



**WORKING PAPER**

**ASSEMBLY — 41ST SESSION**

**TECHNICAL COMMISSION**

**Agenda Item 31: Aviation Safety and Air Navigation Standardization**

**AN APPROACH TO NEW OPERATIONAL CONCEPTS INVOLVING EXTENDED MINIMUM CREW OPERATIONS AND SINGLE-PILOT OPERATIONS**

(Presented by Czechia on behalf of the European Union<sup>1</sup> and its Member States, the other Member States of the European Civil Aviation Conference<sup>2</sup> and EUROCONTROL)

**EXECUTIVE SUMMARY**

Continued technological developments and innovation challenge regulators in their intent to continuously foster the highest possible level of safety in air operations. The development of commercial unmanned aircraft as well as the additional safety and economic benefit deriving from increased flight deck automation and the optimisation of aircrews drive industry to explore the technical feasibility of extended minimum-crew operations (eMCO) and, at a later stage, single-pilot operations (SiPO). Regulators need to assess this evolution from the perspective of enhanced safety.

**Action:** The Assembly is invited to request ICAO to:

- a) create the necessary enablers for a safe and globally harmonised introduction of commercial air transport (CAT) operations of large aeroplanes with optimised crew/single-pilot operations while ensuring an equivalent or higher level of safety compared to that achieved in current operations, in particular by:
- b) explore and subsequently promote more powerful risk assessment methods and tools based on which regulators may assess the industry safety cases provided for related designs and types of operations;
- c) initiate work to review, amend or complement, as required, the Standards and Recommended Practices (SRPs) in Annex 1 — *Personnel Licensing*, Annex 6— *Operation of Aircraft*, Annex 8 — *Airworthiness of Aircraft*, Annex 11 — *Air Traffic Services* and Annex 19 – *Safety Management*.

<i>Strategic Objectives:</i>	This working paper relates to the Safety and Air Navigation Capacity and Efficiency Strategic Objectives.
<i>Financial implications:</i>	The activities referred to in this paper will be subject to the resources available in the 2023-2025 Regular Programme Budget and/or from extra-budgetary contributions.
<i>References:</i>	

<sup>1</sup> Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden

<sup>2</sup> Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Iceland, Republic of Moldova, Monaco, Montenegro, North Macedonia, Norway, San Marino, Serbia, Switzerland, Türkiye, Ukraine and the United Kingdom

## 1. INTRODUCTION

1.1 The development of aviation has been inextricably connected to technological advancement. Despite the exponential growth in air transport over the last century, the rate of accidents has progressively fallen, making commercial air transport the safest means of transport. In large part, this has been brought about by a combination of technological advancement and improved human performance. The emergence of the extended minimum-crew operations (eMCO) concept and the advent of discussions of a single-pilot operations (SiPO) concept calls upon the safety regulators to look at these factors to ensure that the enviable safety standards achieved over decades are maintained or further improved. The eMCO concept involves single-pilot operations during the cruise phase of the flight. This is distinct from SiPO involving end-to-end single-pilot. The main focus of this working paper is eMCO, although it is clear that the eMCO concept can be seen as an early step towards increased automation, ultimately leading to SiPO.

1.2 There are widely and strongly held views on these concepts. While manufacturers are confident about the implementation, associations of pilots are more cautious. There are also considerations for those that manage our airspace, for aero-medical practitioners, those involved in aviation security operators and most importantly, the travelling public. However, the responsibility for ensuring safety in civil aviation rests with States, under the coordination and guidance of ICAO. More than any other party, the responsibility for the safe introduction of these new concepts falls to regulators, under the direction of their respective Directors General of Civil Aviation Authorities. For this purpose, regulators must be strictly independent and adequately resourced. Continued technological developments and innovation challenge regulators to strive towards ever-higher levels of safety in air operations. The prospect of increasingly automated commercial aircraft encourages industry to explore the technical feasibility of eMCO as a steppingstone toward SiPO and has prompted aircraft manufacturers to engage with their regulators.

1.3 Moving from two pilots to one must be accompanied by compensatory measures that are embedded into both the design and the operation of aircraft. Currently, in Europe, the European Union Aviation Safety Agency (EASA) is working with EU aircraft manufacturers to develop criteria for the development of eMCO and SiPO on specific aircraft, provided the safety level of today's two-pilot operations is maintained or even enhanced. Therefore, it is essential to ensure sufficient and appropriate analysis of the impact of a reduction of the number of flight crew, during all phases of flight. There is a need to manage the transition, by addressing areas of concern but with a view on the future. In the past, these transitions have been managed using a risk-based approach and have invariably involved a gradual implementation of the new concept, as seen with the introduction of extended-range twin-engine operations (ETOPS), operations in airspace with reduced vertical separation minima (RVSM), or required navigation performance (RNP).

## 2. ADAPTING TO TECHNOLOGICAL EVOLUTIONS

2.1 Moreover, and thanks to the high level of investment in Automotive and Information Technology industries, autonomy technologies are becoming more and more available and reliable. Consequently, industry will continue to add automation, and this can improve the resilience of aircraft systems and functions, as well as alleviate pilots' tasks in some, or all, phases of flight.

2.2 However, technological evolutions in complex systems may require a paradigm shift. Since the early days of commercial air transport, we have witnessed a continuous reduction in the number of flight crew as more advanced technologies became available. At the same time, over successive decades, these technological advancements have systematically increased safety. This is typically the case when introducing new generations of aircraft, where an overall safety benefit has been observed in the medium/long term. It is therefore considered necessary to perform appropriate analysis of the impact of

reducing the number of flight crew for a limited portion of the flight, and how novel technologies can compensate for the gaps. There is therefore the need for a holistic approach, taking into account the human component in the system and its interaction with technologies introduced in the cockpit.

