Federal Aviation Administration
Aviation Rulemaking Advisory Committee

Air Carrier Operations Issue Area
Fatigue Countermeasures and Alertness Management Techniques Working Group

Task 1 – Develop AC for Fatigue Countermeasures and Alertness Management

Task Assignment

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee, Air Carrier Operations--New Task

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of new task assignment for the Aviation Rulemaking Advisory Committee.

SUMMARY: Notice is given of a new task assigned to the Aviation Rulemaking Advisory Committee (ARAC) and its decision to form the Fatigue Countermeasures and Alertness Management Techniques Working Group to analyze and recommend to it solutions to issues contained in the assigned tasks. This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT:
Quentin Smith, Flight Standards Service, Federal Aviation Administration, 800 Independence Ave., SW, Washington, DC 20591, Telephone: (202) 267-8166.

SUPPLEMENTARY INFORMATION:

Background

The Federal Aviation Administration (**FAA**) has established an Aviation Rulemaking Advisory Committee (ARAC) (56 FR 2109, January 22, 1991; and 58 FR 9230, February 19, 1993). ARAC provides advice and recommendations to the **FAA** Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the **FAA**'s rulemaking activities with respect to aviation-related issues. One area ARAC deals with is Air Carrier Operations issues. These issues involve the operational requirements for air carriers, to include crewmember requirements, airplane operating performance and limitations, and eequipment requirements. The new task is related to these issues.

Task

The following new task is being assigned to ARAC:

To develop an advisory circular that ourlines fatigue countermeasures and alertness management techniques that could improve safety in air transportation. This advisory circular will discuss the current state of the knowledge associated with the physiological mechanisms underlying fatigue; demonstrate how this knowledge can be applied to improve flight crew rest, alertness, and performance; and provide practical recommendations for use by crewmembers.

A recommendation in the form of an advisory circular, or other advisory material, will be submitted in a format prescribed by the **FAA**. The recommendation should be fully justified, and the justification should be presented as part of the recommendation.

ARAC recommendations to the **FAA** should be accompanied by appropriate documents. Recommendations for rulemaking should be accompanied by a complete draft of the notice(s) of proposed rulemaking, including the benefit/cost analysis and other required analyses. Recommendations for the issue of guidance material should be accompanied by a complete advisory circular.

ARAC Activity

In order to carry out the functions of the committee to develop advice and recommendations, ARAC may choose to establish working groups to which specific tasks are assigned. Such working groups are comprised of experts from those organizations having an interest in certain tasks assigned to ARAC. This notice is intended to notify the public that ARAC is establishing the Fatigue Countermeasures and Alertness Management Working Group.

Working Group Formation

Any individual who has expertise in the subject matter and wishes to become a member of the Fatigue Countermeasures and Alertness Management Techniques Working Group should contact the person listed under the caption FOR FURTHER INFORMATION CONTACT expressing that desire, describing his or her interest in the task, and the expertise he or she would bring to the working group.

Working group recommendations must be reviewed and approved by ARAC. If ARAC accepts the working group's recommendations, it forwards them to the **FAA** as an ARAC recommendation.

Working Group Reports

Each working group formed to consider an ARAC task(s) is expected to comply with the procedures adopted by ARAC and given to the working group chair. As part of the procedures, the working group is expected to:

A. Recommend a work plan for completion of the task(s), including rationale, for consideration at the meeting of ARAC to consider Air Carrier Operations issues held following publication of this notice.

B. Give a detailed conceptual presentation on the task to ARAC before proceeding with the task.

C. Give a status report on the task at each meeting of ARAC held to consider Air Carrier Operations issues.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary in the public interest in connection with the performance of duties imposed on the **FAA** by law. Meetings of ARAC will be open to the public except as authorized by section 10(d) of the

Federal Advisory Committee Act. Meetings of the Fatigue Countermeasures and Alertness Management Techniques Working Group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on March 22,1995.

Quentin Smith,

Assistant Executive Director, Aviation Rulemaking Advisory Committee.

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BILLING CODE 4910-13-M

Recommendation Letter

AIR LINE PILOTS ASSOCIATION, INTERNATIONAL
535 HERNDON PARKWAY □ P.O. BOX 1169 □ HERNDON, VIRGINIA 20172-1169 □ 703-689-2270
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April 8, 1999

Mr. Thomas E. McSweeny
Associate Administrator for Regulation and Certification
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Dear Mr. McSweeny:

The Aviation Rulemaking Advisory Committee Air Carrier Operations Issues Group was given a task to develop an advisory circular on fatigue countermeasures. A working group was established to perform this task.

This task has proceeded slowly for a number of reasons. We have recently been given a draft advisory circular by the working group. It has not received the appropriate FAA review and may need some additional technical work.

This draft AC was discussed at a recent meeting of the Air Carrier Operations Issues Group. The group decided to forward the draft AC to the FAA in the interest of expediency. There are now two courses of action: have the FAA complete the draft and publish it for comments or retask the Issues Group to complete the draft and forward it to the FAA for publication for comments. A great deal of effort and technical expertise has gone into this draft AC, it provides valuable and much-needed guidance, and work should be completed on it.

The Issues Group stands ready to assist in completing the draft AC.

Sincerely,

William W. Edmunds Jr.

William W. Edmunds, Jr., Chairman
ARAC Air Carrier Operations Issues Group

WWE: as

Enclosure

Acknowledgement Letter

MAY 24 1999

Mr. William W. Edmunds, Jr.
Chairman, ARAC Air Carrier Operations Issues Group
Air Line Pilots Association
P.O. Box 1169
Herndon, VA 20172

Dear Mr. Edmunds:

Thank you for your letter of April 8 forwarding the advisory circular material on fatigue countermeasures that was developed by the Fatigue Countermeasures Working Group under the Aviation Rulemaking Advisory Committee (ARAC) for Air Carrier Operations.

