



ASSEMBLY — 42TH SESSION

TECHNICAL COMMISSION

Agenda Item 24: Aviation Safety and Air Navigation Priority Initiatives

AVIATION PATHOLOGY IN AIRCRAFT ACCIDENT INVESTIGATION

(Presented by the United Arab Emirates)

EXECUTIVE SUMMARY

This information paper highlights the vital role that the aviation pathology may play in determining pilots' medical factors contributing to aviation accidents by integrating autopsy, toxicology, and medical history analyses. Standard forensic pathology methods alone are often insufficient, highlighting the need for aviation-specific pathology practices. Despite ICAO Doc 8984, *Manual of Civil Aviation Medicine*, Part IV - *Aviation Pathology*, offering general guidance, it lacks governance structures and detailed protocols for coordination among stakeholders. Recent studies, including those by the FAA and UAE, stress the value of incidental medical findings and standardized evaluation methods. The UK's 2025 *Guidelines on Autopsy Practice for Aviation-Related Fatalities* addresses the gaps between conventional forensic pathologists and aviation pathology specialists. A national aviation pathology system with trained personnel, defined procedures, and standardized reporting is recommended to enhance aviation safety and support medical certification improvements.

<i>Strategic Goals:</i>	This paper relates to the Strategic Goal <i>Every Flight is Safe and Secure</i> .
<i>Financial implications:</i>	No financial implications are anticipated.
<i>References:</i>	Annex 13 — <i>Aircraft Accident and Incident Investigation</i> Doc 8984, <i>Manual of Civil Aviation Medicine</i> , Part IV - <i>Aviation Pathology</i> Doc 9756, <i>Manual of Aircraft Accident and Incident Investigation</i> , Part III — <i>Investigation</i>

1. INTRODUCTION

1.1 Medical, pathological, and human engineering examinations are crucial in aircraft accident investigations, particularly within the context of human factors analysis. Their significance lies in uncovering evidence that links the sequence of events, causes, and contributing factors to the pilot's medical and physical condition. For a comprehensive accident investigation, aviation pathology is a key element in connecting human factors with aircraft engineering.

1.2 In some fatal accidents, there were insufficient aviation pathology examinations performed on the pilots' bodies, with post-mortem autopsies typically only focusing on identifying the immediate cause of death. As a result, the investigations were unable to determine from the autopsy reports the pilots' physiological, physical, or psychological condition and how these factors may have contributed to the accident.

1.3 Few forensic pathologists have experience on accidents which pose problems that are quite distinct from those encountered in routine medico-legal pathology practice. Examination of fatalities by pathologists, who may not have particular experience of aviation pathology, are expected not to be countered frequently.

1.4 The absence of proper autopsy procedures using aviation pathology techniques prevents investigators from obtaining crucial information related to the pilots' deteriorated health, which may have affected their performance. Furthermore, the connection between the injury patterns and the aircraft wreckage, which could offer valuable evidence regarding the aircraft's crashworthiness and survivability features, remains unidentified.

2. DISCUSSION

2.1 Investigating medical factors related to the likely cause of an accident is a detailed scientific process that requires a multidisciplinary analysis of available facts concerning the human, the aircraft, and the environment. Medical records, toxicology test results, and autopsy reports of pilots who were fatally injured, assist the Investigation Authority in determining whether medical impairment or incapacitation played a role in causing the accident.

2.2 In accidents' fatalities, it is insufficient for the forensic pathologist to merely state that the cause of death was multiple crushing injuries. A thorough scientific investigation requires pinpointing and describing the precise cause of the injury leading to death. The aviation pathologist must carry out a meticulous and detailed examination, using inductive reasoning and relevant techniques like biochemical and toxicological analysis, color photography, dental assessments, and post-mortem X-rays. In collaboration with aviation medicine, the aviation pathologist should also evaluate the pilots' medical history to determine the likelihood of any pre-existing diseases that may have contributed to pilot incapacitation.

2.3 ICAO Doc 8984, *Manual of Civil Aviation Medicine*, Part IV — *Aviation Pathology*, provides general guidance for a medical examiner appointed as a member of the accident investigation team, and outlines how specialists in aviation medicine, pathology and human engineering may contribute to an investigation. However, the document does not establish governance for this field to clarify how various stakeholders within the State government structure can effectively engage in conducting post-mortem autopsies, assisting in accident causation analysis, and providing recommendations for improvements in aviation medicine, while maintaining integrity, impartiality, and preventing any potential conflict of interest between judicial and aircraft accident investigations.

