FLIGHT DATA INVESTIGATION AND ANALYSIS

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I am an Aerospace Engineer. My current role at Serene Air is to manage the SMS Program of the airline that includes areas related to ground handling, cargo, catering, ramp operations and engineering elements. I am also the Flight Data Analyst where I am looking after the Flight Data Monitoring of Boeing 737-800NG and Airbus A330-200. My area of responsibility also includes analyzing the flight data, and formulate safety performance indicators and safety performance targets. I spent 23 years in Pakistan Air Force as an Aircraft Maintenance Engineer, Aircraft Accident Investigator and Aviation Safety Trainer.

Some of the major courses that I have done include Aircraft Accident Investigation Management ***(Singapore Aviation Academy)****, Safety Management System, ISO 9001:2015 QMS Lead Auditor, Quality Assurance and Management, Human Factor in Aviation Safety, Risk Management in Military Environment* ***(Canada),*** *Aircraft Technical Investigation and Project Management.*

I have done Masters of Business Administration (MBA) in Aviation Management, Master in Science (MS) in War Studies, Post Graduate Diploma in Maintenance Safety Management and Bachelors of Engineering (BE) in Aerospace.

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Flight Data Management

Flight data management is a key player in effectively managing routine flight operations under the ambit of safe operations. It is a highly effective tool that provides valuable piece of information to safety mangers in maintaining a useful database, which helps in drawing a better picture for safe flight operations. Mandatory implementation of Flight Operations Quality Assurance Program (FOQA) is the outcome of the grey areas in operations that could not be proactively arrested on time, and led to some serious incidents / accidents in the past.

Flight data investigation and analysis cannot be done without a reliable database of recorded events. Fight Data Monitoring Program (FDM) is therefore, an essential part of FOQA. In general, they both are synonymous to each other in present day flight operations. With the advancement in technology over a period of time, FDM has now matured with extended list of recorded flight parameters, and proven to be a highly effective tool for the Safety Managers. Investigation of data and its critical analysis is a tested proactive measure that can prevent events leading to serious incidents / accidents; a highly effective Safety Approach. It works really well for the operators who run a dedicated FOQA Program.

FOQA Program works on the principle of a proactive approach through regular flight data monitoring. In order to run flight operations on a Proactive Approach Model, monitoring of flight data is extremely important. This is the first phase of the process. The second, yet difficult part of the process is to analyze the collected data and then extracting useful information out of it. This piece of useful information actually helps in arresting the red flags residing in the collected data. Implementation of corrective actions is the third phase of the process. Interestingly, FDM is not limited to the operations, it has equal utility to manage engine performance. That makes it a way stronger and effective tool in managing, both operational and engineering elements for an operator.

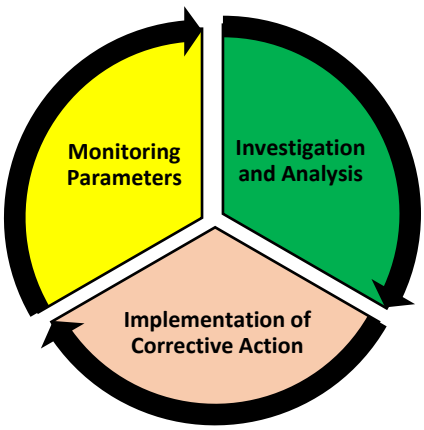


Figure 1: Flight Data Management Process

Exceedance

An exceedance is an event that shows a particular parameter going below or beyond the defined limits (i.e. min or max); assigned to each flight parameter in the FDM Software. Multiple events of similar nature lead to a particular trend. As a Flight Data Analyst, it is all the more important to maintain a strong monitoring of excedence(s) recorded during each flight. Generally, maintaining monthly frequency of flight data collection, is an effective way of monitoring and arresting the deviances (excedences).

Tricky Part of the Game

Now, comes the tricky part of the game. Interestingly, many operators (commercial, charter, government) are in possession of the Flight Data Monitoring (FDM) System. Unfortunately, the program is not implemented in the same manner as it is designed for. Some of the commercial operators are ticking the box which means they are using the program just for the sake of using. Most of them, especially the small fleet operators have fear of operation closure by the regulators. They get into hot waters during the annual audits since their database is not being managed methodically. With the data in tits and bits, they manage to sail though the audits but with multiple objections. These objections, if not being satisfied by the regulators over a certain period of time ultimately lead to operations on hold temporarily and sometimes, for good as well.