The Federal Aviation Administration (FAA) appreciates the accomplishments of this working group. I understand that participation on the working group included members from other countries, which makes its recommendation for advisory material especially worthwhile for the FAA. Rather than re-task another working group, it seems more logical for the FAA to develop the advisory circular. I appreciate your offer of the alternative option, however.

Please convey my thanks to the working group for their dedication in providing much needed materials on the important issue of fatigue. I appreciate, too, your leadership of the Air Carrier Operations membership.

Original Signed By
Margaret Gilligan

Thomas E. McSweeny

Associate Administrator for
Regulation and Certification

Recommendation

Proposed Draft Advisory Circular
Fatigue Countermeasures

Purpose/Overview

This Advisory Circular (AC) provides individuals with an introduction to managing fatigue in aviation operations. The AC is divided into three sections. The first section provides basic information on the physiological factors that underlie fatigue. The second section presents information on personal alertness strategies, including both preventive and operational fatigue countermeasures. The third section examines practical considerations of managing fatigue in four specific flight environments.

It is important to acknowledge that managing fatigue in aviation operations is a complex task, and any industry-wide attempt to address these issues requires participation from all areas, including federal agencies, industry organizations, companies, and individuals. The information contained in this document merely introduces the topic, focusing on personal strategies for individuals. Many sources are available that provide more in-depth discussion of these issues, outline in detail the challenges to aviation operations, and describe comprehensive, scientifically-based approaches to fatigue management (see representative references).

The Issue

Maintaining aviation safety is a complex endeavor. Despite sophisticated technological equipment, human operators (pilots, controllers, maintenance personnel, and others) are central to safe, efficient flight operations. Human-related error accounts for approximately 70% of all transportation accidents, including aviation. Fatigue has been identified as a significant factor that contributes to human error in the industry. Over 20% of incident reports to NASA's Aviation Safety Reporting System (ASRS) refer to fatigue. The National Transportation Safety Board has cited fatigue as a probable cause in the aircraft accident involving a DC-8 in Guantanamo Bay, Cuba, and as a contributing factor in several other aircraft accidents.

Flight operations can lead to fatigue, disruption of sleep and circadian rhythms, and degradation of alertness and performance. Clearly, these factors affect operational safety. Acknowledging and managing these physiological challenges promotes safety and performance in flight operations, while ignoring them can increase the potential for errors, incidents, and accidents. Fortunately, a wide range of strategies is currently available to effectively manage fatigue in flight operations.

The first step in any effort to manage fatigue must be education, because even the most effective strategies cannot be used optimally without a basic informational foundation. Since the task of

managing fatigue is a shared responsibility among individuals, companies, industry organizations, and federal agencies, education should occur in each of these groups. The ultimate goal is to maintain—and wherever possible—enhance safety and performance in aviation operations. By developing effective, personalized approaches to managing fatigue, individuals in the aviation industry benefit themselves and contribute to that overall goal. This AC is only one element of any comprehensive effort to successfully address fatigue in aviation operations.

Basic Human Physiology: Sleep and the Circadian Clock

Sleep Basics

1. Sleep is a vital physical need. Like food, water, and air, sleep is required by the body for survival. Further, sleep is a critical requirement for alertness and performance. Data collected during actual flight operations demonstrate that, with sleep loss, alertness and performance degrade significantly; conversely, with sleep, alertness and performance can be optimized.

2. Sleep is a complex physiological process. Sleep comprises two distinct components. NREM (non-REM) sleep generally involves restoring the body, while REM (rapid eye movement) sleep generally involves restoring the mind. NREM sleep is divided into four stages, with stages 3 and 4 being the deepest sleep.

3. Average sleep requirement is 8 hours. An individual requires the amount of sleep necessary to achieve full alertness and an effortless level of functioning during waking hours. Most adults require about 8 hours of sleep, though there is a range of individual sleep-needs (e.g., about 6 to 10 hours).

4. Sleep debt: lost sleep accumulates. An individual who requires 8 hours of sleep and obtains only 6 hours is sleep-deprived by 2 hours. If that individual sleeps only 6 hours each night over 4 nights, then the sleep loss accumulates into an 8-hour sleep debt. Estimates suggest that in the U.S. today, most adults obtain 1–1.5 hours less sleep per night than they actually need. Generally, recovery from a sleep debt involves obtaining deeper sleep and sufficient amounts over 1 to 2 nights.

5. Sleep changes with age, alcohol, and disorders. Some of the most significant changes to sleep occur as a natural function of age. While younger people sleep more and deeper, as people age, they get less sleep during the night (although they still need the same amount), get less deep sleep, and have more awakenings. Sleep also changes with alcohol consumption. Although many people use alcohol to "wind down" and foster sleep, it can actually reduce sleep quality and quantity overall. Alcohol can reduce REM sleep in the first half of night, then disturb sleep in the second half of night.

A range of physiological sleep disorders also can disturb the quantity and quality of sleep, and subsequently can degrade waking performance and alertness. In any given year, about one third of American adults report a sleep disturbance. This figure is conservative, considering that sleepers often are unaware of these disturbances. One example of a common disorder is sleep apnea, characterized by a cessation of breathing during sleep that causes the sleeper to awaken repeatedly to resume breathing. A cardinal symptom of sleep apnea is snoring (although there are other causes for snoring besides sleep apnea). Sleep apnea is an example of a sleep disorder that is a well-documented health risk and can significantly reduce waking alertness and performance. Evaluation and treatment for sleep disorders are available at accredited Sleep Disorders Clinics.

6. Physiological vs. Subjective Sleepiness. Two aspects of sleepiness can be considered: physiological and subjective. Physiological sleepiness is the result of sleep loss: lose sleep, get sleepy. Sleep loss will be accompanied by increased physiological sleepiness that will drive an individual to sleep in order to meet the physiological need for sleep. Subjective sleepiness is an individual's introspective self-report of how sleepy they feel. Subjective reports of sleepiness can be affected by many factors, such as physical activity or a particularly stimulating environment (e.g., an interesting conversation), which tend to mask or conceal physiological sleepiness and lead people to overestimate their own level of alertness. Subjective reports of sleepiness often differ significantly from physiological measurements; individuals will generally report greater alertness than indicated by physiological state. Applying this fact to operations means that a flight crewmember who reports being alert, in fact, may be close to falling asleep.

