

## Aeromedical Concerns About Extended Minimum Crew Operations

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The aviation industry is exploring possibilities to operate extended long-haul flights with two pilots in the cockpit during critical flight phases and a single pilot flying during cruise flight while the other pilot is sleeping. This Extended Minimum Crew Operations (eMCO) concept raises important aeromedical concerns: 1) a two-pilot cockpit is considered a main safety risk-mitigating factor and eMCO would therefore necessitate a new aeromedical risk assessment concept; 2) sensors and algorithms for monitoring physical and/or cognitive incapacitation are not available or insufficiently reliable; 3) scientific data of augmented long-haul flights is not valid for predicting effects of monotony and boredom or in-flight sleep and sleep inertia on alertness during eMCO cruise-flight; and 4) medical conditions regarding urination, defecation, or menstruation may cause an unscheduled visit to the toilet of the single pilot flying during cruise flight, who then has to request the resting pilot to take over the controls.

**KEYWORDS:** reduced crew operations, single-pilot operations, aeromedical risk, fatigue, sanitary needs.

Simons R, Maher D, Vermeiren R, Wagstaff AS. *Aeromedical concerns about extended minimum crew operations*. *Aerosp Med Hum Perform*. 2025; 96(7):590–592.

The European aviation industry is exploring possibilities to certify extended minimum crew operations (eMCO), which means two pilots in the cockpit during takeoff, climb-out, approach, and landing, while during cruise flight, one of the pilots operates the aircraft and the colleague pilot rests/sleeps.<sup>1</sup> Cost-effectiveness and longer onboard sleep duration, facilitating extended flight times, are mentioned as rationale. The present paper will focus on the aeromedical safety aspects of eMCO and reflect the aeromedical and human factors concerns based on the results of a scientific literature study and gap analysis performed by the authors in the context of a safety evaluation concerning a potential certification of eMCO.

### Incapacitation Risk Assessment

Current aeromedical incapacitation risk assessment concepts for airline pilots are based on a two-pilot cockpit. The two-pilot cockpit concept is considered a main safety risk-mitigating factor<sup>2,3</sup> because pilots are trained to monitor and correct each other. Incapacitation training is a mandatory part of commercial airline pilot training and pilots are trained to manage the flight in

case their colleague pilot is incapacitated. This is an important determinant of the current “1% rule” risk concept<sup>3</sup> in which a second pilot in the cockpit reduces the risk by a factor of 1000. Because eMCO is a single-pilot flight during the cruise phase, the European Union Aviation Safety Agency’s operational limitations indicate that pilots with a medical condition, such as operational multipilot limitation (valid only as, or with, a qualified copilot), and pilots beyond the age of 60 cannot be certified for eMCO operations.<sup>4</sup> It is concluded that a new aeromedical incapacitation risk assessment concept should be developed before eMCO can be implemented in large aircraft operations.

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This manuscript was received for review in March 2025. It was accepted for publication in April 2025.

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DOI: <https://doi.org/10.3357/AMHP.6671.2025>

### In-Flight Incapacitation

Sudden in-flight incapacitation with loss of consciousness of the single pilot flying during cruise flight might be a catastrophic failure condition because the pilot flying might not be able to activate the sleeping pilot in time. Therefore, eMCO can only be implemented if reliable crew monitoring and alerting techniques are developed, along with new automation techniques, to maintain safety of flight before the resting pilot can take over the flight management. Although many physiological monitoring systems are used in clinical settings to monitor clinical patients, algorithms that use these methods to reliably pick up in-flight incapacitation are currently not available. Dedicated algorithms will have to be developed and thoroughly tested on reliability and predictive value for pilot incapacitation.

Subtle incapacitation is a reduced state of alertness or a mental preoccupation which may result in impaired judgement and impaired performance. A pilot flying with a reduced state of alertness or a mental preoccupation might deny or be unaware of any dysfunction. Therefore, a second pilot in the cockpit is considered as the main safety instrument to prevent incidents/accidents caused by subtle pilot incapacitation. Behavioral methods developed to replace the monitoring function of a second pilot are still in an experimental stage and would have to be thoroughly tested before they can replace intercollegiate monitoring in the cockpit.

