximum Discomfort During Afternoon.

MANIFESTATION OF HEAT STRESS



(Fig 2)

roll, which was significantly longer in MiG-27 pilots. Thirdly, the non-effetiveness of the air-conditioning system when performing low level high speed flying as it becomes effective only bove 2 Km attitude. This problem is aggravated during humid conditions which may finally result in fatigue.

Discussion

Aircrew often encounter significant heat stress during ground operations and high speed low level flying. Subjective assessement of heat stress in MiG-27 aircraft indicated significant heat stress whereas in Jaguar aircraft, it was relatively less. (Fig 2) This was mainly attributed to the air-conditioning system which is less effective in MiG-27 aircraft. 75% of MiG-27 pilots stated that use of Cockpit Air Cold-Auto Hot selector switch does not help in bringing down the cockpit temperature during high speed low level flying. Though, there is a provision of air-ventilated suit in MiG-27 aircraft, they are not being used now due to their non-availability (87%).

Ventilation inside the cockpit in MiG-27 was inadequate (71%) and adequate (91%) in Jaguar aircraft. Jaguar pilots routinely keep their canopy partially open (100%) while taxy-out, where as in MiG-27 it has been seen in only 62% of the cases.

As a result of inadequate ventilation, clothes are soaked with sweat, specially in MiG-27 aircraft,

which may affect the performance as the pilots find it difficult to concentrate on controls (53%) due to irritability and fatigue.

The study showed that only 75% of the briefing/ crew rooms were adequately air-conditioned. Air-conditioned crew rooms and rest rooms will help in quick recovery from the previous exposure and improve the aircrew combat readiness to a great extent in short time between the flights.

Conclusion

The problem of heat stress in fighter operations under high humidity and high temperature conditions is mainly encountered during low level flights and while taxy-out. Provision of an adequate ventilation and effectiveness of air-conditioning system from ground itself would be of immense help to the aircrew.

The findings of the study were subjectively obtained. An objective assessment required is to be carried out by mounting the heat stress monitor inside the cockpit.

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