7. Daily Maximum Sleepiness. Humans are hard-wired to experience two periods of physiological sleepiness each day. These are at about 3–5 AM and 3–5 PM, and are dictated by the circadian system controlled by the brain.

Circadian Basics

1. The Circadian Clock. Humans, like other mammals, have an internal circadian (*circa* =around; *dies* = day) clock that regulates physiological and behavioral functions on a 24-hour basis. Located in the brain, this "body clock" is set by external time cues, especially bright light.

2. Control of 24-Hour Rhythms. The clock coordinates daily cycles of sleep/wake, performance, physiology, mood, and other functions. It programs us to sleep at night, to be awake during the day, and to have daily peaks and troughs in different functions at specific times. Between 3 and 5 AM, physiological sleepiness peaks, and virtually all aspects of alertness and performance slow and degrade. Less dramatically, an afternoon dip between 3 and 5 PM also affects sleepiness, alertness, and performance.

3. Circadian Disruption. The circadian clock cannot adjust immediately when a person suddenly changes schedule (e.g., by flying to a new time zone or changing to a new work/rest schedule). This is the basis for the circadian disruption associated with jet lag and shiftwork patterns.

To shift schedules (e.g., from day to night shift), the body must override the circadian signals to sleep at night and be awake during the day. Also, the clock will receive conflicting time cues from the environment.

"Jet lag," resulting from flying to a new time zone, produces a different challenge to the circadian clock. The time cues in the new time zone provide consistent information to the clock, but it can take several days to weeks for the clock to get into step with the new local time. In addition, circadian rhythms in different body functions do not all adjust at the same rate and therefore may be out of step with each other for an extended period of time.

Fatigue Countermeasures: Personal Strategies

For the individual facing the challenges of managing fatigue in flight operations, a variety of well-tested countermeasure strategies can help maintain alertness and on-the-job performance. However, there is no simple, universal solution to fatigue in the workplace. Both operational requirements and human physiology are complex, and each individual is different. It is important to use multiple strategies, and tailor the strategies to individual needs. As new strategies become available, individuals should test them and evolve their approach to managing fatigue.

Fatigue countermeasures can be divided into two categories: 1) Preventive strategies are those used before work and during rest periods, and 2) Operational strategies are those used on-the-job (in flight, at a computer terminal, etc.). Preventive strategies are designed to minimize the sleep loss and circadian disruption caused by work demands. They are aimed at the physiological causes of fatigue. Operational countermeasures are designed to minimize the impact of sleep loss and circadian disruption on alertness and on-the-job performance. They can temporarily relieve the symptoms of fatigue, to help get the job done as safely and efficiently as possible.

1. Preventive Strategies

a. Minimizing Sleep Loss. A number of preventive strategies can be used to minimize sleep loss. The effective use of days off and rest periods to catch up on sleep is critical. Field studies in flight operations indicate that sleep loss is common. Since the effects of sleep loss are cumulative, it is important not to begin a new work schedule or trip pattern with an existing sleep debt. Therefore, try to get at least two nights of unrestricted sleep before a trip.

On nights before or between duty days, try to get at least as much sleep as you get on normal off-duty nights. If your duty schedule prevents you from getting that much sleep in a single sleep period, try to sleep more than once (e.g., morning and evening) or to take naps. Take advantage of times in the circadian cycle when it is easy to fall asleep. Conversely, because it is impossible to force sleep, don't depend on getting sleep during peaks in the circadian cycle when you would usually be awake.

b. Naps. Naps can acutely improve alertness and performance, and even very short naps can provide benefits. However, the duration of a nap is important because if you enter deep NREM sleep you may experience sleep inertia, a feeling of grogginess, sleepiness and disorientation that can last for 10 to 15 minutes. Therefore, if you have a short nap opportunity just before work, or if you are likely to be interrupted by a duty call, then limit the nap to about 45 minutes or less. At other times, longer naps can be beneficial, and 2 hours will normally allow for a complete cycle through the different states and stages of sleep. Generally, performance improves, even when people do not report feeling refreshed on awakening.

A nap reduces the duration of continuous wakefulness before a work period, and can be particularly beneficial before a period of night work, when the challenge of working through the circadian low point is also a factor. Getting some sleep is always better than none.

c. Good Sleep Habits. Good sleep habits can help improve sleep quality on a regular basis, at home and while on trips. By practicing a regular pre-sleep routine, you can teach your body and mind that certain activities mean that it is time to sleep. It separates the psychological stressors of the day from the sleep period. Once this pattern of cues is established, it can be used anywhere and anytime. It may include such things as checking door locks and turning off lights, or reading something relaxing and entertaining (not work-related). Also, various physical and mental relaxation techniques can be learned and used in this way, such as meditation, autogenic training, yoga, and progressive muscle relaxation. These skills must be developed and practiced before they can be expected to provide benefit. It is also important that the bedroom remain an environment conducive to relaxation and sleep, and does not become associated with stressful activities, such as work or worry. Sleep time needs to be given priority and kept as free as possible from other commitments and activities.

d. Sleep Environment. Physical aspects of the environment can also affect sleep. A dark, quiet room is preferable. Eye shades are a simple and portable solution to the problem of intrusive light. Earplugs can help by reducing noise, but they must be used such that they do not interfere with a required wake-up signal (such as an alarm clock or call for duty). Sudden sounds can disturb sleep, and continuous background "white" noise can help mask such noises. One

suggestion is to set the radio between two stations for this purpose. In general, sleep quality is better if the environment is cooler rather than warmer. A comfortable sleep surface also can be important.

e. Effects of Food, Alcohol, and Exercise. Food, alcohol, and exercise shortly before sleep can affect the quantity and quality of the sleep you obtain.

