Original Article

Analysis of fatal human error aircraft accidents in IAF

Wg Cdr BK Umesh Kumar1, Gp Capt H Malik+

ABSTRACT

Human error causes more than half of all aviation accidents. Records of all the fatal human error accidents available at Dte. of Flight Safety from 01 Apr 1996 to 01 May 2001 were analysed for various factors such as age of the Pilot, total flying hours, type of aircraft and rating of the Pilot. Human factors were analysed in detail for factors such as inexperience, breach of discipline and lack of situational awareness. Pilot error accounted for 68% of all fatal aircraft accidents followed by Technical defect 22.9%. Mig-21 is the commonest aircraft involved and accounted for 50% of all accidents. Nearly 50% of the aircrew were aged between 24 - 26 years with mean service flying hours of 900 hours and 200 hours on type with Ops/White instrument rating. Among the human factors, incorrect decision accounted for 48.6% of all accidents followed by lack of situational awareness (40%) and Poor Skills (36%). Weather accounts for 10% of all fatal aircraft accidents.

IJASM 2003; 47(1) : 30 - 36

KEY WORDS: Human Factors, Fatal Accidents

Human error causes of fatal aircraft accident constitute more than half of all aviation accidents. Man continues to be a weak link in the man machine dynamics of aviation. Advances made in the design and reliability of avionics has reduced technical system failure. Although there has been a significant improvement in the training of the aircrew to prevent human error accidents, human error continues to be a leading factor in most of the fatal aircraft accidents. Understanding and preventing human error in aircraft accident remains the foremost challenge in aviation safety. A review of 545 aircraft accidents in US Air Force revealed that 52% of these accidents were caused by human error [1]. In another study by Naval Safety Centre wherein 308 Cat A mishaps were studied, 178 (58%) were attributed to aircrew error. 47% of the accidents were attributed to the supervisory error, another form of human failure [2].

Material and Methods

Records of all the fatal aircraft accidents available with the Directorate of Flight Safety from 01 April 1996 to 01 May 2001 were analysed. Various factors analysed were :

(a) **Age of the pilot** : Age of the pilot till date of accident was noted to determine the most frequently involved age group in fatal aircraft accidents.

(b) **Flying hours of the Aircrew** : in terms of total service flying and flying hours on type were also noted.

1 SMO, 12FBSU, AF. C/O 56 APO + DMS (AM) AIR HQ (RKP

(c) **Rating of the pilot** : Rating and category of pilots were noted. In case of fighter pilots the instruments ratings are White, Green and Master green. In case of transport and Helicopters flying category is classified into D-White, C-White, C-Green, B-Green and A-Master Green. Instructor category classified into C, B, A2 and Al.

(d) **Last leave period** : Period of absence from flying was noted (in terms of months) since aircrew availed his last leave.

(e) **Past history of accident** : Past history of accident in terms of ejection, crash landings.

(f) **Visibility** : Visibility in Kms.

(g) **Terrain** : Operating terrain was noted to find out any cause / relation with accident.

(h) **Aircraft involved** : Type of aircraft involved in the accident.

(i) **Mission** : Type of mission to determine which type was most frequently involved in the aircraft accidents.

(j) **Time of flight** : Time of flight to find any relation of time with accident.

(k) **Ground Crew Errors** : Ground crew errors were classified into errors of ATC, Met personnel and radar personnel including servicing crew holding themselves directly or indirectly responsible for the accident.

(1) **Aircrew Errors** : Were analysed in depth under following heads [3] :-

(i) **Inexperience** : In terms of total flying hours, flying hours on type, type of mission and type of terrain.

(ii) **Habit interference** : Accidents due to the factors such as changing over from one aircraft to another.

(iii) **Breach of disciplines** : Violation of existing orders and instructions.

(iv) **Supervisory inadequacy** : In terms of failure to lead the mission lapses in the duties of supervisor.

(v) **Poor skill of flying** : As noticed by the COL

(vi) **Improper handling of controls** : Such as steep turns with high angle of attacks, rough handling of controls.

(vii) **Lack of situational awareness** : Lack of situational awareness was classified into three levels [4]. Level - 1 Failure to perceive the situation, Level - 2 Failure to comprehend the situation and Level - 3 Failure to project the situation into the future.

