



**Paper prepared for the**

**ETSC “Meeting to discuss the role of EU FTL legislation in reducing cumulative fatigue  
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**by**

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## Preface

ETSC first became involved in the issue of flight-time limitations through being invited to participate in the FTL forum hosted by the European Commission in 1996. Several things were immediately clear from that meeting:

- There was a lack of consensus about the way forward between the interests represented around the table.
- A long time had already been spent under the auspices of the JAA in attempting to achieve a resolution of this issue.
- The scientific and medical evidence on the issue of duty times and fatigue and alertness was not well understood by all the delegates.
- Certain critical issues, such as time-zone transitions were not being effectively addressed in current regulations or in new proposals.

Following the forum, the Commission established a task force on Flight Time Limitations, representing the operators, the employees, the national authorities and the scientific community. The scientific community was represented through the ETSC by its Executive Director Jeanne Breen, Hans Wegmann, M.D. of the DLR and Dr. Nick McDonald of Trinity College Dublin. Subsequently Dr. Alexander Samel replaced Dr. Wegmann. In the context of new European regulation, the task force was an important development in so far as it represented a commitment to formulate safety regulation which fully took account of the scientific evidence.

There is a remarkable level of agreement in the extensive international scientific evidence about the basic parameters of sleep and alertness in relation to flight operations. Such is this agreement of fact that the leading international scientists have been able to formulate a consensus document with broad recommendations about how these parameters should be taken into account in formulating FTL regulations<sup>1</sup>.

The regulation of duty or working time represents at the same time one of the oldest forms of safety regulation and one of the most difficult. It sometimes seems that each generation has to learn the same safety lessons afresh – the hard way. The difficulty partly arises because time on-duty represents one of the core dimensions of transport operations, as well as one of the key determinants of the style of life and well-being of those who work in transport. For this reason the evidence about safety has too often played only a minor role in the work- or duty-time negotiation between the social partners. Even now, there are some representing the transport operators who seek to dispute the relevance of scientific evidence to determining this issue. However it is also clear that some operators follow exemplary practice, based on the scientific and medical evidence, in their internal management of fatigue and alertness. Nevertheless, there was, increasingly, a real sense in the task force that some of the major interests were reserving their position and that, despite the efforts of the Commission, that this was not fundamentally a serious attempt to achieve an effective and viable resolution between the scientific and medical evidence on the one hand and the operational requirements of civil aviation on the other.

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<sup>1</sup> Dinges, D.F., Graeber, R.C., Rosekind, M.R., Samel, A., & Wegmann, H.M.(1996): Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation. NASA Technical Memorandum 110404. Washington DC: National Aeronautics and Space Administration.

The difficulty of achieving a 'one-size-fits-all' regulation, including both short and long haul operations, was always apparent. The airline operators require flexibility and geographical location will always reflect the viability of particular flights in a prescriptive scheme. Two trends directed attention to the future as well as current problems. The increasing intensification of daily work in flight operations led the task force to an entirely new consideration in FTL schemes: the necessity of including provision for meal breaks in the regulations because these could no longer be taken for granted, in the case of cabin crew. The second concerns the increasing technical capacity for very long flights which exceed the parameters of any current FTL scheme.

In order to address these issues ETSC proposed a framework for a new regulation in which some flexibility could be allowed within an envelope of acceptable limits. However, that flexibility would require an active approach to the management of fatigue and alertness on the part of the operators and a requirement for the national authorities to monitor the real impact of such rostering schemes on the incidence of fatigue and to allow for confidential reporting of unsafe situations.

Despite the intensive work over the nearly three years of its existence the task force failed to achieve consensus over the successive drafts of proposed regulations, despite the efforts of the Commission, and particularly its chairman Claude Probst. His position always returned to a concern that a regulation that purports to ensure and improve safety should be as far as possible compatible with the evidence about safety. It is because of concerns in ETSC and amongst the members of ECASS that the subsequent proposal drafted by the European Parliament's rapporteur, Mr. Simpson, does not fully reflect the scientific evidence that the present workshop has been convened.