Although commercial aviation is about reaping the profits but smaller fleets try to bend the corners when it comes to earn some extra bucks. For that matter, they at times tend to overlook the trends intentionally (company culture), and sometimes fail to manage it effectively. Both conditions are unsafe in one way or another. In short terms, it’s a certainly good bargain but in the longer run, they are paying much more than saving. How?

The maintenance cost incurring on the fleet due to overlooking these critical trends are quite high, and if we talk about serious operational / technical incidents, it goes much higher than anticipated. Even so, to the extent that the airlines have to shut down their businesses. A very common experience, witnessed in case of operators with limited fleet size. But that doesn’t give leverage to the larger operators either. Increased downtime due to operational / maintenance issues or serious incidents do affect rapport of big operators. Moreover, the losses in terms of financial aspects are also very high. Flight Data Monitoring is a critical element of SMS that provides actionable information to the airlines. Operators need to implement SMS in a manner where it supports the sustainability of operations 24/7. It is not a onetime activity, but it is a continuous cycle where FDM Program warrants constant vigilance. Regulators also have a major role to play in maintaining an effective oversight of the operators’ FDM Programs. Though, it should never be aimed to work with a punitive perspective, but for correction purposes only, as covered in the SMS Manual (Document 9859).

Practical Drift

Managing a FDM Program to its true potential to control deviances is all the more important for an operator. The concept of practical drift in SMS Manual (Document 9859) outlines the reasons for the gap between projected outputs versus real time outputs. By virtue of an integrated system, unbalanced functional performance indexes among the departments lead to this drift. The aim of an implemented SMS Program should be able to keep the system work with minimum drift factor. Flight Data Monitoring backed up with investigation and analysis is a critical operational factor in this integrated working environment, and it has a fair contribution in increasing / decreasing the gap between the projected and real time outputs of safety performance.

Runway Excursions

Talking in terms of runway excursions, **'Unstable Approaches'** is one of the leading causes of runway excursions. The root cause for its recurrence around the globe every day is due to a non-serious attitude of operators towards flight data investigations and analysis. Training refreshers, if done on a serious note, follows after the flight data investigation and analysis. Problems occur due to a possible lapse on the FDM Program or ineffective Training refreshers or it could be a combination of both. Timely arrest of a problematic area observed during FDM can actually help the operators to contain futuristic operational risks.

Using Scaled Analytics as a tool for FDM, loads of information (significant / insignificant) is collected during the data collection process. As a reference for understanding the issue in hand, some of the most commonly identified root causes for runway incursions (based upon random occurrences) are mentioned below with a pictorial representation.

