



WORKING PAPER

ASSEMBLY — 42ND SESSION

TECHNICAL COMMISSION

Agenda Item 24: Aviation Safety and Air Navigation Priority Initiatives

**MODERNIZING FATIGUE MANAGEMENT AND HUMAN PERFORMANCE STANDARDS IN
AIR TRAFFIC CONTROL**

(Presented by the United Arab Emirates)

EXECUTIVE SUMMARY

This working paper highlights the urgent need to modernize fatigue management systems and human performance standards in air traffic control (ATC). Fatigue among air traffic control officers (ATCO) is an increasingly recognized safety hazard with operational and global implications. Current fatigue risk management frameworks are outdated, inconsistent across Member States, and not sufficiently integrated into organizational safety culture. This paper outlines the shortcomings in current practices, recognizes innovative national efforts, and proposes actions aligned with global best practices. It emphasizes the need for ICAO to update guidance, facilitate harmonization, and support evidence-based fatigue management systems for ATCOs.

Action: The Assembly is invited to:

- a) recognize fatigue in Air Traffic Control as a critical safety issue requiring urgent international attention;
- b) request ICAO to update and expand fatigue-related guidance specific to ATCOs, drawing on scientific evidence and best practices from Member States;
- c) encourage Member States to implement Fatigue Risk Management Systems (FRMS) for ATCOs as part of national safety programs;
- d) support research and innovation in fatigue modeling, real-time monitoring, and education tailored to air traffic control environments; and
- e) promote regional collaboration, training, and data sharing to foster harmonization and continuous improvement in fatigue management across air navigation systems.

<i>Strategic Goals:</i>	This working paper relates to <i>Every Flight is Safe and Secure</i> .
<i>Financial implications:</i>	

<i>References:</i>	<i>Annex 6 — Operation of Aircraft</i> <i>Annex 11 — Air Traffic Services</i> <i>Doc 9966, Manual for the Oversight of Fatigue Management Approaches</i> <i>Doc 9965, Fatigue Risk Management Systems Manual for Regulators</i> <i>Eurocontrol (2022), Guidelines for Fatigue Risk Management in ATM</i> <i>FAA (2021), Fatigue Management in Aviation: Research and Policy Implications</i> <i>Airservices Australia – Fatigue Risk Management Strategy and Implementation (2020)</i> <i>NAV CANADA (2021), Fatigue Risk Management and Sleep Hygiene Program Overview</i> <i>UK CAA – CAP 737, Flight Crew Human Factors Handbook, applicable ATCO adaptation</i> <i>CAAS Singapore, ATCO Work Schedule Optimization Pilot Report (2021)</i> <i>New Zealand CAA, Research on Predictive Fatigue Modelling in ATC Rostering (2020).</i> <i>International Federation of Air Traffic Controllers' Associations (IFATCA), Position Papers on Fatigue and Human Performance in ATC</i>
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1. INTRODUCTION

1.1 Fatigue is a well-documented risk factor in safety-critical environments. In air traffic control (ATC), sustained attention, rapid decision-making, and continuous vigilance are essential. However, many existing fatigue management protocols for ATCOs are outdated or insufficiently enforced, posing a direct threat to operational safety and human performance.

1.2 Current fatigue management approaches in several States are still rooted in prescriptive duty-hour limits rather than evidence-based, performance-focused strategies. These legacy models fail to capture the dynamic nature of fatigue, overlook individual variability, and lack integration into daily operational decision-making. Furthermore, ICAO's existing fatigue provisions under Annex 11 are limited in scope compared to more comprehensive frameworks available for other sectors such as flight crew operations.

1.3 The result is a fragmented global landscape where ATCOs may be subject to high workloads, irregular shifts, and insufficient rest without adequate organizational monitoring or support. This exposes air traffic systems to elevated risk, particularly as traffic demand grows and operational complexity increases.

1.4 Scientific research has shown that fatigue impairs cognitive performance, slows reaction time, and increases the likelihood of errors. Despite this, some States continue to rely on fixed scheduling limits without implementing proactive fatigue risk management systems (FRMS).

1.5 While ICAO has provided baseline guidance on fatigue management, current standards and practices do not sufficiently account for the unique operational differences and cognitive demands placed on ATCOs globally. A modernized, role-specific framework is essential to ensure sustained human performance and the safety of global air navigation services.

1.6 The objective of this paper is to present a case for updating and harmonizing fatigue management standards and human performance guidelines for ATCOs in accordance with evidence-based practices and international collaboration.