## **Scientific Overview**

The operational demands of the aviation industry require activities to be carried out round the clock, and the growth in global long-haul, regional, overnight, and short-haul operations will continue to increase this 24-hour requirement. As a result, flight crew must be available and able to support operations for 24 hours a day to meet these industrial demands. In addition, travel across multiple time zones is a feature of much activity in international aviation. Therefore, shift work, night work, irregular work schedules, unpredictable work schedules, and time zone changes will continue to be commonplace components of the aviation industry. These factors pose known challenges to human physiology, and because they result in fatigue and performance impairment they pose a risk to safety. It is estimated (e.g. by the NTSB) that fatigue contributes to 20-30% of transport accidents (i.e. air, sea, road, rail). Since, in commercial aviation operations, about 70% of fatal accidents are related to human error, it can be assumed that the risk of the fatigue of the operating crew contributes about 15-20% to the overall accident rate. The same view of fatigue as a major risk factor is shared by leading scientists in the area, as documented in several consensus statements.

Several factors are involved in the development of fatigue: the time of day that duty is undertaken, a loss of sleep before the start of duty, and long spans of wakefulness during the working day. These factors determine in a predictable way the background level of fatigue/alertness at any given moment. In addition, there are acute influences such as the duration of the duty period, monotony, and environmental factors at the workplace (i.e. on the flight deck).

The main cause of problems associated with unusual rest and activity patterns, such as those experienced by aircrew, is the conflict with the biological clock, situated in the hypothalamus in the brain, which synchronizes our activity with that of the environment. This clock guides the circadian rhythm by activating the body, through increased metabolism during the day, and reduced levels at night, to promote recuperation. This results in lowered wakefulness and functional capability at night and increased alertness during the day. The reduction in performance at the lowest point (around 05:00h) is severe and will markedly impair various aspects of performance including attention, reaction time and co-ordination. Furthermore, sleep taken after night duty will be truncated by 1-2 hours, because the circadian rise of metabolism in the morning will interfere with the sleep process. Here 'night' refers to the biological night. Thus, if sleep is taken during a local night after a 6-9h westward time-zone crossing, it will be displaced during the biological day even though it is taken during the local night time. The reason for this is that the biological clock will adapt only gradually and the individual will retain his/her original biological night for some days after arrival in the new time zone. This phenomenon is generally known as 'jet-lag'.

Sleep is a state of pronounced physiological regeneration. The ideal sleep duration for full recuperation seems to lie around 8.5 hours, although acute sleep loss of 1-2 hours has little significant effect on fatigue or performance. A sleep deficit of more than 2 hours has a discernible effect and an acute reduction of sleep to below 6 hours will cause increased fatigue and reduced performance in most individuals. Sleep loss will also accumulate across time: 5 hours of sleep per day will be equivalent, in terms of fatigue and performance, to one full night of sleep loss after 5 days. Sleep reduction usually arises as a result of night work, time zone shifts and early rising. There are other factors, like stress, disease, noise, vibrations/movement, or an upright sleep posture that can also influence sleep quantity and quality. Indeed, it should be emphasized that 8 hours of sleep may fail to provide restitution if it is highly fragmented as a result of these or other disturbing factors. This is particularly likely to be the case with sleep taken during the day, when a range of environmental factors often contribute to sleep disturbance.

The various factors that contribute to fatigue, including time since sleep, circadian rhythm and sleep loss, are individually capable of causing dangerous impairments in performance. However, the most serious problems arise when they combine to provide even larger impairments. Night duty will involve work at the circadian trough and an extended time awake. The two together will cause psychomotor impairment similar to that which is seen after the ingestion of enough alcohol to generate a blood alcohol level of 0.08% (which is significantly beyond the drink-drive limit in most European countries). If the lack of sleep extends into the next day (comparable to the late morning after a 6-hour time-zone crossing without any post-flight sleep), there is a large impact on memory processes – with an impairment in the ability to respond to changed circumstances. The effects are further exacerbated in the event that prior sleep (i.e. before the flight/night duty) has also been disturbed.

Any regulatory countermeasure against fatigue risks from work timing must include consideration of the circadian timing of work, possible adjustment to other time zones, total time spent awake and the size and temporal position of the daily rest period. Therefore, it is critical to acknowledge and, whenever possible, incorporate scientific information on fatigue, human sleep, and circadian physiology into 24-hour aviation operations. Utilization of such medical / scientific information can help to promote crew performance and alertness during flight operations and thereby maintain and improve the safety margin. For the formulation of flight time limitations and rest requirements, the understanding of the factors that generate

fatigue and affect performance can provide an important contribution to the increased safety of the commercial aviation industry.