Results

Total number of Aircraft accidents from 01 April 96 to May 2001 was 48. The distribution of accidents depending on the type of Aircraft is given in Table-1.

Table - 1

MiG-21	24
MG-23	01
MG-27	05
MG-29	02
KIRAN	03
ISKARA	01
AN-32	01
AVRO	01
CHETAH	03
Mi-8	03
HPT-32	03
Mi-17	01

The causes of fatal aircraft accident has been divided into four categories namely human error aircrew [HE(A)], human error ground crew [HE(S)],

Technical defect [TD], bird hit and unresolved [UN]. Their distribution is as follows :

HE (A)	32
HE (S)	01
TD	11
UN	02
BIRD HIT	02

Age of the aircrew : Age varied from 23 years to 34 years with mean age of 28.5 years. 50% of the aircrew were in the age group of 24 - 26 years.

Total service flying varied from 63 hours in a U/T pilot flight cadet to 3150 hours in a helicopter pilot.

Rating of the pilot involved in the air crash is as given below.

U/T	01
OPS / UN RATED	09
OPS / White / D - White	13
Green / B-Green	07
A Master Green / Master Green	02

It is clearly seen from the above table that most frequently involved aircrew in terms of category are Ops White / D - White.

Last leave in correlation with fhe accident showed that 24 aircrew had taken leave beyond six months and 7 had availed leave less than six months.

Break in Flying Analysis showed that only 3 out of 32 had break in flying.

Past history of accident only one Aircrew had a past history of ejection.

Flying condition total number of aircrew on VMC and IMC was 26 and 6 respectively.

Visibility : On analysing the visibility of the area where the accident took place it was seen that in conditions where the visibility was more than 6 km there were 13 accidents, 4 - 6 km 15 accidents, 4 km in 3 accidents and in only one case visibility was less than 200 Mts.

Terrain : There were 14 accidents in desert terrain, 12 accidents in plains and 6 were in hilly terrain.

Type of mission : Were classified into various types such as Ground attack, Air attack. Tactical and Miscellaneous. Ground attack included all stories at Range, Valley attack, BAS. Air combat included PI, 2 VS 2, 1 Vs 1 and scramble. Tactics included medium level tactics, Low-level tactics and close formation. Lastly miscellaneous group included sorties such as aerobatics, ferry, A&E checks and IF (Instrument flying). It was seen that there was an almost an equal distribution of Aircraft accidents in all the categories. There were 9 ground attack sorties, 8 Air Combat sorties, 9 tactical sorties and 6 miscellaneous sorties.

Time	**No of Accidents**
0600-1100	13
1100-1600	17 (1300-1500-10)
1800-200	02

It was seen that nearly more than 50% of the accidents took place in the time zone between 1100 - 1600 hours. Out of this time zone 1300 - 1500 hours accounted for 10 fatal aircraft accidents.

Human errors were analysed in detail and the distribution of errors is as shown under :-

(a) Inexperience as contributory cause of accident was found in ten cases. Their distributions were as under :

(i)	Inexperience on aircraft	05
(ii)	Inexperience on type of mission	02
(iii)	Inexperience on Situation	02
(iv)	Inexperience on terrain	01

(b) Breaches of discipline were found in four aircrew. The type of breach of discipline were as under :

(i)	Deliberate low flying	01
(ii)	Not maintaining adequate distance during take off	01
(iii)	Not adhering to the SOP's	01

(c) Supervisory inadequacies included various factors such as :

(i)	Wrong R/T calls	02
(ii)	Incorrect manoeuvre by chase	02
(iii)	Assigning the task beyond the capabilities of pilots	03
(iv)	Improper briefing	01

(d) Poor skill was attributed in 12 fatal crashes. Type of poor skill was as under :

(i)	Mishandling of controls	06
(ii)	Flapless approach for landing	01
(iii)	Selection of wrong fuel mixture	01
(iv)	Negotiating a pull	04

(e) Fatigue was attributed in 03 cases. One of them was attributed to chronic fatigue and another two were attributed as acute fatigue.

(f) Not seeking help : This was seen in 03 cases. In 02 cases pilot did not seek help from the radar and in one case he did not seek the help of buddy.

