

BUREAU OF AIRCRAFT SAFETY INVESTIGATION PAKISTAN & CONDUCT OF AN AVIATION ACCIDENT INVESTIGATIONS

1. Aviation accident investigations are critical processes designed to understand the causes of aviation incidents, prevent future occurrences, and improve safety across the aviation industry. These investigations are carried out by specialized authorities like Bureau of Aircraft Safety Investigation Pakistan (BASIP), Inter State Aviation Committee (IAC), National Transportation Safety Board (NTSB), Aircraft Accident Investigation Board (AAIB) UK and Aircraft Investigation Board (AIB) under National Transport Safety Cooperation KSA and involve a meticulous and comprehensive approach. Understanding how to conduct an aviation accident investigation can help professionals within the industry ensure the highest levels of safety and provide insights into the procedural and regulatory frameworks governing these investigations.

History of Aircraft Investigation Body in Pakistan

2. Pakistan has been a signatory to the Chicago Convention on International Civil Aviation 1944 since Dec, 1947. As a Contracting State, Pakistan is responsible for conducting investigations of civil aircraft accidents, serious incidents, and incidents as the State of Occurrence, in compliance with ICAO Standards & Recommended Practices. The sole objective of such investigations is to enhance aviation safety by preventing future accidents and incidents of a similar nature, without apportioning blame or liability.

3. In this regard Safety Investigation Cell was established under Directorate of Civil Aviation Department under Ministry of Defence in December, 1947. After establishment of Pakistan Civil Aviation Authority in 1982, Safety Investigation Board (SIB) was established which was responsible for aircraft investigations. Following the first USOAP audit in 2011, due to conflict of interest, SIB was positioned under Aviation Division of Federal Government, however, the funding continued from PCAA. In year 2019, SIB was renamed as Aircraft Accident Investigation Board (AAIB) under National Aviation Policy. Following the second USOAP audit in 2021, the major audit concerns were functional independence and lack of legal framework for aircraft investigation.

4. To overcome the ICAO concern, efforts were made to establish BASIP. Following the segregation of the Pakistan Civil Aviation Authority on 08 August 2024, the Bureau of Aircraft Safety Investigation Pakistan (BASIP) was established and notified as a separate department vide SRO 1215 (I)/ 2024 dated 09 August 2024 initially under Ministry of Aviation (MoA). Subsequently, due to merger of MoA with MoD, BASIP has now been declared an attached department of the Ministry of Defence (Defence Division) vide Cabinet Division Memorandum No. 4-1/2025-Min-1 dated 08 April 2025. ***For fully Functionally Independent Investigation Body, Pakistan Air Safety Investigation (PASI) Act, 2023 and Air Safety Rules (ASR) 2025 have been formulated whereas Establishment / Human Resource and Financial Rules are in process***

of Government approval to make BASIP as fully functional independence department under MoD.

5. Transparent, effective and uninterrupted communication is essential for BASIP to ensure smooth conduct of aircraft safety investigations and timely coordination with national and international stakeholders. Considering the wide coverage and reliable services of NTC Pakistan, BASIP intends to obtain Webhosting, Domain Registration & E Mail Hosting Services for its officials.

6. The following paras elaborate “**How to Conduct an Aviation Accident Investigation**” For the awareness of public on aircraft investigation.

Introduction to Aviation Accident Investigation

7. An aviation accident is an event involving an aircraft in which, under certain conditions, a severe or fatal injury occurs or significant damage is caused. According to the International Civil Aviation Organization (ICAO), an aviation accident involves an aircraft that suffers substantial damage or loss of life during flight, landing, or while in motion on the ground. The ICAO's definition also highlights that the aircraft must be involved in the incident during any phase of flight, including takeoff, cruising, descent, or landing.

8. All aircraft investigation bodies follows similar guidelines for categorizing aviation accidents. The critical difference between an “accident” and an “incident” lies in the severity of the damage or injury, where an accident typically involves substantial harm to the aircraft, passengers, or crew.