## **Aircrew studies**

A considerable amount of data have been collected over the past 20 years on the sleep and alertness of aircrew, and a large majority of these studies have been carried out by European scientists. Indeed, we believe that this is an area where we, in the European Union, can claim to be at the forefront of research. Several years ago, we formed ECASS (the European Committee for Aircrew Scheduling and Safety) to ensure that all those involved in this work, and at present this includes five laboratories, could meet on a regular basis and co-ordinate their various research activities in this area.

Another objective in the formation of ECASS was to provide a unified source of advice on aircrew fatigue to the European airline industry, including operators, regulators and aircrew and their representatives. We would certainly see it as part of our responsibility to provide scientific input to the debate on European flight-time limitations. We were therefore disappointed not to have been consulted at any stage in the formulation of the current EP-proposal and we welcome the opportunity that has now been given to us to state our position. We would emphasize that the individual members of ECASS are united in their views, and that this paper therefore represents the combined opinion of the scientific community within the EU.

Data have been collected extensively over a wide variety of different types of operation, ranging from short-haul and integrated tour operations to long-haul two-crew operations and very long-range flights with augmented crews. We have collected subjective information from the crews using diaries of sleep and wakefulness and objective information using performance tasks and EEG measures on the flight deck. We have also recorded the quality of the sleep before and after a flight and in the bunk facilities on board the aircraft. In addition, some studies have involved the collection of physiological measures such as heart rate, hormone levels and body temperature. We estimate that these studies have covered a total of over 1,000 aircrew on more than 15,000 individual flights. This clearly represents a large body of information on which to base our understanding of aircrew fatigue and the issues related to flight-time limitations.

The analysis of the data from these studies has enabled us to evaluate the relative impact of many of the factors that are known to influence the alertness of aircrew. These include the circadian rhythm, or body clock, the reporting time, the time on duty, the number of sectors, the number of time-zones crossed and the number of consecutive flying days. Between us, we have developed computer models that incorporate this information, and provide an instant evaluation of alertness levels on any given roster. It is possible for us to compare the effects on fatigue of different rosters and to estimate the effects of modifying the pattern of duty in different ways. We can also relate the effect of fatigue at different times during a flight to equivalent levels of blood alcohol concentration on various measures of performance, as well as estimate the probability that either a single pilot or both pilots will be asleep on the flight deck at any particular time. This is the background, therefore, for our assessment of the provisions of this proposal.

# Comments on the EP-Proposal

## General comments

A common European approach to flight-time limitations, which has been the subject of discussions and debate for many years, is now urgently required, to provide further support for the formation of a single market for commercial aviation within Europe. For this reason, ECASS welcomes the intention of the EP-proposal to build such a common basis within Europe, by providing regulations that are compulsory for all members of the European Union. To the extent that it specifies common flight-time limitations and rest requirements, the EP-proposal will harmonize the individual national regulations which have widespread deviations between each other. In addition, through the formulation of the provisions, the EP-proposal sets limits to the worst excesses of some existing regulations which currently raise concerns for flight safety.

It is therefore to be regretted that the proposal is so limited in its scope. For example it is concerned only with short-haul flights, i.e. generally only those within Europe. This is because there is no account taken of the fatigue associated with travel across time zones and the problems of the unacclimatized individual (see below: specific comments). Moreover, although the majority of inter-continental flights carry an augmented flight crew (either enforced by national rules and/or by industrial contracts), there is no specific common provision in this proposal for crew augmentation. It is left to the national regulator under provision F 1:

***“ Flight Crew Augmentation: An Operator will agree with the responsible Civil Aviation Authority the Regulations in connection with the augmentation of a basic flight crew for the purpose of extending the flight duty period beyond the limits in D above;”***

This invites operators to deviate from (stricter) current national practices and to utilise provisions D (Maximum Daily Flight Duty Period) and E (Rest) for the establishment of rosters that are currently not permitted by their national rules. “Responsible Civil Aviation Authorities” may be compelled by commercial pressures to ease their national regulations with respect to the provisions of regulations of other nations (since these may be less restrictive).