(g) Incorrect decision : This was seen in 15 cases. Incorrect decision varied from getting into high angles of attack which was present in 6 cases and getting in to clouds was seen 2 cases. This was the major factor in human errors accounted for 48.6% of all the fatal aircraft accidents.

(h) Poor Airmanship was mainly seen as ignoring the Ground Proximity Warming Signals (GPWS), incorrect procedures and ignoring the radio altimeter warming. This was seen in 5 cases, which accounted for 15.6% of all the human error accidents.

(i) Lack of Situational awareness was attributed in 13 cases. Their distribution were as under :

SA Type 1	6
SAType 2	5
SA Type 3	2

(j) In three accidents failure of the Air traffic controller was attributed as major factor.

(k) Meteorology as a contributory cause of accident attributed in three cases wherein Met section failed to inform the development of Cumulus clouds after take off.

Discussion

Pilot error continues to be one of the major factors in fatal aircraft accidents. Data varies with various studies. In our study we found that pilot error in fatal aircraft accidents dominated the list with 68%. Technical defect accounted for 22.9% of fatal aircraft accidents. Percentage of unresolved fatal accidents was 4.16%.

MiG-21 contributed to 50% of all our fatal air crashes from April 1996 to May 2001. This is because MiG-21 is the backbone of Indian Air Force fighter flying. Every fighter pilot goes through the MiG-21 flying before they are converted to other types of fighter aircraft. The next common aircraft was MiG-27, which accounted for 10% of the total aircraft accidents. This could be because of the role assigned to MiG-27, which is basically a ground attack aircraft.

There have been two mid air collisions in a five-year span involving MiG-21 aircraft from the training Squadrons. This rate is high hence a special attention should be given to collision avoidance during training flights in the traffic pattern where midair collisions occur involving the instructional flights. Presently, avoidance of mid-air collision in VFR primarily depends on the pilots to see and avoid the aircraft. To prevent collisions in the traffic pattern, all the pilots should report their positions and intentions as they approach the airport and turn on to each leg.

On analysing the age of the aircrew involved in the fatal aircraft accident it is seen that nearly 50% of the aircrew belonged to the age group between 24-26 years. This is a "hot pants" carrier of aircrew, wherein aircrew can get into any bravery acts. This could be one of the reasons where in he may get into a situation because of his bravado and he may not able to get out of the situation later. This group needs to be watched carefully in the Squadrons.

When fatal aircraft accidents analysed with their total service flying and flying on type it was found that pilots on MiG-21 with 200 hours of flying, MiG-27 with 400 hours and a much higher hours of flying in helicopter and transport aircrew i.e. 595 and 1318 hours respectively. It was also seen that category of pilots with White instrument rating with fully ops was more frequently involved in the aircraft accident compared to any other category. This is similar to the study by Li G et al wherein decreased aircraft accidents with higher instrument rating [5]. Younger pilots with d/ops or non-ops are more rules bound and he would complete the mission if all the requirements were met. In case of fully ops / white rating pilot he may take the aircraft to extreme situation with his skill which may be limited. Helicopter / transport aircrew with vast flying experience when involved in fatal aircraft accidents, complacency could be one of the reasons.

Our study did not find any correlation between the type of mission and the accident. Incidence of aircraft accident was almost same in all types of mission.

Break in flying was found in only three pilots and in one it was found to be significant and contributory to the fatal aircraft accident. Presently IAF has a policy of re-inducting the aircrew into fighter flying after a long break i.e., two months for day flying and three months for night flying. Aircrew are given a dual check before he is re-flighted to fighters.

There was only one pilot with a past history of ejection. However there was no involvement of other aircrew in any type of accident/incident previously. This clearly rules out the possibility of empirical foundation such as accident proneness, which had become part of the tactical armamentarium used in blaming the victim for occupational injuries.

Time of accident played a vital role in our study. We found that nearly 60% of accidents occurred from 1100 - 1600 h and out of which 10 occurred during 1300 - 1500 h. It could be because of fatigue or because of low level of alertness. Another probable reason is hypoglycaemia, which is bound to occur during this period.