Why Aviation Accident Investigations Matter

9. Although rare, aviation accidents can have catastrophic consequences. The primary goal of aviation accident investigations is to identify the root causes behind an incident or accident. Understanding these causes helps prevent future occurrences, improves operational procedures, and enhances the safety culture within the aviation industry. In fact, as per the NTSB, safety measures introduced as a result of aviation investigations have contributed to the sharp reduction in aviation accidents over the last few decades and similarly BASIP and Pakistan Civil Aviation Authority (PCAA) have developed State Mandatory Occurrence Report (MOR) System and implemented wef May 2025.

10. Accident investigations also serve legal and insurance purposes, and their findings can lead to essential changes in aviation regulations. For instance, after a significant accident, authorities like the FAA, the European Union Aviation Safety Agency (EASA) or PCAA might implement changes to safety protocols, aircraft maintenance procedures, or pilot training programs. These outcomes can have a lasting impact on safety standards across the aviation industry globally.

Regulatory Bodies and Stakeholders in Aviation Investigations

11. Multiple entities regulate aviation accident investigations, and these organizations play a critical role in overseeing the process, providing expertise, and ensuring adherence to international standards. ICAO, through its Annex 13, outlines the fundamental principles and processes that should guide an aviation accident investigation. These include recommendations on reporting, investigating, and communicating findings to promote safety improvements globally. On the other hand, the BASIP handles investigations within the Pakistan, determining the probable cause of accidents and offering safety recommendations to prevent similar occurrences.

Critical Phases of an Aviation Accident Investigation

12. Phase 1: Immediate Response and Securing the Scene

13. The first phase of an aviation accident investigation is the immediate response to the incident. This phase is crucial, as timely actions can significantly impact the investigation's success. When an aviation accident occurs, the priority is to alert the relevant authorities, including local law enforcement, medical teams, and aviation investigators. Securing the accident site is critical to preserving evidence and preventing contamination, as physical evidence like wreckage, flight data recorders, and human remains can be pivotal in determining the cause of the accident.

14. The response also includes efforts by the airline or aircraft operator to assist in the rescue and recovery efforts. In parallel, investigators, often led by a designated body like the BASIP, must move quickly to assess the scene and begin collecting evidence. This process can involve isolating the crash area, setting up a secure perimeter, and preventing unnecessary individuals from entering the site.

15. Phase 2: Evidence Collection and Preservation

16. After securing the scene, the next phase involves gathering all possible evidence of the accident. Investigators will begin collecting physical evidence, such as the aircraft's wreckage, cockpit voice recorders (CVRs), flight data recorders (FDRs), and other components that might offer insights into what went wrong. The location of the crash site often plays a significant role in evidence collection. For example, *investigators may need specialized equipment, such as drones or heavy machinery, to retrieve scattered wreckage from remote or inaccessible areas.*

17. Investigators must carefully document the crash site with photographs, sketches, and detailed reports to preserve the scene before any physical evidence is disturbed. One key element of this phase is *maintaining a chain of custody for all collected evidence, ensuring its integrity and reliability when it is later analyzed.*

18. Phase 3: Data Analysis and Forensic Examination

19. Once the evidence is gathered, investigators analyze the data to reconstruct the events leading up to the accident. *One of the most essential tools in this phase is the flight data recorder (FDR), which records the aircraft's performance, speed, altitude, and other variables. Similarly, the cockpit voice recorder (CVR) provides investigators with the conversation between the flight crew, providing crucial context for understanding decisions and actions taken during the flight.*

20. This phase also involves a detailed forensic examination of the aircraft's mechanical systems. Technicians and engineers assess whether aircraft structure, propulsion systems, or avionics failures might have contributed to the accident. The analysis of data, combined with the inspection of physical evidence, helps the investigators piece together the sequence of events leading up to the accident.

