Original Article

INFLIGHT THERMAL DATA RECORDING FROM IAF AIRCRAFT

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This paper presents a new method to procure the inflight thermal data from some of the IAF aircraft. In the past similar studies were attempted in various aircraft using conventional mercury/alcohol thermometers. In this study, a miniaturised digital heat stress monitor was used after suitable modification for its installation in different aircraft where inflight thermal data were manually noted down. The system was successfully employed in Chetak, Chitra, Kiran, Trishul trainer and Shamsher trainer. The results of the study, in general, indicated the maximum cabin temperature to be at the ground and this was found falling as soon as the aircraft was airborne except in Chetak where the cabin temperature showed continuous rise throughout the duration of sortie.

Key Words: Thermal Stress, Cockpit Thermal Data, Digital Heat Stress Monitor.

During summer operations, more so at low altitudes and high speeds, the cockpit temperatures of IAF aircraft are likely to rise to a level which may compromise flight safety. The levels of heat stress vary considerably from aircraft to aircraft, both on ground and inflight. Though military aircraft have cabin conditioning systems designed to meet the requirements of cabin thermal environment as per specifications (2,3, 6), they are often inadequate to meet the requirements of our country. In the past, inflight cockpit temperatures in military aircraft were being measured by conventional mercury/alcohol thermometers (1,7-9,11,12,17,18). These measurements had limitations of inadequate and cumbersome methodology for frequent and repetitive data collection during a short duration sortie. Therefore, this study was carried out at the Institute of Aviation Medicine, IAF to design and standardise a facility for more precise recording of inflight thermal data for subsequent use in actual field trials.

Materials and Methods

The WIBGET RSS-211 heat stress monitor (Reuter Stokes, Canada) was used in this study. RSS-211 is a portable battery operated electronic instrument used for measuring environmental factors contributing to human heat stress in many industrial environments. The sensor trident consists of wet bulb, dry bulb and globe temperature sensors. The original size of the monitor (15.5 x 11 x 9 cm) was found to be too large to be accommodated in the fighter aircraft. It was locally modified to the size of 18.5 x 11 x 3.8 cm.

This equipment is capable of very rapid determination of the dry bulb temperature (Tdb), natural (unaspirated) wet bulb temperature (Twb) and 6" Vernon globe temperature (TG). From these data, it also computes Wet Bulb Globe Temperature Index (WBGT) defined as follows:

WBGT (outdoors)

$$= 0.7\ \mathrm{Twb} + 0.2\ \mathrm{TG} + 0.1\ \mathrm{Tdb}.$$

WBGT (indoors)

$$= 0.7\ \mathrm{Twb} + 0.3\ \mathrm{TG}.$$

The measurement is on a four digit liquid crystal display. The instrument was located at suitable positions in the various aircraft cockpits. However, TG and WBGT could not be recorded from Chitra and Kiran aircraft due to equipment malfunction. In these instances the Tdb and Twb were noted down and Oxford Index (Twd) was calculated using the following formula:

$$\mathrm{Twd} = 0.15\ \mathrm{Tdb} + 0.85\ \mathrm{Twb}.$$

Results and Discussion

In a tropical country like India one can normally expect a fair amount of heat stress in the cockpit, especially during summer months and in low level high speed flying. Another important development of recent years is the increased usage of helicopters for military requirement. Battle experience gained by many advanced countries advocate having a strong helicopter force (12). Very high thermal loads of the order of 60 deg C (Tdb) were reported from helicopters (5,15). A proper and accurate inflight measurement will have a stable foundation for the proper development of the cabin conditioning of the military aircraft. Thermal conditions in aircraft cockpits are often far from ideal even in advanced countries, resulting in crew discomfort and varying degrees of physical disturbance (4,10,13,14,16,19,20).

To date only limited data are available on cockpit thermal conditions during flight (14). Air temperature is

Table I. Inflight thermal data (deg C) from Chetak Helicopter

Phase	Time	Tdb	Twb	TG	WBGT
Tarmac	0940	26.0	19.9	29.9	23.2
Start up	0945	26.0	20.0	30.4	22.1
Taxying	0950	23.9	18.8	26.2	21.1
Take off	0955	27.4	20.9	33.8	25.0
240 m	1000	26.0	17.3	34.2	22.4
	1005	28.2	17.9	37.6	23.9
	1010	25.5	19.5	32.0	23.5
	1015	27.7	20.7	37.5	25.7
	1020	28.3	20.7	37.4	25.7
Landing	1025	28.7	21.1	37.4	26.0
Switch off	1030	31.0	22.3	40.5	27.6