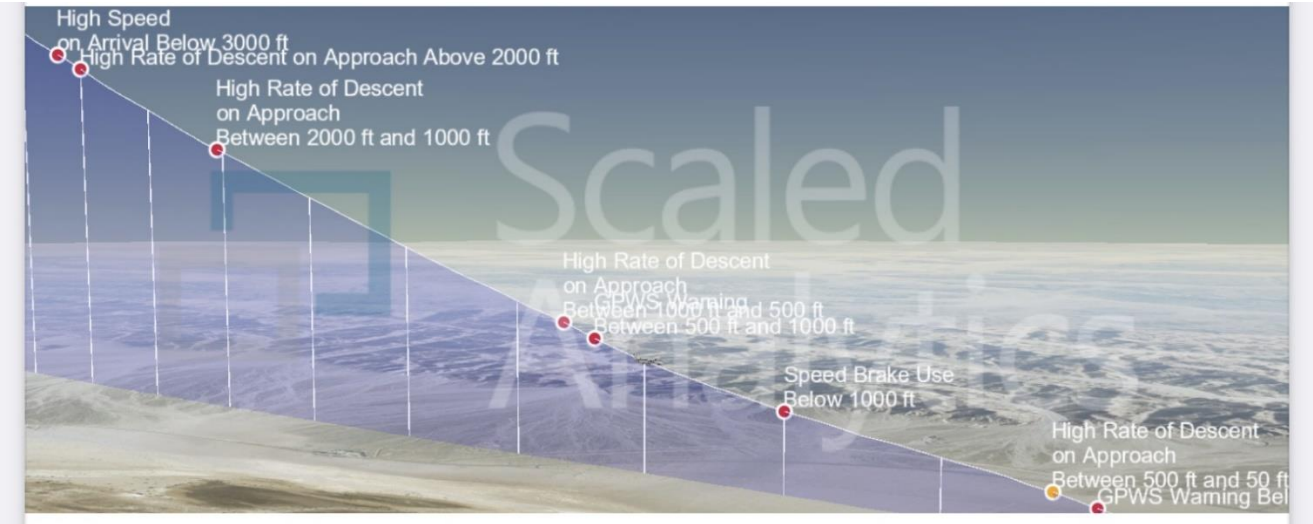


Figure 2: Most Commonly Identified Events of Unstable Approach Leading to Runway Excursions

- High speed on arrival below 3000 feet
- High rate of descent on approach above 2000 feet
- High rate of descent on approach between 2000 feet and 1000 feet
- High rate of descent on approach between 1000 feet and 500 feet
- GPWS Warning between 1000 feet and 500 feet
- Speed brake use below 1000 feet
- High rate of descent on approach between 500 feet and 50 feet

Case Study

A case study based upon an operator (not being named) using FDM Program, yet giving no serious attention to the excedence trends over a period of time faced similar nature of situation. One of the aircraft of its small fleet underwent runway excursion which incurred serious damages to its landing gears and both engines. It actually cost the airline a fortune. So much to the extent that airline had to shut down its operations after this major accident. But there is another side of the story that relates to the seriousness of operator's engagement with its FDM Program. Had this operator been investigating and analyzing the red flags during the data collection process, things would not have turned out that ugly.

Investigation Details

Prior to this runway excursion, the data above shows five critical yet highest recurring events recorded on different aircraft of the operator. The blue, yellow and red lines correspond to low, medium and high severity events. To be more pragmatic, they can also be referred to as Alert Level 1, Alert Level 2 and Alert Level 3. From the perspective of flight data investigation and analysis, all alert levels are equally important to be monitored. However, the red or Alert Level 3 is the most critical. Depending upon recurrence of a particular event viz a viz calculated alert level values, appropriate risk controls can be applied through multiple ways of intervention. Severity of alert levels make it easier to focus on a specific event / parameter critically.

