Analysis of Fire Accidents in Airports and Its Mitigation Measures

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***Abstract:* - Among all the types of accidents at airport, Fires and explosions were, and continue to be, the greatest threats to the safety of personnel and the survivability of all aircrafts both in peacetime and during combat operations. In this paper we have discussed about the statistics of fire accidents, the causes of these accidents and also the existing fire prevention facilities or technologies available at every airports. Wehave also done case study on major fire accidents at airports and aircrafts. After a detailed analysis of the case study, we have discussed about few of our ideas in improving the fire prevention and safety in airports and for aircrafts that can be done by the government for the safety of all the passengers, the airport staffs and aircraft crew**.

I. INTRODUCTION

Fig 1

The efficient management of the facilities that exist on and around an airport's airfield is important to the safety and effectiveness of aircraft operations. Airport operations management symbolizes many of the defining issues concerning airport planners and managers. Common airside hazards faced are because of vehicles in the apron region, pedestrians, weather changes, dangerous goods, foreign object debris, runway incursions and fuel spillage. Most of these hazards faced leads to fire accidents, which has been the major cause of fatal deaths. Those issues have been addressed by FAA in Federal Aviation Regulations (FAR) Part 139. In order to prevent these accidents Aircraft rescue and fire fighting (ARFF) operations were undertaken by FAR Part 139.ARFF is a special type of firefighting that involves the response, evacuation, hazard mitigation and possible rescue of aircraft's passengers and crew involved in an airport ground emergency. The main objective is "to save lives in the event of an aircraft accident or incident". The ARFFs will act to all aircraft emergencies within the airport's boundaries and will also act to some 'off airport' incidents within a certain distance from the airport. The local authority fire and rescue service are responsible for all incidents that occur outside of the airport.

II. CURRENT STATUS

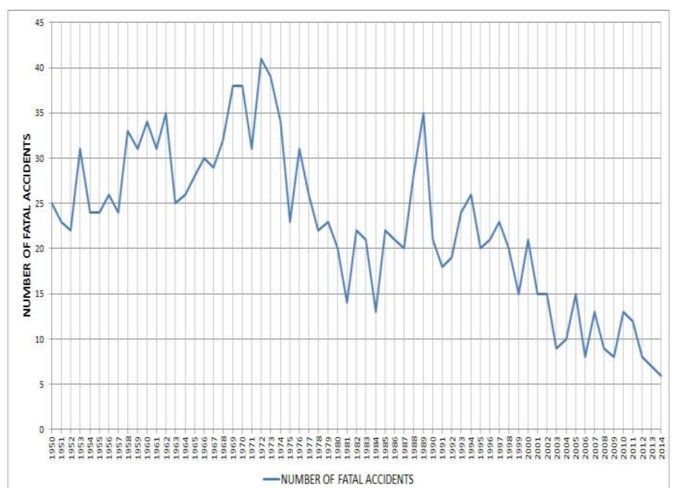

Fig 2. Number of fatal accidents in the world

Comparatively the accidents rate has been reduced but majority of the accidents that are taking place are fire accidents.

America is the worst affected country in the world for fatal airline disasters, according to data from the Aviation Safety Network, closely followed by Russia, Brazil and Canada in Fig 3. Compiled in a graphic by statistics portal and the data charts the geographical regions with the maximal number of fatal civil airplane accidents from 1945 to the present day. It does not include data from military accidents, corporate jets, hijackings or other criminal occurrences.

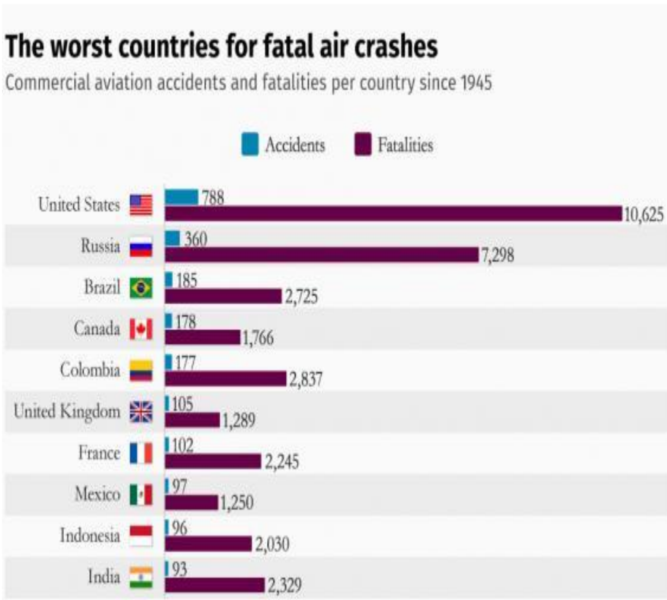

Fig 3. The regions showing the maximal number of fatal civil airplane accidents from 1945 until now

America has proven to be the country with the worst record, with a total of 10,625 fatalities recorded in 788 accidents over the past 70 years. The United Kingdom has had the highest number of fatal civil aviation accidents in Europe, recorded at 105, with a total of 1,289 fatalities, making it the sixth worst region in the world. Outside of the worst 10 countries China, Peru, Bolivia, Germany and Spain were all recognized as regions with high numbers of aviation accidents and fatalities.