2.4 In September 2018, the FAA released a study examining incidental medical findings (IMF) in autopsied U.S. civilian pilots who died in aircraft accidents between 2013 and 2016. The study concluded that autopsy results can contribute valuable insights for data-driven decisions in aeromedical assessments. It emphasized the importance of maintaining a system to collect and analyze IMFs in pilots, in order to assess the risks that chronic medical conditions may pose to flight safety. The study also recommended developing and implementing a standardized grading system for evaluating coronary artery narrowing, using both macroscopic and microscopic pathology.

2.5 The latest edition of *Guidelines on Autopsy Practice for Aviation-Related Fatalities, February 2025*, issued by the U.K Royal College of Pathologists, states that the pathologist who does not specialize in aviation fatalities will not encounter such case frequently, therefore a guidance is required to bridge this gap of unfamiliarity and ensure consistent standards among different practitioners. Given that the full extent of investigative interest in a case may not be clear at the time of the autopsy, it's important to conduct the examination with a level of thoroughness that might exceed what is typically expected in a routine case. If a pathologist believes they lack the necessary time or resources to carry out the autopsy to a sufficiently high standard, it is better to refrain from starting the examination than to proceed and risk future complications due to incomplete documentation or insufficient sampling. This document goes through a formal revision on a 5-years cycle.

2.6 A properly conducted aviation pathology investigation shall:

- Identify the cause and manner of injuries and their timing.
- Detect pre-existing disease(s) that may have impaired the performance of a pilot.
- Detect Toxic/noxious gases, or the presence of drugs, alcohol, or any other psychoactive substance that may have impaired the performance of the pilot.
- Provide a clue to 'who' was on the controls of the aircraft. This task is not straightforward when it comes to small or general aviation aircraft where flight recorders are not available to indicate who was on the controls.
- Correlate the injuries with the aircraft crashworthiness and safety characteristics.
- Detect clues of sabotage.

2.7 In October 2022, an exploratory study was launched by the Air Accident Investigation Sector (AAIS) of the United Arab Emirates to examine the development of an aviation pathology system. This initiative was prompted by three prior accidents. One incident occurred in September 2017, when a captain died while operating a Boeing 777 freighter. The other two involved fatal loss-of-control crashes: a foreign-operated Boeing 707 freighter in October 2009 and a McKinnon G-21 in February 2011. At the time of these accidents, investigations relied solely on classical forensic pathology methods, which limited the ability to assess whether the pilots' performance may have been impaired by physiological, physical, or psychological factors.

2.8 The study proposed establishing a national aviation pathology system that incorporates qualifying forensic pathology specialists to aviation pathology stream. To achieve this, an Aviation Pathology Protocol was developed with the key elements including offering familiarization and advanced training to prepare forensic pathologists for roles as aviation pathologists, creating dedicated aviation pathology teams to operate under the supervision of the IIC, ensuring both investigation and pathology teams have access to relevant medical records of the pilots involved, and standardizing the format of aviation pathology reports submitted to the IIC.

2.9 It is crucial to highlight the guidelines outlined in Document 8984 when assembling and deploying the aviation pathology team. These guidelines stress the importance of balancing the families' and legal authorities' expectations for quick identification and release of remains on one side and the need to conduct aviation pathology examinations on the other side. This balance necessitates early decisions about which bodies will undergo aviation pathology examinations, with specific focus on the flight crew, cabin crew, and selected passengers.

2.10 While body identification procedures for medico-legal purposes are well-established in most parts of the world, the conduct of autopsies for aviation pathology purposes remains inadequately regulated in several States. As a result, there is a risk that these examinations may be compromised due to

inadequate planning regarding body recovery from the accident site, preservation, preliminary identification, autopsy procedures, documentation of injuries, and the collection of samples and biopsies. This issue is further complicated by a lack of coordination between the IIC and the forensic pathology team, which can lead to the loss of critical evidence early in the process. To address this, it is essential that the IIC clearly defines the required pathological examinations, considering different scenarios and hypotheses based on the initial findings.

2.11 It is important that the aviation pathologist's findings are documented in a well-structured report that includes key factual details, such as the timing of the autopsy, the methods used for examination and sample collection, the analytical techniques applied, and the representation of injuries using a recognized anatomical model. The report should also present a thorough analysis and conclusions regarding the cause of death. Nevertheless, as outlined in Document 8984, these pathological findings are only one part of the overall investigation and must be fully integrated with the other investigation aspects.

2.12 To ensure aviation pathology contributes effectively to the overall investigation, States are recommended to establish a comprehensive framework, including standardized methods for aviation pathology examinations, criteria for pathologist qualifications, coordination protocol, and supplementary procedures that align traditional forensic pathology with aviation-specific pathology requirements. For example, the United Arab Emirates Aviation Pathology Protocol addresses these elements, along with guidance on how post-mortem examinations can support aviation medicine requirements and medical certification criteria. In this context, a sample protocol could be included as an appendix to Document 8984, Part IV, to assist States in creating their own versions.

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