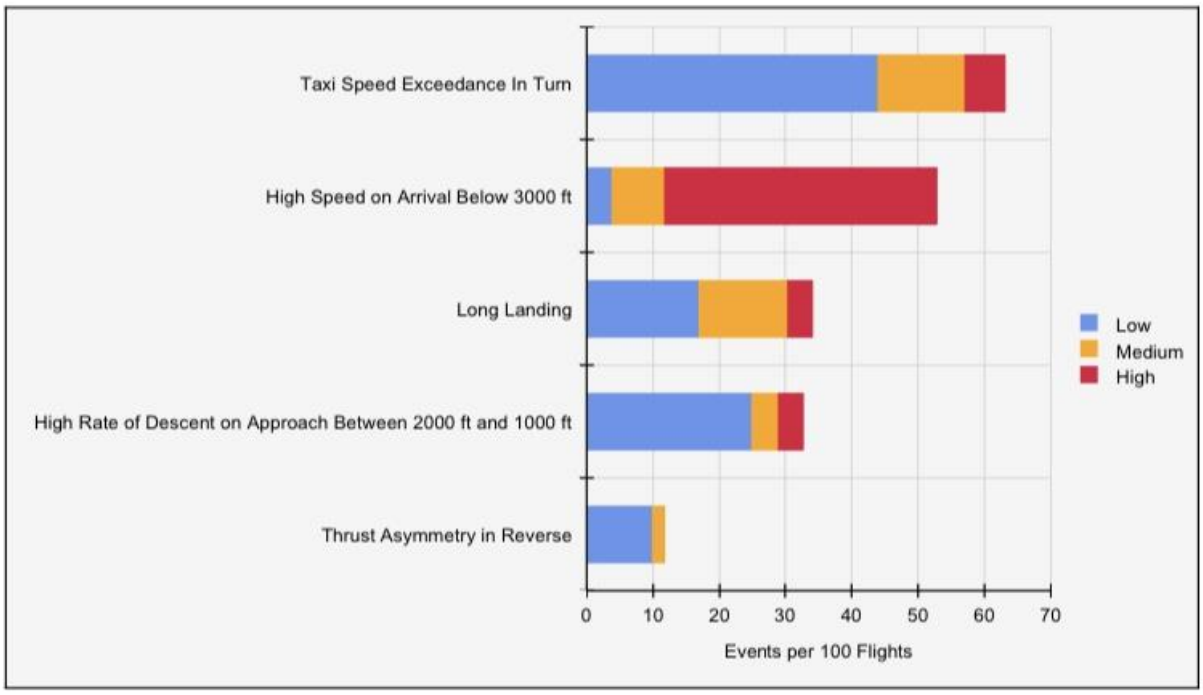
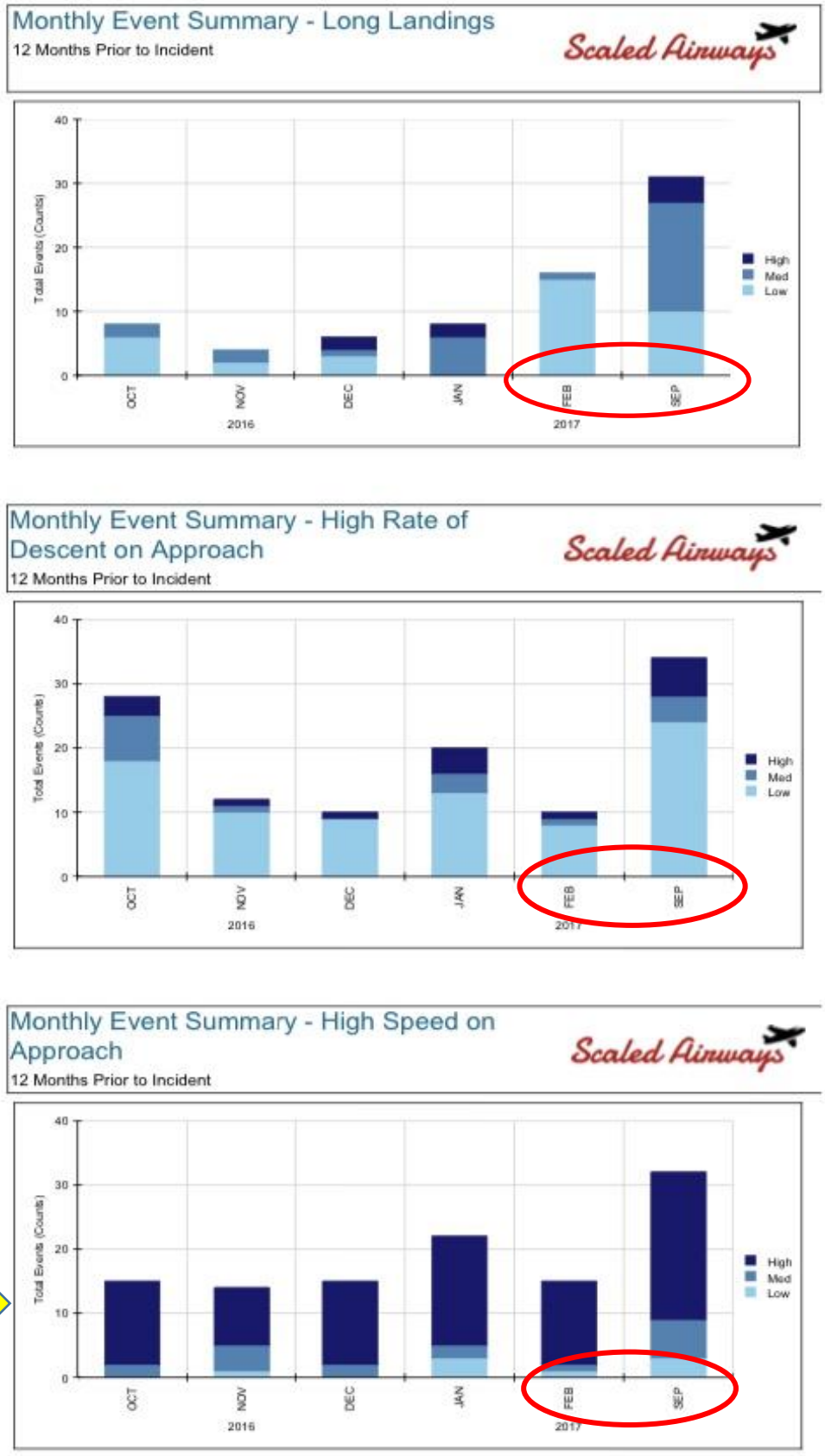


