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# FATIGUE IN THE AIR AND AT SEA: COMPARING IMPACT AND REGULATIONS IN AVIATION AND MARITIME TRANSPORT

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**Abstract**

*Fatigue poses a significant threat to transportation safety across all modes of transport. This paper examines fatigue, its consequences, and the regulatory frameworks addressing this issue, with a focus on the aviation and maritime industries. A comparative analysis is conducted on differences in legislation governing maximum duty hours, mandatory rest periods, and the risks resulting from non-compliance. By highlighting regulatory differences and their implications, this paper underscores the importance of effective fatigue management to enhance safety in both sectors.*

**Keywords**

*fatigue, aviation, maritime*

## 1. Introduction

Both the air and maritime transport operate in highly dynamic and demanding environments, where fatigue is a dangerous challenge. Crew members onboard maritime vessels live and work onboard ships 24 hours per day, often experiencing irregular and extended shifts in noisy and stressful conditions. Similarly, pilots and flight crews face long duty periods, circadian disruptions, and sleep deprivation, all of which impair cognitive function and reaction times. While fatigue is a natural consequence of such work environments, its effects can be severe, leading to reduced alertness, impaired decision-making, and an increased risk of accidents. Despite existing regulations aimed at managing fatigue, both industries continue to grapple with this issue, necessitating further research and enhanced preventive measures to ensure operational safety.

Comparing the impact of fatigue and the regulatory framework governing work and rest hours in aviation and maritime transportation is important, as both sectors are part of High Risk Industries (HRI) (Kandera et al., 2019), and both require high levels of alertness and decision-making. While fatigue poses a significant safety risk in both transport modes, the frameworks governing work and rest periods differ. An analysis of these differences can reveal potential gaps in existing policies and highlight opportunities for improving fatigue management and overall safety in both industries.

## 2. Fatigue, its impact on decision-making and task performance

Fatigue is a critical factor affecting decision-making and task performance across various sectors and industries, especially in safety-sensitive sectors like aviation and maritime transport. In the following chapters, the main differences effects of fatigue in aviation and maritime sectors will be analysed, highlighting its impact on safety and performance.

### *2.1. Fatigue in maritime*

International Maritime Organization (IMO), specialised agency of the United Nations, dealing with safety-related issues, defines fatigue as "a state of feeling tired, weary, or sleepy that results from prolonged mental or physical work, extended periods of anxiety, exposure to harsh environments, or loss of sleep. The result of fatigue is impaired performance and diminished alertness" (IMO, 2014). Fatigue is widely defined as a complex issue in the shipping industry. In the past, factors such as behaviour, intelligence, training, motivation, and physical attributes were mistakenly supposed to protect seafarers from fatigue. This led to the underestimation of fatigue as a significant contributor to human error (IMO Guidance, 2006). However, recent research disproved this statement, pointing out to the significant effects of fatigue on performance and its role in maritime accidents. fatigue's effects on performance and its role in marine casualties.

The effects of fatigue in the shipping industry are often more severe and potentially fatal compared to other transportation sectors. Seafarers face harsh working conditions, including noise, vibration, heat, and adverse weather, while living and working away from home for extended periods—often up to six months. Additionally, the blurred boundaries between work and relax create a stressful environment. Moreover, the multinational crews add another layer of complexity, requiring individuals from different cultural backgrounds to cooperate in confined and demanding conditions (Galieriková, 2020). Furthermore, operational elements such as varying ship types, ship movement, and unpredictable sea conditions further contribute to the stressful environment onboard maritime vessel.

The effects of fatigue are particularly hazardous due to the specialised and high-risk nature of maritime operations, which demand constant vigilance and intense concentration. Fatigue is

indiscriminate, affecting all workers regardless of skill, knowledge, or training (Interreg, 2018). The confined environment on ships amplifies the problem, as crew members often feel "trapped" in their workplace, with little separation between work and downtime. Research (Galieriková, 2019) highlights that fatigue is a significant contributor to maritime accidents. Based on Galieriková et al (2019), the lapses in judgment, resulting from fatigue, have led to high number of casualties. According to the study, the fatigue as the primary cause, resulted into 16% of accidents at sea and 33% share on total number of injuries onboard maritime vessels.

### *2.2. Fatigue in aviation*

The International Civil Aviation Organization (ICAO), authority that set the minimum international standards for aviation sector, defines fatigue as: “a physiological state of reduced mental or physical performance capability resulting from sleep loss, extended wakefulness, circadian phase, and/or workload (mental and/or physical activity) that can impair a person’s alertness and ability to perform safety related operational duties” (ICAO, 2016) (Kandera et al., 2019). In aviation, the fatigue can impair the ability to process and integrate various stimuli, including visual information (Russo, et al., 2005). It also increases the likelihood of reduced situational awareness, which can compromise flight safety in certain situations. This occurs because the brain struggles to merge information from different sources into a cohesive and relevant understanding of the aircraft's status (Keller, 2022).