III. TYPES OF FIRE

Solid Fires: Solid fires are fires that are caused by burning of rags or woods, fabric, soft elastic materials and they are best blown out by water or glycol extinguishers which will cool the fuel.

Liquid Fires: Liquid fire are fires caused by burning of petroleum based fires are best blown out by repressing agents such as dry powder, Carbon dioxide, BCF and Foam. Water extinguishers should not be used.

Gas Fires: Gas fires are fires that can be put offby repressing agents such as Carbon dioxide, BCF or Fire Blanket.

Metal Fires: Metal fires are fires that are difficult to put off. They can be extinguishedbyattacking the fire with BCF and then by using specialized Gel agents that cools the fire.For example, Batteries.

IV. EXISTING SAFETY MEASURES

Fig. 4

- Airport terminal building (ATS) installation and Airport Hanger are classified under Business-cum-Assembly and storage & hazardous, based on the classification of building and hence are required to comply with proper fire prevention and fire protection, confirming to high hazard occupancy as per National Building Code (NBC) and also as per National Fire Protection Association (NFPA).
- Airport Fire Service have also become binding on safety of occupants and avoidance of fire risks to equipments, building and vital installations, hence the design of fire protection and fighting system from planning stage to installation work to be approved from Directorate of Fire Service and also testing of fire prevention and protection equipment and stage wise inspection to be carried out by this Directorate.
- The direct losses can be safeguarded by way of insurance; the indirect losses which are normally in multiples of direct losses can be reduced only if proper fire protection is provided as it is always easy to knock-down fire at initial stage than wait for fire brigade.
- Besides above in view of increasing fire incidents in Terminal buildings, Technical /ATS buildings and other vital installations the nature of fire likely to be encountered in this type of multifunctional occupancy and ongoing public awareness, it is imperative to evolve a suitable yardstick and standard of fire protection.
- Since all airports have almost identical unit with identical surface functions barring a few, it was felt necessary to evolve a uniform scale of fire prevention and fire protection.
- Building fire protection systems have been categorized into Active measures and Passive measures. Active measures involved the control of smoke spread, detection and alarm that informs the

occurrence of a fire and triggers sort of counteraction towards fire extinguishment and Passive measures are concerned with building structure integrity, compartmentation. Passive fire protection measures are proactive approach taken at building design stage.

V. INVESTIGATION PROCEDURE

Many instrumentsare utilized to investigate incidents. An initial assessment helps to figure the type of examination needs for investigation of the case. Regardless of the event, an institution can employ a preplanned event investigation plan. The individual organization gets to decide the most appropriate method was for their organization.

Some of the instruments designed to examine ramp, maintenance and flight operations incidents are Maintenance Error Decision Aid (MEDA), the Ramp Error Decision Aid (REDA) and the Procedural Event Analysis Tool (PEAT). These instruments can be suitable for any operational requirements. Regardless of the procedure, a rigorous, repeatable technique is needed for effective investigations.