Figure 3: Critical Recurring Events Data of the Operator

Analysis of the investigation suggests that the operator in question paid no heed to the recurring unstable approach events, not even to the low severity events, what to talk about the high severity events? These low severity events lead to medium severity events which ultimately lead to the high severity events. *[Latent conditions]*

While managing a SMS Program, the hidden grey areas like recurring unstable approaches are termed as the latent conditions. These latent conditions become active conditions if not taken care of in due course of time. The data above clearly shows absence of any check and balance on the unstable approaches, especially in case of High Speed on Approach Event. Even a single red or Alert Level-3 must sound alarming to a Safety Department to raise a red flag and intervene immediately. However, this operator somehow intentionally ignored multiple red flags (Red or Alert Level 3) prior to the accident.

Interestingly, the operator had no record of the flight data from March to August for the same year, which means no flight data investigations and analyses were carried out during this period or even no data was recorded. Consequently, the operator was in not in picture of what's happening around? For some reason, best known to the company, the questioned data was also never referred to during any flight data investigation and analysis. The program failed not because of its own limitations, but due to ineffective engagement of the management with the FDM Program. A quick glimpse of the graphs below actually tells the whole story.



High Speed on Approach

Figure 4: Monthly Events Summary

High Speed on Approach Event

Considering this one particular event, by virtue of its repeated recurrence, we see no improvement in any of the months depicted on the graph. There is a blank picture between April and August of the same year. Moreover, September shows a significantly high number of Red or Alert level 3 events prior to the accident.

Compromising Safety

Compromising safety at the stake of earning few extra bucks is a short lived approach to safe operations. FDM Program must be considered to be a safety tool to prevent incidents / accidents. It requires flight data investigation and analysis to be done on routine basis, in order to arrest grey areas on time. Safety advisories, warnings, alerts and refreshing training are some of the most effective means of arresting these grey areas, unless there is a willingness of the company to engage into safety actions.

High Speed on Approach *(Analyzing from a Different Angle)*

Although we have established the fact that ignored or missed out excedences lead to catastrophic results; mentioned below is a 2D graphical representation between Corrected Air Speed viz a viz months for a closer look at the problem.