2. BACKGROUND

2.1 ICAO's fatigue management guidance primarily stems from Annex 6 — *Operation of Aircraft* (focused on flight and cabin crew), while Annex 1 — *Personnel Licensing* and Annex 11 — *Air Traffic Services* include limited provisions for ATCOs. However, the operational environment and human performance risks faced by ATCOs are distinct, particularly in 24/7 control centers with demanding shift schedules and increased operational demand outside daylight hours.

2.2 Additionally, the COVID-19 pandemic underscored the importance of mental resilience and psychological well-being in maintaining safe air traffic services, especially during periods of staffing constraints, uncertainty, and sustained stress.

3. DISCUSSION

Problem Identification

3.1 Existing fatigue management strategies vary significantly across States, with some lacking formal implementation entirely. Where frameworks do exist, they often focus on compliance with scheduling limits rather than addressing individual or operational fatigue risks in real time.

3.2 In some regions, ATCOs are subject to long shifts, short rest periods, and irregular rosters. Reports from national oversight bodies and safety investigations have repeatedly cited fatigue as a contributing factor in operational incidents.

3.3 Current ICAO provisions on fatigue in Annex 11 and related guidance materials do not provide sufficient detail or applicability specific to the ATC environment, unlike the more advanced fatigue guidance available for pilots under Annex 6.

Related Efforts by Member States

3.4 Several Member States have undertaken progressive steps to address ATCO fatigue. For example, Australia's Airservices organization has adopted a FRMS tailored to ATC operations, incorporating data from biomathematical models and sleep monitoring. The United Kingdom has implemented real-time fatigue reporting tools within its air navigation services provider (ANSP) to allow operational adjustments based on fatigue data.

3.5 In Canada, NAV CANADA has introduced fatigue education programs and is piloting the use of wearable technology to assess sleep quality and alertness. Singapore and New Zealand have updated their shift design models using predictive fatigue modelling to better match controller performance with operational demand.

3.6 The UAE has conducted internal reviews of human reliability and safety performance, identifying the need for a strategic framework that links fatigue management, psychological support, and operational oversight. This includes:

- a) predictive rostering and workload modeling;
- b) continuous monitoring of fatigue indicators;
- c) integration of human performance metrics into safety assurance; and
- d) mental health and stress management support.

Global Implications

3.7 Fatigue is not a localized problem. As global air traffic increases and ATCO workloads intensify, the risks associated with unmanaged fatigue grow exponentially. Inconsistent fatigue management practices across borders create an uneven safety landscape, particularly in shared airspace regions and during transboundary operations.

3.8 If left unaddressed, fatigue-related incidents could erode public trust in air navigation safety, hinder regional airspace integration, and impair the resilience of global air traffic networks.

Expected Improvements and Benefits

3.9 Implementing modern FRMS tailored to ATCOs will enhance operational safety, reduce errors, and improve decision-making under pressure.

3.10 A modern approach includes predictive modelling, real-time fatigue monitoring, education programs, and organizational culture change—resulting in better scheduling practices, reduced absenteeism, and improved job satisfaction.

3.11 Harmonized global standards for fatigue and human performance in ATC will strengthen cross-border operations, allow for consistent oversight, and contribute to ICAO’s broader objectives of safe, efficient, and integrated airspace systems.

3.12 The Next Generation of Aviation Professionals (NGAP) initiative must also consider human performance sustainability. ATCOs of the future will require not only technical proficiency, but also adaptive cognitive capacity and resilience under pressure.

4. CONCLUSION

4.1 Fatigue among ATCOs is a global safety challenge that requires proactive and evidence-based solutions. Modernizing fatigue management practices and human performance standards will lead to safer skies, better working conditions, and more resilient air navigation services. With coordinated international action and ICAO leadership, Member States can collectively reduce fatigue-related risks and ensure long-term sustainability in air traffic operations.

4.2 To maintain safety and operational excellence in modern air navigation services, it is imperative that ICAO modernizes its approach to fatigue management and human performance standards for ATCOs.

4.3 Human reliability must be supported through systems that proactively manage fatigue, stress, and cognitive demands, ensuring resilient performance in dynamic ATC environments.

4.4 This working paper urges ICAO and Member States to modernize and harmonize FRMS policies, shift toward proactive fatigue mitigation, and embed human performance standards into safety culture. Doing so will not only reduce fatigue-related risks but also promote consistency, resilience, and long-term sustainability in global air navigation services.