The proposal also departs from its objective of harmonizing the regulations by permitting individual authorities to over-ride the rules. For example, the provision E 1.3:

***“Notwithstanding 1.2 and provided that an adequate level of safety is demonstrated, the responsible Civil Aviation Authority will grant reduced rest arrangements based on existing national legal provisions.”***

invites operators to deviate from the EP-provisions in the case of a more favourable national regulation. Thus, even a minimum rest period of 10 hours (provision E 1.2), which, in many cases, may not provide sufficient time for recovery (see below: specific comments), can be further reduced. Again, pressure may be used to change a national provision in one country in line with a less restrictive regulation of another country.

The ability of the national regulator to specify additional provisions is enshrined in provision A2.1:

***“The flight and duty time limitations and rest scheme is in accordance with both:***

***a) the provisions of this Subpart; and***

***b) any additional provisions that are applied by the responsible Civil Aviation Authority for the purpose of maintaining safety;”***

In particular, this would even permit the retention of all existing national regulations, where they lie within the proposal. The only effect of the current EP-proposal would then be to limit some of the most excessive practices that may be allowed under some existing national rules. In principle, there could be no objection to this, since there would be no additional adverse effect on flight safety, if all existing regulations within the EP-proposal limits were retained. However, the concern that we, as members of ECASS, would have, is that this could place intolerable pressures on the regulating authorities who would be seen as opposing a move to the 'level playing field'. Operators would still be able to relocate to a more favourable location (i.e. to a different European country with more liberal rules). There would be a clear competitive advantage for those airlines who operate as close as possible to the limits specified in the EP-proposal.

These examples highlight some loopholes which the industry could exploit, within the different regulations, to promote their economic benefit. It is the opinion of ECASS that this ability could easily

- (1) violate the attempt to create a harmonised common regulation, that should define a mutually agreed basis for competition within the industry;
- (2) place intolerable pressure on national authorities and the airline industry;
- (3) lead eventually to the whole of the European airline industry working up to the limits specified in the EP-proposal.

There will be no 'level playing field' while individual national schemes are allowed to persist. As the only harmonized scheme available is the one currently under discussion, it is naïve to suppose that the pressures to move to the limits defined therein may not soon become intolerable. It is important, therefore, to assess the protection provided by the specific provisions of the EP-proposal.

### **Specific comments**

In commenting on the specific proposals, we take into account the proclaimed goal of the European Union with regard to aviation safety and human factors, namely to reduce the accident rate by 50% in the short term and 80% in the long term. In addition, the objective is explicitly stated in the 6<sup>th</sup> Framework Research Programme of achieving a 100% capability for avoiding or recovering from human error. The role of adequate FTL-regulations in meeting this objective is based on the large proportion (estimated at 70%) of fatal accidents caused by human error and the known contribution of fatigue to human error.

Based on our current understanding of physiological and psychological factors contributing to fatigue in aviation operations, it is our view that there would be a significant increase in the risk of fatigue-related incidents and accidents if operators were permitted to operate to the limits specified in the EP-proposal. It will be sufficient to highlight some of the most significant issues.

#### **(1) Section D: Maximum Daily FDP:**

The extensions specified in paragraph D2, in combination with the provisions of paragraph D1.3, lead to a maximum FDP between 12 hours during the night (or 11:45h, if the conditions of D2.7 apply) and 14 hours during the day.

The ability of aircrew to sustain levels of alertness during long flight duty periods has been the subject of many scientific investigations. There is an interaction between time of day, or circadian factors, on the one hand, and time since sleep and time on task on the other, with the result that duties at certain times of day are particularly susceptible to the effects of fatigue.

- a. Night duty (flights ending during / extending through the WOCL).  
Scientific investigations show that the night duty hours are especially vulnerable to severe fatigue. The longer the duty period extends the greater the pressure for sleep becomes, and there is strong evidence to show that many crews fall asleep, either voluntarily or involuntarily, on the flight deck. The longer the flight, the greater the risk that both pilots will fall asleep at the same time. Their ability to respond to an emergency situation, or to land the plane in adverse conditions, may also be severely impaired. For this reason, ECASS is concerned about the 1- and 2-sector limits for FDPs and cannot support duty periods as long as 12 hours when the WOCL is encroached.
- b. Duty during day time – early departures.  
Whereas long duty hours can be sustained during many day-time flights, specific problems are associated with early starts. Early start times are inevitably associated with a loss of sleep, the result of which is lower levels of alertness throughout the entire duty period. The effect is exacerbated over several successive early starts, due to an accumulating sleep deficit. ECASS has no objection to an FDP of 12 hours during the day, but does not support FDPs as long as 14 hours for early starts.