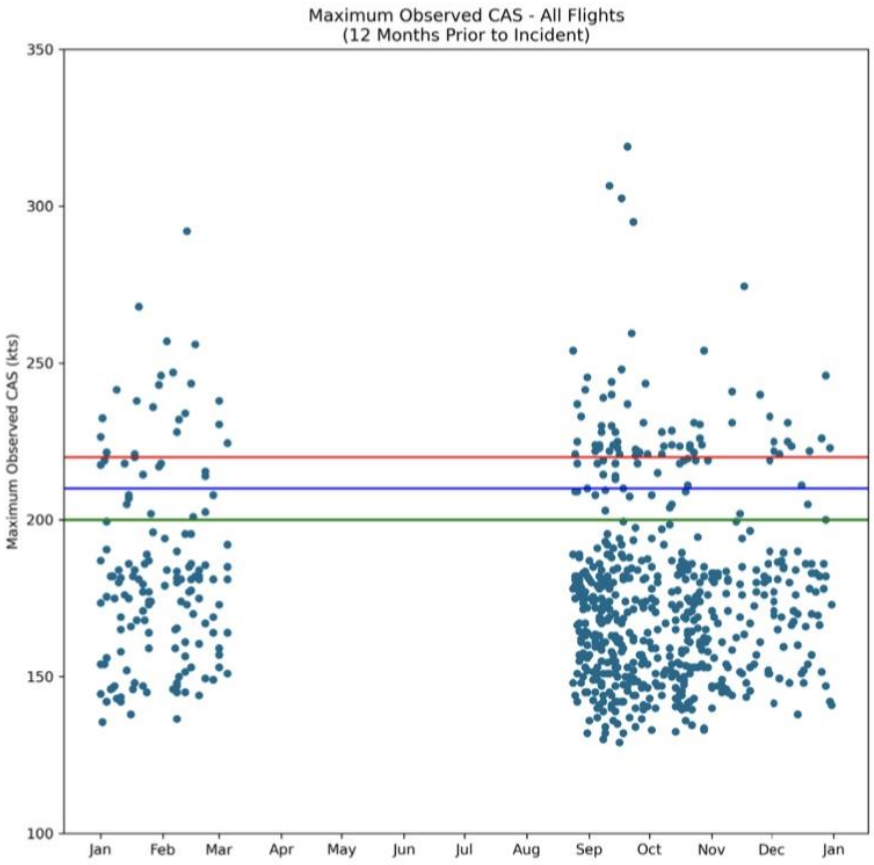


Figure 5: Twelve Months Data (High Speed on Approach Event)

The green line depicts Low Severity Event or Alert Level 1. The blue line depicts Medium Severity Event or Alert Level 2 whereas, red line represents High Severity Event or Alert Level 3. Anything below green line is completely acceptable without any special consideration.

Analysis

Analyzing this particular event, 'three' glaring issues have been identified.

(a) First, the collected data during the initial months of the year show multiple events touching or even crossing the red line or Alert level 3.

(b) Secondly, there is missing data from April to August i.e. there was no visibility within the company as where things were heading.

(c) Thirdly, data from September to January shows even higher number of events crossing the red line or Alert level 3 as compared to the initial months of the year, which reflects following multiple discrepancies:

(i) There was no data monitoring mechanism existed in the company.

(ii) The evidence speaks of the level of operator's engagement with the FDM Program.

(iii) The evidence also reflects company's safety culture and alignment of safety objectives within the organization.

(iv) Unavailability of data for five consecutive months left no room to the management for a timely decision to take the next course of action in terms of error correction.

Small fleet operators are at times in a rush to add an additional aircraft to their fleet. Adding a new aircraft, without fixing underlying safety issues increases the risk of a serious incident. This is a very important consideration. An operator cannot afford to lose two aircraft to go off the runway to ruin the entire day – just one is too many. Adding another aircraft without addressing one runway excursion risk just increases the odds of it actually happening. Also important to consider is the fact that if any operator thinks that its fleet is too small to benefit from an FDM program, then it must take a closer look and address any safety concerns before growing the fleet – not after when it could be too late.

Runway excursion is one of the 'Significant Five' high consequence risk outcomes, computed at the global level. The root cause of this event is recurring un-stabilized approaches without being monitored critically in the FDM Program; ultimately becoming the precursors for these events. Most of the non-safety conscious operators consider it a financial burden. Therefore, some of the operators yearning for quick bucks with a non-serious attitude towards safety becomes a ready recipe for a disaster. It is not just a requirement but it's a need for safe operations.

While, so much being done proactively, flight data has always remained a valuable aid during the events followed by a serious incident / accident. This is another face of the FDM Program that has helped mysteries hidden in post-accident scenarios.

Current Challenges of Aviation Safety

Accustomed to the COVID working model, personnel working in different operational areas of aviation had set their pace accordingly. However, due to increased traffic growth in recent months, the work load has increased at the airports. In view of the present travel, pacing up day by day, requirement of aircrew has also increased. It has put an additional psychological pressure on the air crew due to companies' financial perspective, which resultantly increased the likelihood of aircrew committing errors.

The local ALoSP (Acceptable level of safety performance) of an average organization must meet the defined ALoSP of the regulator. Small fleet operators, in particular, always have the tendency to operate below or around Acceptable Level of Safety Performance (ALoSP). The situation becomes challenging for those organizations which are already at the verge of ALoSP, and even ignore the recurring red flags especially Alert Level 3. Regulators have an important role to play here. They must go through the readouts of FDM Programs during audits in order to have a deep insight of real organizational safety performance.

Safety Recommendation

In order to have sustainability in safe operations, it is very important to have an effective flight data monitoring mechanism that remains instrumental through a continuous process of data investigation and analysis.

References

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- SMS Manual (Document 9859)