Pilots are not expected to be superhuman beings. Therefore it must be accepted that they will make mistakes. Some of these mistakes will have disastrous consequences. It will be prudent on the investigating agency to find out the gross violation of orders and procedures or where in pilot has exhibited poor airmanship, which has led to the accident. It is also true that the aircrew who commits mistakes can never be a repeater if it is a fatal crash.

Pilots actions do not take place in a vacuum but are shaped by many factors including policies, aircraft characteristics, presence of other pilots, contact with ATC and a great variety of other environmental determinants. It is also seen that in a similar situation one is able to come out of the situation compared to the other. Hence most of the human factor in pilot error is relative to the general error of pilot population.

Inexperience attributed as a factor of accident in nearly 20% of the fatal accidents. Our study percentage was similar to that of US Air Force in instructional flights wherein 28% of all the fatal aircraft accidents were attributed to inexperience. This can be improved by improvement in emergency perception / decision making. Other factors, which include are selection, training and improvements in the hardware both in terms of reliability and man machine compatibility [6].

Breaches of discipline accounted for 12.5% of aircraft accidents. Reasons for the violation of SOP's are not clearly established. It could be because of thrill of flying or 'one up manship'. One of the means by which this can be curbed is by serious punishments for those who violate existing orders or SOP's. This will be a hindrance to others, which will help in preventing further air crashes. Incorrect decision amounted for 48.6% of all fatal aircraft accidents. Study results are similar to that of Billings and Raynard WD [7]. This could also be because of inadequate stress coping as suggested by Alkov et al [8].

Supervisory inadequacies were seen 20% of the total fatal aircraft accidents. Major inadequacies included wrong R/T calls, not assessing the capabilities of the junior and incorrect manoeuvre by chase. In our study most often Flight commander was one of the supervisors. He has to handle so many variable jobs at the same time. It requires a separate study to assess the stress level of flight commanders and their chances of error / inadequacy during their tenure.

Over keenness was seen in one, wherein the pilot was keen to get the target while forgetting the flying parameters. This must be emphasised at all range sorties especially in young aviators to avoid accidents in future.

Poor skill of flying mainly exhibited by young aviators in which mishandling of controls accounted for nearly 50% of the poor skill. Other factors that included in the poor skill were selection of wrong fuel mixture, insufficient altitude during the mission. Major causes for exhibiting the poor skill are not practicing the emergencies, casual attitude and preoccupation with other things [9].

Nearly 10% fatal aircraft accidents have been attributed to fatigue as one of the major factor. It is long known that fatigue leads to aircraft accidents. In our study we found that long time fatigue in one case and short time fatigue in two cases as a causative factor for the accident.

Nearly 15% of Aircrew displayed poor airmanship qualities wherein they have ignored GPWS (Ground proximity warning systems) warning and Radio altimeter warning. Lack of situational awareness accounted for nearly 40% of all the fatal aircraft accidents. This was mainly due to failure to monitor the data or misperception of data. In two cases controller had lack of situational awareness and lead the aircrew from a normal situation into an accident. Misconception is another factor, which had lead to lack of situational awareness. Misunderstanding of information due to task saturation occurred in 4% compared to 2.3% of US study by Jones et al [4].

Weather accounted for nearly 10.6% of fatal aircraft accidents. In one case weather was below captains minima and in another development of CB was not informed to the aircrew.

Conclusion

This study gives an insight into the various factors associated with fatal aircraft accidents. Man continues to be a weak link in the man machine dynamics. However better selection, training and good supervision will definitely reduce/ avoid pilot's errors to the minimum. This study provides valuable data in understanding the aetiology of pilot error and formulating the prevention strategies. It also provides evidence that pilot error is not merely a function of human nature rather it is determined by both exogenous and endogenous variables which are at times predictable. Environmental stresses that increase performance demand often play an important role in the causation of pilot error and fatal aircraft accident.

To minimise pilot error, enhancing performance ability through safety training may be beneficial but has its limits. Developing and applying technologies that reduce pilot performance in dangerous situations appear to be more effective.

"A typical fatal accident prone aircrew can be described as Pilot aged between 24 to 26 with Ops / White category on a MiG-21 with nearly 200 hours of flying on type, flying between 1100 hours to 1600 hours, committing mistakes either in the form of mishandling of controls or exhibiting poor skills with lack of situational awareness".

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