21. Phase 4: Conducting Interviews and Witness Testimonies

22. Another essential component of an aviation accident investigation is interviewing witnesses and involved parties, such as the aircraft's crew, air traffic controllers, and anyone else who may have witnessed the accident. The BASIP follow strict protocols during interviews to ensure they collect reliable and unbiased accounts of what happened.

23. Witness testimony can provide critical insights into human factors, such as miscommunications between the flight crew and air traffic controllers or potential crew performance, decision-making, or fatigue issues. In many cases, these interviews' findings help pinpoint errors or lapses in judgment that contributed to the accident. *However, investigators need to ensure that interviews are conducted impartially and without leading questions to maintain the integrity of the findings.*

The Investigative Tools and Techniques Used by Experts

24. Forensic Tools in Aviation Investigations

25. Aviation accident investigations often require advanced forensic tools to analyze the physical evidence recovered from the crash site. *Forensic engineers, aviation specialists, and human factors experts use various techniques, including digital forensic tools and non-destructive testing, to assess and examine wreckage and components.*

26. *For example, aircraft components may be tested to detect mechanical failure or wear signs. A forensic examination may also involve reconstructing parts of the aircraft to understand the cause of the crash. In addition, specialists in human factors, such as cognitive psychologists and ergonomists, can assess the actions of the flight crew to identify whether human error is a factor.*

27. How Technology Enhances Accident Investigations

28. Technology plays an increasingly critical role in modern aviation accident investigations. *Innovations in digital forensics, data analytics, and 3D modeling have significantly enhanced investigators' ability to reconstruct accidents. For example, investigators now frequently use **drones** and **satellite imagery** to gather data from crash sites that are remote or difficult to access.*

29. Additionally, *AI-based systems and machine learning algorithms are increasingly used to identify patterns or anomalies in the data that human investigators may overlook.* These tools allow for a more thorough analysis of flight paths, weather conditions, and other factors contributing to the accident. These technologies have transformed how accident investigations are conducted, allowing investigators to conclude more quickly and accurately.

Regulatory Framework and International Collaboration

30. The Role of ICAO and International Standards (Annex 13)

31. The International Civil Aviation Organization (ICAO) provides a regulatory framework for conducting aviation accident investigations. ICAO's Annex 13 outlines the principles and procedures that countries must follow to ensure consistency in the investigation process. These guidelines emphasize the importance of impartiality, transparency, and international cooperation.

32. The standards set by ICAO help to ensure that investigators work within a globally accepted framework and that the findings of any investigation contribute to the overall improvement of aviation safety worldwide. In international accidents, ICAO is critical in facilitating cooperation between countries to ensure thorough investigations and that *lessons learned are shared globally.*

33. How Countries and Agencies Collaborate in Investigations

34. Given the international nature of aviation, collaboration between countries and organizations is essential for conducting thorough investigations. For instance, in the case of Malaysia Airlines Flight MH370, countries such as Malaysia, Australia, and the United States worked together to piece together evidence, share findings, and collaborate on forensic analysis.

35. Major agencies like the FAA, NTSB, BEA, IAC, TSA, ATSB and EASA often collaborate on complex investigations, sharing expertise, resources, and data to ensure a comprehensive investigation. These partnerships are vital to ensuring that lessons are learned and safety improvements are implemented globally.

36. Navigating Jurisdictional Challenges

37. Aviation accidents often involve multiple parties from different countries, which can create challenges in determining which country or agency has jurisdiction over the investigation.

International conventions, such as those outlined by the ICAO, provide a jurisdiction-determining framework. However, issues still arise, particularly in accidents in international airspace or near national borders.

38. Investigators must navigate these legal complexities carefully to ensure that all relevant parties are involved and that the investigation proceeds according to established legal and procedural guidelines.

