Aeromedical Acceptability of 'G' Loaded Visors

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Abstract

DETAILS of Aeromedical evaluation of a 'G' loaded visor specially developed for Ajeet aircraft are discussed in this paper. The evaluation included centrifuge trials to ensure that the visor does not drop at low 'G' values, ejection test rig trials for assessing the automatic tripping mechanism and high speed wind tunnel trial for measuring any lifting of the visor produced by the wind blast.

Introduction

During ejection from high speed aircraft wind blasts and wind drag decelerations can cause injuries eg :—

(i) laceration of skin. muscles etc ;
(ii) fluttering of eye lids and flailing of head;
(iii) rupture of ear drums and spinal cord;
(iv) tracheal, bronchial and pulmonary haemorrhages;

if the subjects are not properly protected. Deceleration values with an ejection seat giving frontal area of 5.0 sq. ft., for different speeds of ejection are given in fig. 1. It may be seen that with a speed of 650 knots, the drag could be as much as 35g, which is considered to be the limit of human tolerance for this type of force. However, the wind drag deceleration is a rapidly decaying force and acts only momentarily on the subject. Once the seat is separated from the aircraft, the speed of the seat decreases very fast under the high magnitude of wind drag, and so also the drag values. The decay pattern of the drag forces is given in fig. 2.

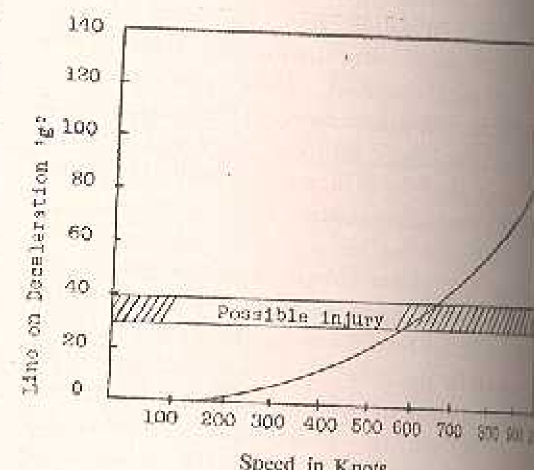

Fig. 1.

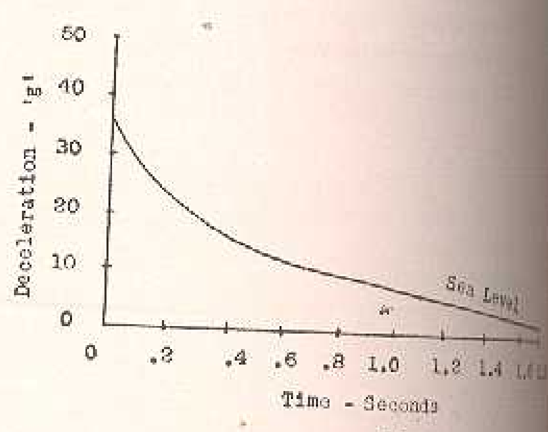

Fig.2.

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It is evident from fig. 2 that protection from wind blast is required during the first one second after ejection. In ejection seats, which are operated with face blind, such protection to the face is given by the blind. However, in ejection seats, which do not have face blinds protection to the face has to be given by the visor and mask.

Normally visors are fitted to the aircrew bone domes and are brought down in front of the eyes by using the visor knob whenever protection is required from glare or to cut down high illuminance. The visor is kept in the "Up" position in normal flying. The visor is brought down manually or automatically prior to ejection to obtain the required protection. However, dropping the visor manually will introduce a new task which, aircrew will have to undertake prior to ejection in an emergency. Time is a critical factor in ejections. Additional task such as manual operation of visor will cause loss of altitude particularly in aircraft with a large sink rate and can be critical in low altitude ejections. Most of the ejections which turned out to be fatal had been due to lack of sufficient altitude and time for the parachute to deploy fully. Introduction of additional task on the part of aircrew requires to be avoided if possible. It is for this purpose that a 'G' loaded visor which can automatically trip down during ejection was developed. The 'G' sensor unit of this visor gets activated by the high +Gz value developed during ejection.

G loading is done in such a way, that the visor does not drop down during normal flying and +Gz aerobatics and drops only at higher +Gz values. Since the normal values of +Gz in high G manoeuvres are of the order of 6 – 7g; G loading has to be done in such a way as to initiate lowering of the visor at 8g. This will ensure that the visor drops down as the seat rises on the guide rails and gets exposed to the slip stream. G loading at a higher value will lead to the tripping of the visor at a late stage in ejection and the face of the subject gets exposed to the wind blast.

Prototype of such helmets were specially developed for Ajeet aircrast with MBGF4 ejection seat and were subjected to aeromedical evaluation.

Aeromedical Evaluation

Three important aspects which require evaluation are the following :

(i) Centrifuge trials, to ensure that the visor does not drop for +Gz values less than 8.

(ii) Ejection test rig trials, to ensure that the visor drops, within a few inches of travel on the guide rails during ejection, and

(iii) Wind tunnel trials ensure that the visor does not get lifted up during wind blast upto 500 knots, E.A.S.