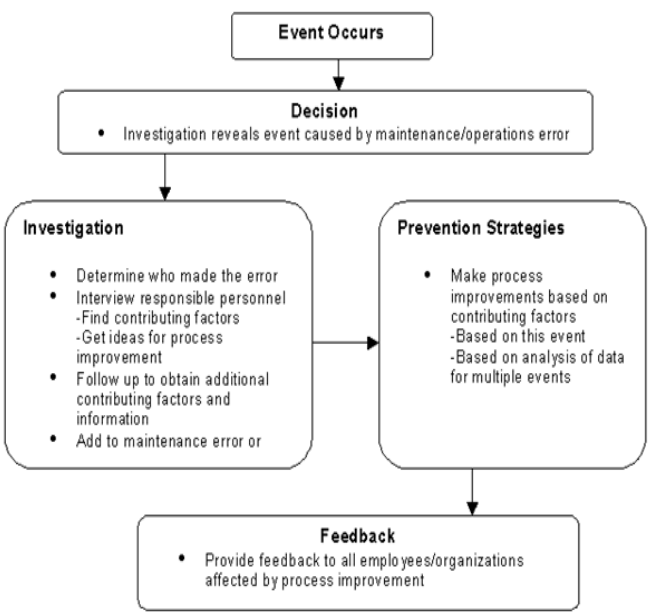

Fig 5. Procedure flow chart

Boeing developed MEDA, REDA and PEAT to approach the human performance aspects that must be considered during an event examination. PEAT focuses on the important incident elements and figures the factors that bestowed to the procedural deviation. The aimof the investigation procedure is to help the examiner at putting an end to the happening of similar types of procedural change. MEDA looks for the aspects that can lead to human error such as bad communication, insufficient information and low lighting. While REDA is a well planned investigation process to determine the aspects that bestowed to error made by groundoperation personnel such as baggage handlers and aircraft servicing crew.MEDA, REDA and PEAT employs investigative procedures that look for the aspects that originally contributed to the error, rather than blaming someone.

VI. CASE STUDY

A selection of accidents caused due to fire is listed to understand about each type of fire.

1. Fumes without fire

Event:

AIRBUS A-319 operated from Liverpool to grove on 6 January 2011 encountered a sudden onset of cabin air contamination. A smoke-like appeared as the aircraft cleared the runway at destination and it started to grow thicker. One of the 52 passengers acquired a minor injury during the evacuation process. Luckily the aircraft was undamaged.

Fig 6

Cause:

Faults were not found in the aircrafts air conditioning systems. The cabin environment was consistent with higher levels of potassium acetate which was found on the seat headrest. Potassium acetate and urea based de-icing products were applied on the runway and taxiway which was found to be the source of the fumes. This de-icing chemical seems to have ingested into the engine, before entering the cabin though the overhead vents. Smoke was produced due to two factors. First, it was probably due to more de-icing product on this taxiway than on other parts. Secondly, it was probably due to the continuous use of reverse thrust which increased the volume of the chemical which increased the smoke density.

Coincidence was found with the use of reverse thrust on the taxiway.

Action taken:

Actions were taken by the Operator to enhance pilot training in the use of reverse thrust and to track use of reverse thrust. The cabin crew was briefed with new instructions to enhance their response to emergencies

2. Fire due to dangerous goods

Event:

Airbus A330-300 which was operated by Philippine Airlines arrived at Manila after which an ECAM Warning was announced because of smoke emission from aft of cargo.It was later confirmed by the crew to be fire. The Aircraft rescue and fire fighting team extinguished the fire. The aft hold was damaged as a result of the fire.

Fig 7

Cause:

Containers containing permanganate and glycerin were found in luggage of one of the passengers. The fire was caused when this dangerous substance spilled from the container, which damaged the aft portion of the cargo. First of all, these dangerous goods were not properly covered by the officials at the aircraft. Secondly, upon indication of smoke warning, the pilot failed to immediately execute Level 3 procedure. Level 3 procedure is to call out for help from airport fire fighting team.

Action taken:

Implementation improvised security checks for inspection of the cargoes and baggage of the passengers in all the airports. Simulator training with scenario of fire in any part of the aircraft at any point during the flight procedures was implemented for airline pilots by the aircrew and was updated in the syllabus for training process.

3. Fire after crash

Event:

Airbus A330-200 was operated by Libyan airline on 12 May 2010 from Johannesburg to Tripoli. The IMC failed to obtain the required visual reference to land and made a non precision approach to runway. The aircraft crashed short of the intended landing runway outside the aerodrome and was completely destroyed by the impact caused and caught fire with all but one of the 104 passengers being killed.

Fig 8

Cause:

In the final approach segment, the weather report that the crew had did not match with the actual weather situation at Tripoli International Airport. Because of poor visibility, they couldn't get the ground clearance. The lack of common action plan and inappropriate use of flight control inputs continued below MDA led to the crash of the aircraft.

Action taken:

ATC was made to report about the abnormal occurrences associated with the operation of aircraft to Civil Aviation Authority. Orders were passed to ensure that the National Meteorological Centre upgrades weather services as well as meteorological warning and were instructed to issue the change in weather time to time. Training courses were emphasized on emergency procedures accounting to somatogravic illusion.

4. Overheating of landing gear

Event:

Boeing 767-300operated from Copenhagen to Tokyo on 24 August 1999 faced problems because of the overheated brakes and the aircraft was unable to get airborne from the take-off roll on runway. It made a rejected take off from high speed. Thisleft the aircraft's landing gear and rear fuselage being damaged.

Fig 9

Causes

For the first officer this flight was the first for which he set up FMS. When the weight has to be entered on the load sheets, the first officer entered ZFW into the ACARS in the space where the Actual Take-off Weight has to be entered. The data has been computed and the computed take-off speed has been displayed on the flight instruments. None of the flight crew actually checked the take-off data. The wrong value of relative speed made the aircraft rotate at too low a speed.

Action taken

After thorough investigation 3 safety recommendations were made by Danish Civil Aviation Administration.