Writing the Final Investigation Report

39. What Goes Into an Investigation Report?

40. Once the evidence has been analyzed and the investigation has concluded, a final investigation report is drafted. The draft report is sent all stake holders for vetting. The comments received are either imbedded or appended in the final report. The final report is then published and publicly available which includes a detailed timeline of events, an analysis of the findings, and the accident's probable cause(s). The report must be clear, concise, and accessible of ambiguity to ensure that aviation professionals, policymakers, and the general public can understand it.

41. A thorough investigation report typically includes a narrative summary of the events leading up to the accident, followed by a technical analysis of the causes. It also includes recommendations for safety improvements, such as changes to aircraft design, new safety protocols, or additional training for flight crews.

Safety Recommendations and Preventive Measures

42. *Safety recommendations are one of the most critical aspects of an investigation report.* Based on the investigation's findings, they are designed to prevent similar accidents from happening in the future. Once the report is completed, the investigating agency, BASIP works with the appropriate regulatory authorities to ensure the recommendations are acted upon.

43. Safety recommendations include changes to pilot training, aircraft design improvements, or operational procedures. For instance, following the investigation into PIA 8303, recommendations were made to improve pilot training on automatic systems and to enhance cockpit communication.

Challenges in Aviation Accident Investigations

44. Overcoming Technical and Logistical Challenges

45. Conducting an aviation accident investigation is a complex and challenging process. One of the primary challenges investigators face is the *sheer volume and complexity of the data*. Analyzing flight data, interpreting evidence, and understanding the interdependencies between various factors requires specialized knowledge and technical expertise. *Furthermore, investigations often occur in remote locations, making gathering proof difficult.*

46. Advanced technologies like AI and machine learning have dramatically helped investigators overcome some challenges, allowing for faster data analysis and better accuracy.

47. Legal, Ethical, and Cultural Considerations

48. Aviation investigations involve a variety of legal and ethical considerations. For example, investigators must respect the privacy and rights of individuals involved in the incident, including the victims and their families. *They must also remain impartial, ensuring their findings are based solely on facts and evidence.*

49. Cultural differences can also arise in international investigations involving jurisdictions and legal systems. Respecting the legal processes and cultural norms of the countries involved is critical to handling the investigation appropriately.

The Impact of Aviation Accident Investigations on the Industry

50. How Investigations Drive Aviation Safety Improvements

51. The findings from aviation accident investigations often lead to significant changes in industry standards, aircraft design, and operational procedures. Safety improvements, such as changes to cockpit instrumentation, flight crew training programs, and more stringent maintenance requirements, are direct outcomes of thorough investigations.

52. These changes often have far-reaching effects, improving aviation safety globally. As aviation technology advances, the methods used in accident investigations will continue to evolve, allowing for more effective safety enhancements.

53. Case Studies: Major Accidents and Their Long-Term Impact

54. Many significant accidents have reshaped aviation safety standards. For example, the Air France Flight 447 crash substantially changed pilot training and cockpit design. Lion Air Flight 610 helped introduce changes in how the aviation industry monitors and responds to system failures. Each of these investigations serves as a reminder of the importance of a thorough and transparent investigation process.

Conclusion

55. As the aviation industry evolves, so do the methods and technologies used in accident investigations. The future of these investigations will likely be shaped by ongoing advancements in technology, particularly in artificial intelligence (AI), machine learning, and big data analytics. These technologies will provide investigators with faster and more precise ways to analyze vast amounts of data, allowing them to identify patterns that may have been overlooked.

56. *Moreover, innovations in drones, 3D scanning, and virtual reality enhance investigators' ability to reconstruct accident scenarios with greater accuracy, even in remote or dangerous environments.* These advancements will continue to improve the speed and efficiency of investigations, leading to quicker case resolutions and faster implementation of safety measures.

57. The *role of human factors analysis will also grow in importance.* Understanding the psychological and cognitive aspects of pilot performance and decision-making will be crucial as more aviation automation and pilots' roles continue to shift. Training programs will likely incorporate more human factors education, helping to ensure that pilots are better equipped to handle the complexities of modern aircraft and flight systems.



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