(2) **Section E: Minimum Rest**

Rest periods should provide sufficient time to recover from the immediate effects of the previous flight and to obtain sufficient sleep prior to the next report. For this reason, ECASS is concerned with provision E1.2:

*“The minimum rest which must be provided before undertaking a flight duty period starting away from base shall be at least as long as the preceding flight duty period or 10 hours whichever is the greater; when on minimum rest away from base, the operator must allow for an 8 hour sleep opportunity taking due account of travelling and other physiological needs;”*

which is contrary to the provision for rest at home base. A sleep opportunity of 8 hours may not be sufficient after a night flight or a flight with a large (= 4 hours) time difference. Scientific investigations show that sleep during the day on layover (before commencing another flight duty) is shallow, disrupted and shorter than during the WOCL. This has a detrimental effect on alertness during the subsequent flight duty. ECASS recommends that E1.1 is also applied to rest time away from base. Provision E1.3, which permits the further reduction of minimum rest based on existing national provisions, has been discussed earlier. It should be dropped both for scientific reasons and because it violates the standards and the spirit of a common European regulation.

(3) **Time-zone transitions**

As previously mentioned, provisions against the fatigue-inducing effects of time-zone differences are not included in the EP-proposal. Scientific studies have clearly demonstrated that flights across 4 or more time zones lead to the disturbance of sleep and circadian rhythms. As a result of these disturbances, more time is required to recuperate, both during layover and after return to base, before further flying duty is undertaken. ECASS recommends that provisions are included for a longer sleep opportunity (rest time) during layover and an extended resynchronisation period after return to base. For example, the latter could be combined with the rest period provided by provision E 2.



We have highlighted three areas where we do not believe that the EP-provisions would, on their own, provide sufficient protection against the risks associated with fatigue. There are other areas, for example the failure to address consecutive night duties and consecutive early starts. However our main concern is not just with these individual aspects of the proposal. It is that, when taken together, and applied in an environment of increasing competition, individual airlines may be encouraged, or indeed compelled by business considerations, to operate everywhere close to the defined limits. In that case, ECASS would certainly consider it likely that this would lead to a significant reduction in the safety of airline operations. ECASS therefore recommends that the current EP-document is redrafted to reflect the scientific position more closely and, if required, we would be happy to provide more detailed input to assist in this process.

### **A possible way forward**

Since, in our view, the current EP-proposal does not provide a sufficient and – in many provisions - acceptable basis for a harmonized scheme, it is necessary to consider what alternative approaches are available. One possibility is that the current proposal could be amended to take account of the objections that have been made on scientific grounds. This would lead inevitably to a set of limits for all operations that would generally be more restrictive than those of the current EP-proposal. However, there are several problems with this approach, the first of which is the extreme difficulty in defining such a scheme. This is because, in order to avoid being too conservative on the one hand and too restrictive on the other, it would need to take into account the many complex interactions between all the various key factors. Moreover, any such scheme would inevitably be inflexible, and include rigid rules that would be seen to impose arbitrary limits. The main reason, however, for questioning the practicality of following this path is that the attempt to define a single regulative scheme for Europe has been tried many times before without success. Every initiative over the past 10 years or more has ended in failure.

There is another approach that we believe should be given at least some consideration. It would move away from a rigid regulatory framework and place more responsibility on individual operators for the fatigue management of their own operations. The present EU-proposal could still be retained as an ‘outer circle’, although we believe that it would need to be modified to correct some of its worst excesses and most glaring omissions. It might also be possible to define an ‘inner circle’ within which all schedules would be considered acceptable with regard to fatigue. However, the main difference with this approach is that it would allow flexibility to individual operators to define their own schemes and to demonstrate that they are safe. The elements of this approach would include:

- 1) the requirement for operators to submit their own schemes within the limits of the regulations, and to define their own procedures for fatigue management;
- 2) a European body which would evaluate the operators’ schemes, with access to expert advice;
- 3) the implementation of monitoring and auditing systems;
- 4) a confidential reporting system for fatigue-related issues, administered by an independent body with the ability to influence the audit process.

Such an approach would avoid the rigidity of fixed regulatory schemes and provide the flexibility for individual airlines to operate differently according to the demands of their particular operations. It could also take into account, where appropriate, cultural differences between different parts of Europe. At the same time, it would provide a framework which would ensure that the same standards are applied everywhere within the European Union.