- The flight performance data and flight planning data must be estimated by the commander.
- Make sure that the layout of flight data reduces the possibility of mistakes.
- When approving operators FOM, make sure itcomplies with ICAO Standard 6.3.10.

5. Fluid contamination

Event

Airbus A320-200 was operated by Wizz Air Hungary from Stockholm Vasteras to Poznan on 2 March 2009.The flight crew members found an unknown smell on the flight deck and the passenger cabin. They protect themselves by wearing their oxygen masks from time to time throughout the flight. All the 85 passengers were saved.

Fig 10

Causes

There was a heavy snowfall at Vasteras prior to departure. So it was treated with hot water and then was cured with anti-icing fluid. Due to the wrong usage of the fluid some of the fluid entered the APU that resulted in the contamination of breathing air.

Action taken

Orders have been made to ensure that the transport agency, acquainted with airport operational checks, has to confirm that there is an agreement between the purchaser and the supplier of de-icing services in accordance with EU-OPS 1.

6. Fire due to electrical origin

Event

Airbus A380-800 was operated by Singapore Airlines from Hong Kong to Singapore on 31 January 2011, suddenly there was a loud noise and signs of possible fire accompanied by a and also corresponding ECAM Smoke alert in one of the toilet compartments. A fire extinguisher was discharged and the location is carefully monitored. There were no further signs of combustion and the flight to destination was completed.

Causes

It was shown by the non-volatile memory (NVM) that the negative main excitation wire had been damaged by electrical arcing. The damage was the consequences of exposure of to a high voltage over a long period due to excessive current flow through the wire.

Fig 11

Action taken

The design of the lightening protection system is reviewed by the Airbus to prevent the short circuiting. Fire detection and suppression is installed in the vicinity of the feeder terminal block.

7. Fire due to fuel leakage

Event

Boeing 767-300 (CN-RNT) was operated by Royal Air Maroc from Casablanca to Montreal.They discovered a burning odor from the passenger cabin after reaching Montreal. After landing, the crew had declared that the smokes origin was due to fire in equipments close to the aircraft andan emergency evacuation was enacted.

Causes

There was a fuel leakage from the loader engine compartment, positioned near the aircraft aft left cargo door, which caused the fire. The fuel leakage was caused by the disconnection of connecter between the fuel line and the inlet of the filter regulator. Within a short period, the smoke reached the aircraft cabin that caused the burning smell that filled the aircraft. This happened because the aft cargo door was already open that allowed the thick black smoke to enter the underfloor hold and spread into the passenger cabin.

Fig 12

Action taken

The fuel systems of all the belt loaders are inspected and an emergency stop switch was installed. The maintenance program checklist was also amended for the whole belt loader model to include a specific inspection of the filter regulator and related lines, connectors and fixing rings.

VII. MITIGATION MEASURES

1. *Enhancing rescue and emergency services systems*

The rescue and emergency service systems were improved by the government by providing closer cooperation relations between concerning organizations to deal instantly and efficiently with air distress incidents and other aircraft accidents.

Improvement of search and rescue systems

The Rescue Co-ordination Center shouldwork to improvise planning of activities, training, and collecting information and processing systems, to cast complete and efficient search and rescue proceedings when aircrafts are found distressed or disappeared. It also improves communication and collaboration by improving the performance of facilities.

Fig 13

Improvement of Fire-fighting and emergency medical systems

- Improvisation of fire-fighting systems at Class 1(International routes) and Class 2(domestic routes) Airports in accordance with relevant international standards, by providing chemical fire engines as per requirement.

- Guidance of airport managers of Class 1, Class 2 and Class 3(local air transport) airports to improve fire-fighting facilities.
- To provide appropriate medical facilities according to annual plans. So, they improved the collaboration with proper medical institutions to conduct emergency medical procedures effectively and efficiently.
- To provide sufficient fire-fighting and emergency systems in areas close to airports, to instruct with proper fire-fighting equipments and to improvise the facilities.
- Ensure that the first aid treatment is directly delivered when needed and also to ensure that the first aid seminars are being attended by airport officers.

2. Encouragement of victim support by government

Victims who suffered losses were provided with support activities by the government. They were supported by victim support organizations run by both private and public institutions. Not only them but also hospitals, police and common people were ensured to support them in the event of huge accidents.

VIII. CONCLUSION

Fire in airports and aircrafts can happen anytime or anywhere and only preparation will allow us to successfully handle the situations. So it's very important to have effective fire prevention facilities at the airports and also in the aircrafts. Every airport must have Aircraft Rescue and Fire Fighting (ARFF) who are trained well and provided with all equipments. Responders' faces many problems because of aircraft fire accidents.Buttraining is the best key for all the claims regarding fire service.

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