The discomfort associated with being hungry or, conversely, with having eaten too much, may interfere with falling asleep. If you are hungry or thirsty at bedtime, have a light snack or a small drink. In general, evidence that common foods significantly affect sleep is not yet conclusive. However, both caffeine and alcohol have well-documented disruptive effects on sleep.

Caffeine stimulates the nervous system, generally taking effect 15–45 minutes after ingestion and remaining active for 3–4 hours (up to 10 hours in some individuals). The effects of caffeine depend on a number of factors, including habitual usage, body mass, and previous food intake. However, regardless of how much caffeine someone habitually takes, caffeine before sleep can lead to lighter sleep with more awakenings and reduced total sleep time. Consider eliminating or minimizing caffeine intake at least 3 hours before bedtime. Individuals sensitive to caffeine effects should consider avoiding caffeine as much as 6 hours before bedtime. Nicotine has much the same effects as caffeine on nocturnal sleep and subsequent daytime sleepiness and performance. As with caffeine, avoid nicotine (tobacco or patch) for several hours before the time you want to fall asleep.

Alcohol is reported as the most commonly used sleep aid in the U.S. It can promote relaxation and thereby help a person to fall asleep. However, with moderate to excessive alcohol intake, sleep is easily disrupted. Alcohol suppresses REM sleep in the first half of the night, leading to REM rebound and withdrawal effects in the second half. Therefore, avoid drinking even moderate amounts of alcohol 2–3 hours before sleeping. Also, individuals with breathing disorders during sleep, for example apnea, should keep in mind that alcohol worsens these conditions and reduces oxygen levels during sleep. FAA regulations govern alcohol consumption in proximity to duty periods.

There is evidence that regular exercise may enhance deep sleep, which has been shown to be physically restorative. However, strenuous exercise results in physiological activation, which may interfere with sleep. Therefore, avoid strenuous exercise within several hours of going to bed.

f. Circadian Strategies. Currently, there are more practical, well-tested preventive strategies for minimizing sleep loss than there are for speeding circadian adaptation to different schedules. Resetting the circadian clock in an operational setting is complex for several reasons. First, unless a technique is applied correctly, interventions that reset the circadian clock can shift the clock in the

wrong direction, depending on when in the circadian cycle they are administered. At this time, there is no simple, practical way of measuring precisely where a person is in the circadian cycle, particularly in an operational setting. Without this information, an intervention intended to move the circadian clock "eastward" may end up sending it "westward." Further, for such a treatment to be successful, it is necessary to control exposure to the natural time cues in the environment, such as sunlight and darkness. In practice, this can be very difficult to achieve, especially on a trip.

In some situations, it may not be possible or even desirable to adapt the clock fully to rapidly changing schedules. For example, during long-haul flight operations, crewmembers usually spend each consecutive rest period (layover) in a different time zone, so it may not be preferable to adapt to the destination time zone. The known clock-shifting interventions (e.g., melatonin and bright light) need much more testing to determine their feasibility and effectiveness in improving alertness and performance in operational settings, including aviation environments.

2. Operational Countermeasures

Once on the job, the range of available strategies to combat fatigue is more restricted. In most commercial aviation operations, there is an additional constraint that crewmembers must remain in their cockpit seats from take-off through landing, except for "biological need," which currently does not include sleep. In general, operational countermeasures do not address the underlying physiological causes of fatigue. Instead, they are meant to temporarily enhance alertness and performance by masking fatigue, so that operational safety and efficiency are maintained.

a. Social Interaction and Conversation. Interacting with others can be a useful operational strategy. To maintain alertness, it is necessary to be actively involved in the conversation, not just listening and nodding. In fact, a lack of conversation can be associated with declining physiological alertness.

b. Physical Activity. Physical activity is one of the most effective ways of combating sleepiness. Some stretching and isometric exercises can be done in the cockpit seat. Even writing or chewing gum may help. Almost any physical activity is preferable to passivity.

c. Caffeine. Use the alerting effects of caffeine to help you stay awake during circadian low points or other times during operations when you struggle to maintain wakefulness (remember: on average, about 15–30 minutes to take effect, lasting 3 to 4 hours). To optimize caffeine as an operational strategy, avoid or minimize its use when you are already alert, such as at the beginning of a daytime work period or just after a nap. Start consuming caffeine about an hour before expected times of decreased alertness (e.g., 3–5 AM). However, consider your planned bedtime, and try to stop caffeine consumption at least three hours before that to avoid its disruptive effects

on sleep. In some situations, these requirements may be conflicting. For example, using caffeine to help work through the circadian low point at the end of a night flight could result in problems trying to fall asleep after coming off duty in the morning. In that case, consider the benefits and drawbacks in light of overall operational demands.

Caffeine is a diuretic, which can cause further dehydration for flight crews, who are already vulnerable due to low humidity in the cockpit. Another consideration when using caffeine is that, in high doses, caffeine can lead to anxiety, irritability, tremulousness, and insomnia.

d. Diet. Currently, there is no compelling evidence that specific types of food directly affect alertness and performance. Candy or other "energy boosters" can produce a transient increase in alertness (e.g., "sugar highs"), but this is frequently followed by a decrease in alertness (sometimes suddenly) as blood glucose levels fall. Stomach (gastrointestinal) upsets can be disruptive to sleep, and maintaining a balanced diet is important. Duty schedules can make it difficult to maintain a regular pattern of well-balanced meals, so plan ahead and bring nutritious snack foods with you on long flights or shifts.

e. Naps. The goal of all operational countermeasures is to improve on-the-job performance and alertness when compared to the no-countermeasure condition. Napping is one of the only countermeasures that has been rigorously tested in this way in a real-world operational setting. A NASA/FAA study examined the effectiveness of a planned cockpit rest period to improve subsequent performance and alertness in commercial long-haul flight operations. Crewmembers who were allowed to take planned naps showed better performance and higher physiological alertness during the last 90 minutes of flight than the control group crewmembers who had not napped. Planned cockpit rest is not currently sanctioned by the Federal Aviation Regulations. However, based on the results of this study, a proposal to allow planned cockpit rest is currently under review.