Centrifuge trials

Centrifuge runs were carried out with one such helmet using an anthropomorphic dummy. The helmet was firmly fixed on the head of dummy and the visor was kept in "up" position. Dummy was seated in the gondola of the centrifuge and was viewed on a closed circuit TV from the Control Room to observe tripping of the visor.

Centrifuge was run for different setting of peak 'G' values starting from '3g'. Details of the 'G' profiles for various runs are given in Table 1. From

TABLE I

Details of the 'G' profiles for various centrifuge runs

Sl. No.	Rate of onset/Sec.	Profile of Centrifuge Run: Peak 'g'	Duration	Rate of Decel/Sec.	REMARKS
1.	0.5g	3.0g	15secs	0.1g	These initial runs were to see if the mounting of the helmet on dummy head was secure enough.
2.	0.5g	6.0g	15secs	0.1g	
3.	1.0g	6.0g	5secs	0.5g	Non tripping of visor noticed.
4.	1.0g	8.0g	5secs	0.5g	Visor tripped before the peak 'G' was attained.
5.	1.0g	7.0g	5secs	0.5g	Visor tripped during the peak 'G'.
6.	2.0g	6.0g	5secs	0.5g	No tripping of visor.
7.	2.0g	7.0g	5secs	0.5g	Visor tripped during the peak 'G'.
8.	2.0g	8.0g	5secs	0.5g	Visor tripped just before the peak 'G' was attained.

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this table it can be seen that with both rates of onset (ie: 1g/sec; 2g/sec), the tripping of the visor occurred at a peak 'G' value of 7. There was no tripping of the visor before 7g and the visor tripped whenever 'G' exceeded 7.0. Inflight trails on the same helmet was carried out by ASTE in a number of sorties. No tripping was recorded during the flight, when the pilot pulled 'G' during aerobatics.

Ejection Test Rig Trials

For these trials, the ejection tower at ARDE Pune, with a height of 154 ft. was used. The helmet was firmly fixed on an anthropomorphic dummy and was harnessed into one ejection seat with R-type of Personal Survival Pack. Indigenous cartridges of HJT-16 were used for firing the seat-dummy combination.

One AS-100 accelerometer was fitted onto the hip of the dummy for measuring 'G' values. Velocity of the movement of the seat was obtained from velocity coils fixed at 6" gap to the guide rails. All these informations were recorded over a Honeywell U/V viscorder. The ejection of dummy-seat combination from the start was cine photographed with a movie camera having a speed of 64 frames/sec. For purposes of obtaining measurements from the cine photograph, bold markings were made for every 3" and 6" on the guide rails. Load bearing ratio of inertia loaded springs of the visor tripping mechanism was tested prior to ejection trials and is given in Table II.

TABLE II

Load bearing of inertia loaded spring

Load in Kg.	Deflection in mm.	Load bearing ratio mms/Kg
1.725	5.0	2.898
3.500	10.9	2.857
5.225	13.0	2.488

TABLE III

Details of Visor Dropping

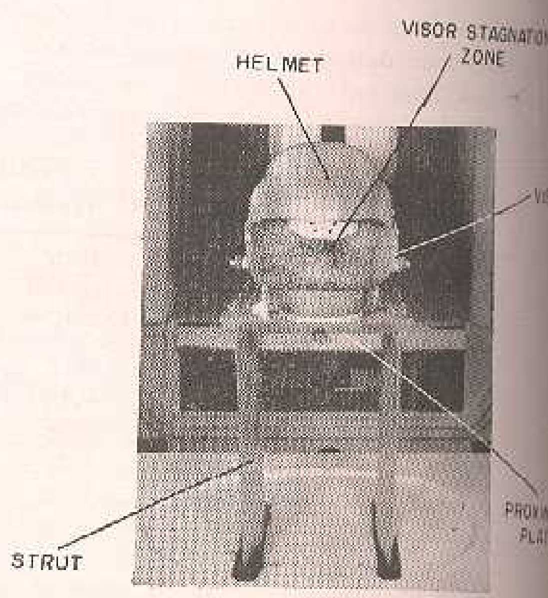
No.	Helmet marking	Travel of seat in inches before visor dropping was initiated	completed
1.	B	4	16
2.	B	3	14
3.	B	5	24
4.	E	4	20
5.	E	5	22
6.	E	3	22
7.	E	3	18

Cine film was analysed using a micro film r[illegible] and the initiation and completion of the [illegible] dropping was observed in relation to the travel of the seat upwards from its original position. The data is presented in Table III. It can be seen from the table that the visor dropping was initiated on an average, within 4" of travel of the seat and completed within 20".

Wind Tunnel Trials

Transonic wind tunnel of National Aeronautical Laboratory—Bangalore, was used to ensure that the visor does not get lifted upwards, under high wind blast conditions. The helmet was fixed to a suitable headform (developed by IAM for helmet testing trials) and secured by the chin strap.

The headform-helmet assembly was mounted in the 4' transonic wind tunnel and the mounting arrangement was as shown in the Photograph. The visor was kept "down" and wind speeds were built up to 450 knots. The helmet assembly was photographed during the wind velocity build up. The peak airflow was kept on for 4 seconds. Analysis of the photograph shows that there is no observable lifting of the visor due to wind blast.



Oil Flow Pattern on Visorland Helmet (View as seen from upstream of 4' wind tunnel)