Aviation accidents are relatively rare, but when they do occur, statistics indicate that human error is responsible for 80% of cases, with pilot fatigue contributing to 15-20% of fatalities. Fatigue impairs reaction time, concentration, and decision-making abilities, increasing the risk of errors. Additionally, there is the serious hazard - pilots unintentionally falling asleep mid-flight. A survey conducted by the British Airline Pilots' Association (BALPA) among 500 pilots revealed that 43% had fallen asleep in the cockpit, and alarmingly, 31% of them awoke to find their co-pilot asleep as well.

## 3. Regulations of working and rest periods

Regulations on working and rest periods in aviation and maritime transport are established in order to mitigate fatigue and ensure safety. In aviation, authorities like the ICAO, FAA, and EASA set limits on flight duty periods, minimum rest requirements, and fatigue risk management practices. The maritime sector follows regulations from the IMO and ILO, which define work-hour limits, mandatory rest periods, and crew fatigue management measures.

### *3.1. Maritime transportation regulations*

The International Maritime Organization (IMO) and the International Labour Organization (ILO) set limits on work and rest hours as the foundation of fatigue risk management in the international shipping industry. Current regulations permit a maximum of 14 hours of work within a 24-hour period and up to 72 hours within a seven-day span (ILO, 2019). Additionally, IMO (2014) mandates minimum rest periods of no less than 10 hours per 24-hour period and 77 hours per week. Failure to comply with these regulations is a significant contributing factor to maritime accidents, as fatigue impairs cognitive function and decision-making abilities (Galieriková, et al. 2019). The physically and mentally demanding nature of maritime work, prolonged working hours make fatigue an ongoing and serious concern within the industry.

### *3.2. Aviation regulations*

In aviation, regulatory bodies such as the European Union Aviation Safety Agency (EASA) and the Federal Aviation Administration (FAA) set specific limits on flight and duty times to ensure safety. According to EASA regulations, a pilot's flight time must not exceed 100 hours in any 28 consecutive days, 900 hours in any calendar year, and 1,000 hours in any 12 consecutive calendar months. Additionally, pilots are restricted to a maximum duty period of 60 hours in any seven consecutive days and 190 hours in any 28 consecutive days. The FAA imposes similar limitations, capping flight time at 100 hours in any 672 consecutive hours (28 days) and 1,000 hours in any 365 consecutive calendar day period. These regulations are designed to mitigate fatigue and enhance operational safety.

### *3.3. Comparation of regulations in maritime and aviation*

Regulatory bodies in aviation and maritime sectors establish guidelines to ensure the safety and well-being of their respective crews. In aviation, ICAO, FAA and EASA set specific limits on flight time and mandatory rest periods to manage crew fatigue. Similarly, the maritime sector is governed by the IMO and ILO, which regulate working and rest hours to ensure the health of seafarers. The Table 1 shows the key differences between aviation and maritime regulations.

*Table 1. Differences in regulations between aviation and maritime*

| Criteria | Aviation | Maritime |
|---|---|---|
| **Maximum work hours (duty time)** | **FAA**: **14 hrs for a single pilot** (under standard conditions).<br>**2 pilots: 14 hrs** with relief, 16 hrs if flying >8 hours.<br><br>**EASA**: **13 hrs** for a **single pilot.**<br>**2 pilots**: **up to 16 hrs** depending on conditions.<br><br>**ICAO: 12 to 16 hrs**. Recommends maximum duty time of 14-16 hrs based on operational scenarios. | **IMO: 12 hrs/24 hrs.**<br><br>**ILO**: **14 hrs/24 hrs**. |
| **Maximum flight/sea time** | **FAA: 8 hrs in 24 hours.**<br>**2 pilots: 9 hrs.**<br><br>**EASA: 9 hours in 24 hrs** (or up to 10 hrs depending on circumstances).<br><br>**ICAO: 8 to 10 hrs** for flight time **in 24hrs** (or extended based on conditions). | **IMO: 10 hrs per 24 hrs** (typically for **up to 2 consecutive days).**<br><br>**ILO: 12 hrs per 24 hrs** for **up to 3 consecutive** |