The significant results of this NASA/FAA study and other scientific research have demonstrated that naps can be extremely beneficial. Strategic naps should be used as a high priority countermeasure in appropriate circumstances. For example, there are many opportunities outside the cockpit environment when a short strategic nap can be an effective countermeasure, such as between flight legs when other duties are completed. Napping is the only operational countermeasure that addresses one of the major physiological causes of fatigue—the need for sleep—and reverses it. While other operational countermeasures primarily mask fatigue, naps actually reduce it.

3. Future Countermeasure Considerations

There are a number of countermeasures currently under investigation that require further evaluation to demonstrate their practicality and effectiveness in operational settings, but that have the potential to reduce the sleep loss and circadian disruption produced by multiple time-zone changes and shifting work schedules.

a. Bright Light. Bright light has received particular attention because of its importance as a cue for setting the circadian clock. Independent of this capacity, light appears to have an alerting effect. Some of the difficulties associated with attempting to shift the circadian clock were described in the section "Preventive Strategies."

b. Melatonin. The naturally occurring hormone melatonin is also under active investigation, for both its sleep-inducing properties and its capacity to reset the circadian clock. Currently, it is classified as a food supplement in the U.S., and is available in health food stores. Therefore, it is not controlled by any quality assurance mechanism, and the percent of active melatonin in health food store products may vary widely, as can any additional ingredients in the products.

An unknown number of shiftworkers and transportation operators already use melatonin. However, the scientific community is still investigating its effectiveness and safety. Melatonin affects a variety of physiological systems in addition to its sleep and circadian effects. It has been reported to have a range of other effects, including restricting the coronary arteries and exacerbating the symptoms of some psychological disorders (e.g., depression). In high doses, it may produce hangover effects on waking function.

While many claims are made about the benefits of melatonin, more information is needed before its effects, both short and long term, are understood. Given the current state of scientific knowledge, it would be prudent to take a conservative approach to melatonin use, particularly on a regular basis, either as a sleeping medication or as a circadian manipulator.

c. Physical Exercise. The role of exercise in resetting the circadian clock is also under investigation. Research has demonstrated that exercise at different times in the day can reset the circadian clocks of animals. Other, preliminary data suggest that exercise can have effects on the human clock as well. However, more research is needed to clarify the effects of different amounts and types of exercise in different parts of the human circadian cycle.

d. Diet. There is also considerable interest in possible dietary components that might promote sleep or alertness, or reset the circadian clock. It has been suggested that foods rich in carbohydrates (e.g., legumes, pasta, potatoes) may induce sleep, or that foods high in protein

(e.g., meats, dairy products, eggs) and certain amino acids may promote wakefulness. For example, one diet published some years ago tried to accelerate adaptation to a new time zone by exploiting multiple circadian time cues, including meal timing, fasting and feasting periods, high protein versus high carbohydrate meals, and timed caffeine consumption. However, two controlled studies have shown that the diet has equivocal effects at best, and can actually slow adaptation in some instances. Other dietary effects, such as the effect of the amino acid tyrosine on stress levels, are under investigation. There may well be other dietary factors that could be useful as fatigue countermeasures. Careful research is needed to demonstrate their effectiveness and to define how they might be used.

e. Anchor Sleep. Another concept that has been considered in the context of shiftwork and aviation operations is called "anchor sleep." This is based on the idea of having individuals obtain at least part of their off-duty or layover sleep during the normal home sleep time. Its usefulness over long sequences of transmeridian flights is limited by the fact that the circadian clock drifts away from a 24-hour period, which makes it difficult to relate sleep to physiological home time.

Addressing fatigue in specific flight environments

Different flight environments have different operational requirements, operate under various sets of regulations, and employ diverse populations of crewmembers. Therefore, each flight environment poses distinct physiological challenges to the individuals involved. This section describes specific fatigue issues facing four types of flight operations. Clearly, other flight environments exist, with their own unique demands.

Short-haul flight operations: While short-haul operations do not present the classic fatigue-inducing demands of "jet lag," (e.g., crossing time zones, flying through the night) these operations pose other challenges to human physiology, alertness, and performance.

Short-haul operations are generally domestic operations characterized by multiple flight legs of short duration. Operational requirements include long duty days, multiple take-offs and landings, and a large percentage of time spent in high-density terminal areas. Because each flight segment requires little flying time, many segments can be flown in a duty day within FAR flight time limitations, and long duty days can result. Not surprisingly, long duty days can result in fatigue and consequent decreases in alertness and performance. Additionally, these long duty days often require early report times. Because physiologically factors make it difficult to fall asleep earlier than normal, early wake-ups can result in sleep loss. Finally, short-haul operations require very high levels of alertness, performance, and vigilance because a larger percentage of time is spent in

busy terminal areas and critical flight phases. Fatigue-induced decrements can be magnified by these performance demands.

Long-haul flight operations: Long-haul operations are characterized by extended flights that often cross multiple time zones. These flights are operated by commercial airlines in jumbo jets as well as by corporate flight departments in business jets. Specific operational requirements include rapid multiple time-zone changes, extended flight and duty times, irregular work schedules, and long periods of time spent in cruise. Additionally, many long international commercial flights are made during nighttime hours. These demands frequently lead to sleep disturbances and circadian disruption which, in turn, result in fatigue, cumulative sleep loss, decreased alertness, and degraded performance.

Multiple time-zone changes have long been acknowledged to result in "jet lag." The primary physiological feature of jet lag is circadian disruption: the body clock is out of sync with the new time zone or schedule, which results in sleep loss and a variety of other physical symptoms. Irregular work schedules, which are common in long-haul flying, also can contribute to circadian disruption by requiring the body to adjust from day "shift" to night "shift" and back. Further, flying through circadian low points, especially in the 3–5 AM window, challenges the body and mind to function at a time when they are programmed to sleep.