### Sanitary Needs

It is generally accepted that most healthy pilots will be able to prevent the urge to urinate or defecate over a period of 2–3 h by using the bathroom before the start of that period. However, in case of significant caffeine intake, drinking larger volumes of fluids, benign prostatic hyperplasia, overactive bladder, dysuria, uncontrollable bowel action, other gastrointestinal symptoms, or unexpected menstrual problems, unscheduled toilet use may be necessary before the end of a 2–3 h period. Since withholding urination or defecation may lead to a deterioration of cognitive function<sup>5,6</sup> and/or abdominal pain, the pilot flying should be able to use the bathroom whenever needed during the eMCO cruise segment. From a medical and human factors point of view, none of the currently evaluated alternative methods for bladder and bowel relief (diapers, urine collectors, relief systems, and diet interventions) seem acceptable or feasible to implement for airline pilots who must remain at the controls in eMCO operations.

It may be possible to schedule toilet breaks and drinking patterns to some extent. However, from the literature it becomes clear that a multitude of mild and common medical conditions regarding urination, defecation, and menstruation can cause an unscheduled urge to use the toilet. In an eMCO operation, with one pilot at the controls, this would mean that the pilot flying might have to declare an incapacitation (i.e., in case of diarrhea, abdominal cramps) and/or request the resting pilot to take over

the controls, which means termination of the eMCO segment and consequently less allowable extension of the flight time.

### Fatigue, Boredom, Sleep Inertia

The conditions during eMCO are incomparable with the current working conditions on augmented long-haul flights, which are characterized by planned rest periods, ample time to wake up after a rest period, and always a minimum of two pilots in the cockpit. Where in augmented long-haul operations available onboard rest time is divided between three or four pilots, available rest time in long-haul eMCO operations will be divided between two pilots, resulting in longer rest times for each pilot. In this context it should be considered: 1) whether the in-flight rest is sufficiently recuperative to keep the single pilot flying sufficiently alert, and 2) what the impact of sleep inertia is on performance and alertness of the resting pilot when taking over the controls.

Available data from current long-haul flights cannot be used for predicting the effects of monotony and boredom, in-flight sleep and sleep inertia, and scheduling factors on fatigue and alertness levels during eMCO operations. Therefore, there is a lack of scientific data concerning the effects of circadian sleep pressure between 02:00–06:00 at night regarding the alertness of a single pilot flying in a monotonous environment with a lack of stimuli. Before certifying eMCO flights, relevant research is necessary to study the combination of circadian sleep pressure and monotony on performance of the pilot flying. It is concluded that the lack of scientific data on aeromedical safety aspects of eMCO necessitates tailor-made studies and considerations before eMCO flights might be certified.

### ACKNOWLEDGMENTS

Ries Simons, M.D., is involved in the research project “Extended Minimum Crew Operations and Single Pilot Operations Safety Risk Assessment Framework” commissioned by the European Union Aviation Safety Agency. The text of the present article solely reflects the opinion of the authors, and not the opinion of the European Union Aviation Safety Agency.

*Financial Disclosure Statement:* The authors have no competing interests to declare.

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### REFERENCES

1. European Union Aviation Safety Agency. Extended minimum crew operations and single pilot operations safety risk assessment framework. 2025. [Accessed January 17, 2025]. Available from <https://www.easa.europa.eu/en/research-projects/emco-sipo-extended-minimum-crew-operations-single-pilot-operations-safety-risk>.

2. DeJohn CA, Wolbrink AM, Larcher JG. In-flight medical incapacitation and impairment of U.S. airline pilots: 1993 to 1998. Oklahoma City (OK): Civil Aerospace Medical Institute Federal Aviation Administration; 2004. Report No.: DOT/FAA/AM-04/16.
3. International Civil Aviation Organization. Manual of civil aviation medicine. 3rd ed. Quebec (Canada): International Civil Aviation Organization; 2012:I-3-4–I-3-5. Report No.: Doc 8984 AN/895.
4. European Union Aviation Safety Agency. Easy access rules for aircrew. Cologne (Germany): European Union Aviation Safety Agency; 2024. Report No.: Regulation (EU) No 1178/2011, revision from December 2024. [Accessed May 13, 2025]. Available from <https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-aircrew-regulation-eu-no-11782011>.
5. Griswold CA, Vento KA, Blacker KJ. Voluntary urinary retention effects on cognitive performance. *Aerosp Med Hum Perform*. 2023; 94(2):79–85.
6. Lewis MS, Snyder PJ, Pietrzak RH, Darby D, Feldman RA, Maruff P. The effect of acute increase in urge to void on cognitive function in healthy adults. *Neurourol Urodyn*. 2011; 30(1):183–187.