| | | |
|---|---|---|
| | | **days, 8 hrs** for **rest.** |
| **Minimum rest periods** | **FAA**: **10 consecutive hrs** between duty periods (for flight attendants and pilots).<br><br>**EASA**: At least **10 hrs** between duty periods.<br><br>**ICAO**: **10 hrs** of rest required for flight crew. | **IMO/ILO: 10 hrs in any 24-hrs**, can be divided into 2 periods. |
| **Break between rest periods** | **FAA; EASA; ICAO**: - typically **12 hours** between duty periods (varies by operation). | **IMO**: **2 hrs** after 6 hrs of work<br><br>**ILO**: not specified. |
| **Maximum work hrs per 7 days** | **FAA: 30 hrs** in **7 consecutive days.**<br><br>**EASA: 60 hrs** in **7 consecutive days (single-pilot).**<br>**2 pilots: 100 hrs.**<br><br>**ICAO**: - **60 hrs** in **7 consecutive days.** | **IMO/ ILO: 72 hrs** per week. |
| **Consecutive Work Days** | **FAA, EASA, ICAO: 6 consecutive days, with 1 rest day** required **each week.** | **IMO/ILO: 6 consecutive days,** mandatory rest after. |

Source: Authors based on data from IMO, ILO, EASA, FAA ICAO.

The aviation sector has stricter regulations than the maritime sector, particularly in terms of maximum work hours. Aviation authorities like FAA, EASA, and ICAO enforce tighter duty time limits, requiring pilots to rest more frequently due to the safety risks associated with fatigue in flight operations. In contrast, the maritime sector (IMO and ILO) allows longer work hours and more flexible rest periods because ships operate continuously over long voyages, and crews can rotate shifts to manage fatigue. The key difference is that aviation prioritises strict fatigue management due to the high risk of accidents from pilot exhaustion, while maritime regulations allow longer duty periods since ship operations are less time-sensitive and often involve multiple crew members sharing responsibilities.

## 4. Comparation of fatigue in maritime and aviation

Fatigue is a critical issue in both the aviation and maritime sectors, but its causes, effects, and regulatory responses differ significantly due to the nature of each industry. Aviation fatigue is often short-term and acute, primarily caused by jet lag, early departures, night flights, and irregular schedules. Pilots must remain alert for quick decision-making in high-risk situations such as take-offs, landings, and various emergencies. In contrast, maritime fatigue is more long-term and cumulative, developing over extended voyages due to long shifts, monotony, and extended time at sea.

In aviation, fatigue leads to impaired reaction times, reduced situational awareness, and poor judgment, which can be catastrophic given the rapid nature of flight operations. The aviation sector is highly regulated, with strict duty-hour limitations, mandatory rest periods, and fatigue risk management systems (FRMS) enforced by authorities like FAA, EASA, and ICAO (Gander, et al., 2011). By contrast, in maritime transport, fatigue builds up over weeks or months due to long working hours, minimal crew rotations, and disrupted sleep cycles (Galieriková, 2019). While maritime work does not demand the split-second reactions seen in aviation, slow decision-making and loss of concentration can lead to navigational errors, grounding, and collisions, sometimes with severe environmental and financial consequences (Akerstedt, 2000).

The work environment also shapes fatigue differently in both sectors. Pilots operate in a high-stress environment, facing intense workloads within short time frames, but they benefit from strictly regulated duty limits and scheduled rest periods. On the other hand, the seafarers experience long periods away from home, unpredictable work schedules, and extended exposure to noise, vibration, and harsh weather, which contribute to mental and physical exhaustion. Additionally, maritime regulations (IMO and ILO) addressing the issue of fatigue, are often less strictly if compared to aviation, with more flexible interpretations of work-rest balance.

While both sectors recognise fatigue as a major safety hazard, aviation regulations tend to be stricter and more proactive, while maritime rules offer greater flexibility but risk chronic fatigue accumulation. Addressing these differences requires industry-specific fatigue management strategies, ensuring that both pilots and seafarers can operate safely and effectively within their unique work environments.

## 5. Conclusion

Aviation and maritime transport are crucial for global connectivity but face serious fatigue-related challenges. Aviation crews manage irregular schedules, jet lag, and demanding flight operations, making fatigue a persistent safety risk. However, scientifically based scheduling and collaborative fatigue management can enhance safety. In maritime transport, long shifts and prolonged sea time lead to chronic fatigue, impairing cognitive function and increasing accident risks. Strengthening fatigue management strategies through better enforcement of rest periods, improved crew rotations, and enhanced monitoring can improve safety in both transport sectors. Addressing fatigue as a systemic issue rather than an individual responsibility will be key to maintaining efficient and secure operations in aviation and maritime transport.

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