In long-haul airline operations, flight hours are limited by FARs, but duty times are not addressed, and long duty days are possible. Long duty days can contribute to fatigue and sleep loss by decreasing the time available for sleep and by creating periods of extended wakefulness. Finally, long-haul flight crewmembers spend extended periods of time in cruise, which generally provides low levels of stimulation and activity.

Regional Flight Operations: Regional flight operations are characterized by multiple short flights within a certain geographical area. These operations present a number of unique challenges. In addition to the issues facing other short-haul operations, many operate under different regulations than the major airlines, regional airlines may in some cases operate older, less technologically advanced equipment (e.g., aircraft, navigation, etc.), and scheduling practices vary widely.

As in other short-haul operations, regional operators face long duty days, multiple take-offs and landings, more time in high-density areas, and the physiological results of these factors. Different FARs mean that many regional crewmembers can fly longer hours and receive shorter off-duty periods, which can restrict sleep opportunities. Additionally, regional crewmembers report that older equipment and less automation can lead to increased fatigue by demanding more vigilance, increasing workload, and creating physical stresses associated with high noise and vibration levels.

Finally, in response to operational and other demands, many regional operators use certain scheduling practices that may contribute to fatigue (e.g., "stand-up" overnights, during which the crewmember remains on duty through the night between flights).

Overnight Operations: Overnight operations include most cargo flights as well as some commercial passenger flights. These operations require that crewmembers (among others) fly when their bodies and minds are programmed to sleep. This can lead to decrements in alertness and performance, as well as circadian disruption.

Maintaining wakefulness during the circadian low 2–6 AM poses a significant challenge to crewmembers. Even if individuals can remain awake, virtually all aspects of alertness and performance are degraded during this time, including reaction time, problem-solving, decision-making, and communication. Monitoring skills, in particular, suffer decrements during the window of circadian low. This is important because especially in highly automated aircraft, monitoring is the primary task during cruise.

Approaching Various Flight Environments. Each flight environment has different operational requirements. However, the physiological needs of the human operator remain the same. Therefore, an understanding of both physiological and operational requirements must be applied to the development and evaluation of countermeasure strategies to create operationally feasible approaches to managing fatigue.

Conclusion

Clearly, there is no single approach or countermeasure that will eliminate fatigue from flight operations. Operational demands, human physiology, and individual differences are too complex for a simple mechanistic approach. Since there is no simple answer, the challenge is to manage fatigue. Education is a crucial first step in any effort to manage fatigue. The information in this AC is provided as one element in this educational process. By learning about the issues involved, by maintaining and spreading awareness of these issues, by developing and using personal strategies to maximize alertness and performance during operations, everyone in the aviation industry can support efforts to reduce fatigue-related risks and can contribute to safer flight operations.

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Mr. William W. Edmunds, Jr.
Human Performance Specialist
Air Line Pilots Association
535 Herndon Parkway
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Dear Mr. Edmunds:

In an effort to clean up pending Aviation Rulemaking Advisory Committee (ARAC) recommendations on Air Carrier Operations Issues, the recommendations from the following working groups have been forwarded to the proper Federal Aviation Administration offices for review and decision. We consider your submittal of these recommendations as completion of the ARAC tasks. Therefore, we have closed the tasks and placed the recommendations on the ARAC website at http://www.faa.gov/avr/arm/arac/index.cfm

Date	**Task**	**Working Group**
February 1999	Reserve Duty/Rest Requirements	Reserve Duty/Rest Requirements Working Group
April 1999	Fatigue Countermeasures	Fatigue Countermeasures and Alertness Management Techniques Working Group

I wish to thank the ARAC and the working groups for the resources they spent in developing these recommendations. We will continue to keep you apprised of our efforts on the ARAC recommendations at the regular ARAC meetings.

Sincerely,

Anthony F. Fazio
Executive Director, Aviation Rulemaking
Advisory Committee

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Fitness for Duty | **Date:** 10/11/12 | **AC No:** 117-3
Initiated by: AFS-200 | **Change:**

1. PURPOSE. This advisory circular (AC) was developed to demonstrate acceptable methods of compliance with Title 14 Code of Federal Regulations (14 CFR) part 117, § 117.5, Fitness for Duty. While the methods outlined in this AC are not the only means of compliance, the guidance contained herein provides concepts for developing appropriate processes and procedures to comply with § 117.5 and instituting appropriate operator-specific fatigue countermeasures. The guidance also provides a means to educate flightcrew members in the potential of fatigue induced by commuting.

2. AUDIENCE. Flightcrew members, air carriers, employees of air carriers responsible for scheduling flightcrew members for operations conducted under part 117, pilot labor organizations and airline industry trade organizations.

3. REGULATORY REFERENCES.

- Title 14 CFR Part 91, § 91.13, Careless or Reckless Operation,
- Title 14 CFR Part 117, Flight and Duty Limitations and Rest Requirements: Flightcrew Members, and
- Title 14 CFR Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.

4. RELATED MATERIAL (current editions):

- AC 117-2, Fatigue Education and Awareness Training Program,
- AC 120-100, The Basics of Aviation Fatigue,
- AC 120-103, Fatigue Risk Management Systems (FRMS) for Aviation Safety, and
- Safety Alerts for Operators (SAFO) 09014, Concepts for Fatigue Countermeasures in Part 121 and 135 Short-Haul Operations.

5. DEFINITIONS.

a. Fit For Duty. Part 117 requires each flightcrew member assigned to a flight duty period (FDP) to be fit for duty prior to commencing a flight. Section 117.3 defines “fit for duty” as being physiologically and mentally prepared and capable of performing assigned duties at the highest degree of safety.

b. Fatigue. Fatigue is characterized by a general lack of alertness and degradation in mental and physical performance. Fatigue manifests in the aviation context not only when pilots fall asleep in the cockpit during flight, but perhaps more importantly, during the task-critical takeoff and landing phases of flight. Reported fatigue-related events have included procedural errors, unstable approaches, lining up with the wrong runway, landing without clearances, and poor decisionmaking.

c. Types of Fatigue. There are three types of fatigue: transient, cumulative, and circadian:

(1) Transient fatigue is acute fatigue brought on by extreme sleep restriction or extended hours awake within 1 or 2 days.