2.3 The aviation industry has pioneered engineering and technological innovation, and aircraft manufacturers have been quick to take advantage of the increased reliability and accuracy of automated systems. In recent decades, automation in the cockpits has progressively increased, while the continued focus in pilot training has remained largely on stick and rudder skills. These proposals are not simply a change from two crew members to one, it is a paradigm shift toward a pilot flying alone at the controls of large commercial aircraft. This inevitably involves a change to the role of the pilot, towards becoming a systems manager, over a physical flyer, and may introduce increased risk, particularly during the introductory phase of the new technology.

2.4 Recent data points to a shortage of skilled aviation professionals in the next 20 years. While there will be shortages across all areas, the introduction of eMCO and SiPO has been suggested as a means to address this increasing demand for pilots. However, these new pilots will have to evolve to command aircraft in a changing environment, and pilot training will play an important part in preparing them for this new situation. Where individual pilots are increasingly responsible for controlling the aircraft and reacting to issues by themselves, the overall skill levels will have to increase also. The requirement for higher-skilled pilots suggests that they will continue to be highly valued professionals.

2.5 Large aeroplane CAT operational procedures have focused in recent years on the concept of ‘two crew’ in order to effectively manage the aircraft. Indeed much emphasis has been made on the requirements for appropriate crew resource management, decision making and when necessary ‘monitoring pilot’ intervention. Although there is available statistical evidence demonstrating the percentage of accidents attributed to pilot error, there is limited data showing the number of accidents avoided by human intervention. To demonstrate the same level of safety of eMCO or SiPO operations, applicable aircraft must be designed to enable one pilot, complemented by automation systems, to manage the workload of two pilots. This suggests a more automated aircraft than those which are in operation today. From a pilot selection and training perspective, a range of considerations arises in relation to recruitment, qualifications and training challenges. Selecting the right individual for the role of the future pilot will be increasingly important. There are also implications for the retention of pilots and ensuring a robust supply chain of highly skilled individuals.

### **3. ECONOMIC CONSIDERATIONS**

3.1 One of the driving factors for the industry to propose taking advantage of the introduction of these new concepts of operations is a foreseen reduction in operating costs. Although transitioning from multi-crew to minimum-crew operations may reduce costs associated with the workforce and potentially introduce more flexible rostering, on the other hand, different pilot competencies may be required. Therefore, economic drivers may not be considerable, taking into account the higher level of competence of the “remaining” pilot. Potential additional costs related to higher-level ground support and two-way communications should also be considered. On the aircraft manufacturer side, the development and certification of new cockpit designs and associated systems may require significant investment, although these will likely produce safety benefits and savings in the medium/long term.

### **4. MEDICAL AND FLIGHT TIME LIMITATIONS CONSIDERATIONS**

4.1 Aeromedicine is a key factor when considering eMCO and SiPO. The risk of sudden incapacitation of the pilot is still a major safety concern in a single-pilot cockpit. The consequences of

pilot incapacitation are much more severe than in a multi-pilot environment, therefore the current class one medical criteria should be reviewed against the requirements of eMCO or SiPO. Changes to medical certificate conditions should be supported by data to ensure equivalent levels of safety, without being overly prescriptive. A particular challenge will be to collect meaningful data to support decisions on medical requirements for single-pilot operations. Furthermore, consideration should be given to the prolonged periods of isolation undertaken by pilots during flight, which should feed into an assessment of future flight time limitations and pilot working hours. The introduction of eMCO and SiPO may also require a review of pilot support programmes. Real-time monitoring of pilot alertness and performance may be required in order to identify fatigue or incapacitation without delay.

## 5. **STAKEHOLDERS CONCERNS**

5.1 Although thus far the most vocal concerns have been raised by pilots, other critical safety interfacing relationships need considering (such as cabin crew, ATC, and maintenance engineers). The opportunity should be taken to ensure all such stakeholders' concerns are collated and addressed during the early phases of eMCO or SiPO safety framework assessment. Whilst it is natural that other not strictly safety-related items will also be raised (such as the impact on pilot employment, responsibilities and even remuneration), it would be advantageous to include such concerns in the broader scope of the pilot evolution. This might, for instance, take account of the concern but justify why from a regulatory perspective it falls outside of a safety or compliance issue. This will help ensure that the safety assessments are transparent in their delivery and avoid the perception that the eMCO/SiPO initiatives are driven solely by commercial expediencies. The welfare of pilots and crew members is an example of stakeholder concern that has potential for flight safety implications. The potential for prolonged periods of isolation for the pilot, and the possibility of changes to flight crew and cabin crew relationship and communication should be assessed. This might be particularly relevant during periods of high workload associated with abnormal flight conditions. A comprehensive evaluation of all the safety concerns should be part of the regulator's activity.

## 6. **CONCLUSION**

6.1 The question of whether new standards can be regarded as sufficiently safe is not normally publicly discussed at the time of the introduction, beyond the involvement of interested stakeholders. One reason that new safety standards do not attract major public attention is the trustworthiness of the international and regional aviation safety systems. However, the implications of single-pilot operations are easily understandable to non-specialists. The general acceptance of these new concepts is of relevance, particularly as there may be concerns from both aviation employees and passengers. The conveyance of the safety-relevant considerations to the travelling public is fundamental. Therefore, there is a need for full transparency in the decision-making process. As described before, these new concepts of operations may only be implemented provided the current level of safety is not lowered, and preferably enhanced. It is crucial that the maintenance of safety standards is credible to the public and that any concerns, including those relating to ground safety, are fully addressed during the development phase. Having regard to the imperative of maintaining an equivalent or higher level of safety, the Assembly is invited to consider the proposed concepts and related concerns raised in this Working Paper, with a view to developing a graduated path forward for the evaluation and implementation of these concepts.