Table II. Inflight thermal data (deg C) from Chitra (HS-748)

Phase	Time	Tdb	Twb	Twd
Tarmac	0925	20.8	17.4	17.9
Cockpit	0925	21.8	17.6	18.2
Taxying	0937	23.9	19.3	20.0
Take off	0940	23.6	19.5	20.1
	0945	24.2	19.9	20.5
240 m	0950	23.9	19.3	20.0
300 m	0955	23.8	18.8	19.5
	1000	23.8	18.4	19.2
	1005	23.7	18.5	19.3
All electricals on	1010	23.7	18.3	19.1
	1015	23.6	18.1	18.9
	1025	26.1	19.4	20.4
Landing	1030	26.1	19.7	20.7
	1035	25.5	19.5	20.4

Table III. Inflight thermal data (deg C) from Kiran

Phase	Time	Tdb	Twb	Twd
Start up	1213	-	-	-
	1214	38.6	25.6	27.6
Taxying	1220	37.0	25.9	27.6
Take off	1225	39.5	26.3	28.3
	1230	33.6	19.4	21.5
45 m	1235	29.8	14.0	16.4
150 m	1240	27.8	13.3	15.5
	1245	25.6	10.6	12.9
	1250	23.4	8.8	11.0
	1255	22.5	9.4	11.4
Start climb	1300	21.2	8.7	10.6
	1305	22.0	7.1	9.4
	1310	20.3	6.3	8.4
3.0 Km	1315	20.7	9.1	10.8
1.8 Km	1320	22.5	13.3	14.7
1.2 Km	1325	22.1	15.3	16.3
	1330	24.8	18.6	19.5
Landing	1335	29.9	23.7	24.6
	1405	43.6	29.7	31.8
Switch off	1410	43.3	28.0	30.3

Table IV. Inflight thermal data (deg C) Trishul Trainer

Phase	Time	Tdb	Twb	TG	WBGT
Before start	1200	34.6	26.9	36.0	29.6
Take off	1208	34.0	26.6	35.2	29.1
45 m,760 kmph	1213	31.8	19.0	33.3	23.1
45 m,870 Kmph	1218	32.3	19.3	34.8	23.8
45 m,760 Kmph	1223	32.4	23.0	35.3	26.6
	1228	33.0	24.7	34.6	27.8
Landing	1230	-	-	-	-

the only thermal parameter which may be recorded during climatic testing of new aircraft but other physiologically critical values remain virtually unknown including humidity and radiant heat load (14). In this study a miniaturised digital monitor system was used after suitable modification for its installation in different aircraft of IAF. The modified system could be installed easily and safely in the aircraft chosen for the study. As there was no arrangement to record the data automatically, it was manually noted by the co-pilot in the trainer aircraft and by one of the authors for Chetak and Chitra. The data obtained are shown in Tables I to V.

Table V. Inflight thermal data (deg C) from Shamsher Trainer

Phase	Time	Tdb	Twb	TG	WBGT
Ground	1005	35.0	23.2	35.5	27.0
Taxying	1012	34.1	23.0	36.5	27.0
Taxying	1017	34.2	24.2	39.4	28.9
Taxying	1021	34.9	25.7	42.1	30.8
Take off	1023	-	-	-	-
150 m	1024	28.5	21.8	35.4	24.8
	1100	24.1	17.5	25.2	21.1
	1107	21.4	10.2	24.0	14.3
Landing	1111	-	-	-	-
	1114	25.3	17.0	28.5	20.6
Switch off	1116	27.4	19.2	31.5	22.9

The data obtained at Bangalore with this arrangement reveal that, except for the helicopters, the cabin temperatures fell as the aircraft took off and remained at this lower level all through the flight. In helicopters, the cabin temperatures tend to increase during the flight due to the absence of an effective cabin conditioning system.

An automatic recording system could have made the collection of desired data much more effective and simple. A better approach in this kind of situation is to measure the thermal stress and strain parameters simultaneously as done by Nunneley et al (14).

The study, having been conducted at Bangalore, may not be representative of actual thermal environment prevalent in most IAF bases. However, it has established that inflight thermal data can be recorded from aircraft using similar methodology. Reports are available on miniature units which can record both stress and strain parameters on a tape for subsequent computer analysis (14). This unit can be mounted on the pilot without interfering with his activities within the aircraft.

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