(2) Cumulative fatigue is fatigue brought on by repeated mild sleep restriction or extended hours awake across a series of days.

(3) Circadian fatigue refers to the reduced performance during nighttime hours, particularly during an individual's "window of circadian low" (WOCL) (typically between 2:00 a.m. and 05:59 a.m.).

d. Symptoms of Fatigue. Common symptoms of fatigue include:

- Measurable reduction in speed and accuracy of performance,
- Lapses of attention and vigilance,
- Delayed reactions,
- Impaired logical reasoning and decisionmaking, including a reduced ability to assess risk or appreciate consequences of actions,
- Reduced situational awareness, and
- Low motivation.

e. Sleep and Performance. Scientific research and experimentation consistently demonstrate that adequate sleep sustains performance. For most people, 8 hours of sleep in each 24 hours sustains performance indefinitely. Sleep opportunities during the WOCL are preferable, although some research indicates that sleep at other times to protect the total amount of sleep is more important than obtaining all sleep during the WOCL. Within limits, shortened periods of nighttime sleep may be nearly as beneficial as a consolidated sleep period when augmented by additional sleep periods, such as naps before evening departures, during in-flight rest periods while other flightcrew members are at the controls, and during layovers. Sleep should not be fragmented by interruptions or environmental conditions such as temperature, noise, and turbulence, which can impact how beneficial sleep is and how performance is restored.

6. FITNESS FOR DUTY–A JOINT RESPONSIBILITY.

a. Joint Responsibility. Part 117 places a joint responsibility on the certificate holder and each flightcrew member. In order for the flightcrew member to report for an FDP properly rested, the certificate holder must provide the flightcrew member with a meaningful rest opportunity that will allow the flightcrew member to get the proper amount of sleep.

Likewise, the flightcrew member bears the responsibility of actually sleeping during the rest opportunity provided by the certificate holder instead of using that time to do other things.

b. Regulatory Obligations. Each flightcrew member must report for any FDP fit for duty, which includes being properly rested and prepared to perform his or her assigned duties. Fitness for duty is a joint responsibility between the air carrier and the flightcrew member. Part 117 imposes regulatory obligations on both air carriers and flightcrew members with regard to fitness for duty. The joint responsibility is established in § 117.5(b), which requires that no certificate holder may assign and no flightcrew member may accept an assignment to a FDP if the flightcrew member has reported for a FDP too fatigued to safely perform his or her assigned duties.

c. Labor and Management Relations. Air carriers and flightcrew members typically handle this joint responsibility in the context of labor/management relations and collective bargaining agreements. Although not all flightcrew members are represented by a labor organization, those that have labor agreements frequently address this issue in those agreements.

d. Replacing a Flightcrew Member. Although a flightcrew member may report for duty well-rested and prepared to perform their assigned duties during the course of their assigned FDP, circumstances may occur resulting in the flightcrew member becoming too fatigued to continue their assigned FDP. If a flightcrew member reports being too fatigued to continue the assigned flight duty period, the certificate holder may not permit that flightcrew member to continue his or her FDP. The certificate holder must remove that flightcrew member and replace him or her with a flightcrew member that is fit for duty.

e. Dispatch or Flight Release. Section 117.5(d) requires that each flightcrew member must affirmatively attest they are fit for duty. This can be accomplished by signing the dispatch or flight release (as applicable) prior to commencing each flight stating that they are indeed fit for duty.

f. Reporting Fatigued Flightcrew. Flightcrew members and other employees should be cognizant of the appearance and behavior of fellow flightcrew members displaying signs of fatigue. If a flightcrew member (or any other employee) believes another flightcrew member may be too tired to fly, the FAA encourages each flightcrew member and other employees to voluntarily inform their employer when they observe a fatigued flightcrew member.

7. MITIGATING THE POTENTIAL FOR FATIGUE.

a. Causes of Fatigue. The Federal Aviation Administration (FAA) defines fatigue as a physiological state of reduced mental or physical performance capability resulting from lack of sleep or increased physical activity that can reduce a flightcrew member's alertness and ability to safely operate an aircraft or perform safety related duties. The primary contributor to fatigue is lack of proper sleep. The root-cause for flightcrew member fatigue may be a combination of scheduling and flightcrew members not obtaining the proper amount of rest during their assigned sleep opportunity.

b. Effects of Fatigue. Small reductions in sleep over a given time period create the accumulation of sleep loss, which is referred to as sleep debt. The effects of fatigue are predicated upon the degree of the individual's sleep debt, but not specifically limited to that sleep debt. The only way to eliminate cumulative sleep debt is to obtain sleep because it addresses the underlying physiology of sleep loss. The effects of fatigue manifest in slightly different ways for each person; however, there are common effects that are associated with tiredness, e.g., weakness, lack of energy, lethargy, depression, lack of motivation, sleepiness, decreased alertness and situational awareness, and poor decision-making skills. Fatigue decreases a person's ability to perform cognitive tasks and increases variability in performance as a function of time on task.

c. Recovery Sleep. To reverse the effects of fatigue, people must receive "recovery sleep." The period for recovery sleep may be different for each person because one person's need for required sleep may vary from that of another person. Some people may require eight hours of continuous sleep while others may require more than eight continuous hours.

d. Managing Fatigue. There are two central elements in managing or mitigating the effects of fatigue. First, each air carrier should prepare their schedules in a manner that accommodates enough time to allow an appropriate sleep opportunity. Secondly, flightcrew members must take full advantage of each sleep opportunity to ensure they receive adequate sleep and are properly rested before starting a FDP.

e. Removing Flightcrew Members. Each flightcrew member is required by § 117.5 to be properly rested to safely perform their assigned duties. Equally, each air carrier has the responsibility to ensure that no flightcrew member is scheduled (assigned), or may continue a FDP, if that flightcrew member has reported to the air carrier that they are too fatigued to perform their assigned duties. Air carriers must remove a flightcrew member from their FDP if that flightcrew member has reported their self as being too fatigued to safely perform their assigned duties.

8. MANAGING REST.

a. Rest and Sleep Opportunities. Rest opportunities and sleep opportunities are two separate issues. A rest opportunity is an assigned period in which the flightcrew member is free from all duty prior to a duty assignment; while a sleep opportunity period resides within that rest period. The sleep obtained within the sleep opportunity is the essential element for being fit for duty.

b. Hours of Rest and Sleep. Managing rest and sleep opportunities are essential for reducing the risk of being unfit for duty due to fatigue. A joint responsibility is again placed on the air carrier and the flightcrew member in § 117.25(e)(f), which prescribes that no flightcrew member may accept an assignment for any reserve or FDP unless that flightcrew member is given a rest period of at least 10 consecutive hours immediately before beginning the reserve or FDP measured from the time the flightcrew member is released from duty. The 10-hour rest period must provide the flightcrew member with an opportunity of a minimum of 8 hours of uninterrupted sleep. If the flightcrew member determines that the rest period will not provide an opportunity of 8 uninterrupted hours of sleep, that flightcrew member must notify the certificate

holder. The flightcrew member cannot report for the assigned FDP until he or she receives a minimum of 8 hours of uninterrupted sleep opportunity.

c. Sleep Debt. This 8-hour sleep opportunity is the essential element in the flightcrew member obtaining restorative sleep, assuming the flightcrew obtains 8 hours of sleep. Without obtaining the appropriate restorative sleep, the flightcrew member starts accumulating a sleep debt. Accumulating a sleep debt over several days exposes that flightcrew to a potential fatigue event. The amount of recovery sleep required to repay the sleep debt is related to the total amount of sleep debt. The amount of sleep required to make up a deficit is less than the total number of hours of sleep missed; therefore, it does not take an additional 8 hours of sleep to make up for an 8-hour accumulated sleep debt. However, since it takes 8 hours of sleep to balance a normal day of wakefulness, it will require more than 8 hours of sleep per recovery day to repay the debt. In general, if a person has experienced several days of sleep restriction below the nominal requirement of 8 hours per day, full recovery of performance may require several days of 9 hours or more sleep per day. Therefore, it is imperative that flightcrew members utilize their sleep opportunities to obtain the required rest.

9. FATIGUE TRAINING.

a. Reasons for Fatigue Training. Fatigue-based training requirements are critical to informing flightcrew members, 1) how their personal behavior can unwittingly lead to fatigue, 2) aggressive scheduling practices can lead to fatigue, and 3) how to mitigate the risk of fatigue in an industry that does not follow a traditional work cycle.

b. Employees Eligible for Fatigue Training. Flightcrew members are not the only employees of the air carrier that need to be trained about the impact of fatigue and the safety of flight. Section 117.9 prescribes that applicable all employees of the certificate holder responsible for administering the provisions of part 117 including flightcrew members, dispatchers, individuals directly involved in the scheduling of flightcrew members, individuals directly involved in operational control, and any employee providing direct management (immediate supervisor) oversight of those areas must receive fatigue education and awareness training. The final rule requires the training frequency to be accomplished annually. The fatigue education and awareness training program must be designed to increase awareness of fatigue, the effects of fatigue on pilots and fatigue countermeasures. AC 117-2, Fatigue Education and Awareness Training Program, provides guidance in the development of the certificate holder’s Fatigue Education and Awareness Training Program.

10. COMMUTING STRESSES.

a. Methods of Commuting. There are several methods for commuting flightcrew members, which include air travel, train, bus and privately owned vehicles. While commuting to their domicile, flightcrew members encounter stress not normally experienced when living within the local area of their domicile. Examples of these stresses are: ensuring they arrive at their domicile for flight duty in a timely manner, planning for potential delays, preparing for potential changes in the mode of their commute, and adapting to sudden changes that are out of their control such as weather disruptions.

b. Commuting by Air. Commuting by air is a common choice for flightcrew members. This mode provides the greatest flexibility for the flightcrew member with regard to where they actually live. However, the total travel time between the flightcrew member's residence and their domicile has the potential for a long day. One part of this problem is the available air service into the domicile from the home location. Flexibility and creativity are essential elements to a successful commute and reducing stress. The downside to commuting is the total travel time involved with the commute, which lengthens the first day of duty and reduces total time.

c. Commuting Loss of Time. One of the biggest disadvantages to commuting is the loss of time off. Because all time commuting is accomplished during flightcrew members' time off, a lot of the flightcrew member's time off may be consumed by the commute. In an effort to compensate for the loss of time, flightcrew members will often commute to work just before their report time, which increases the level of stress and the level of fatigue for that day.

11. COMMUTING AND DEADHEAD TRANSPORTATION. There has been quite a bit of confusion on the part of the general public with regard to the terms "commuting" and "deadhead transportation" or "deadheading." Both are transportation terms normally used by the airline industry.

a. Deadheading. The airline industry refers to the term deadheading as any time that an air carrier assigns a flightcrew member to be transported by a mode of transportation, usually by air, from one location to another and that same flightcrew member is not functioning as an operating flight flightcrew member. Normally, the concept of deadheading is used to move a flightcrew member so that they can be in position to function as an operating flightcrew member for a flight or series of flights. In basic terms, deadheading is an air carrier means of matching crews with the location of their aircraft.

b. Commuting. In contrast, the concept of commuting involves an individual flightcrew member that does not reside within their domicile. This flightcrew member then uses some mode of transportation to get to and from the domicile. Most commuters prefer to commute by air as it provides them with the most flexibility. Unlike deadheading, the commuting flightcrew member is solely responsible for determining and using the mode of transportation to commute to and from their domicile. In basic terms, commuting is an individual initiated function.

12. COMMUTER INDUCED FATIGUE.

a. Commuting Fatigue. While commuting offers many benefits to the flightcrew member, the stresses associated with commuting can contribute to flightcrew member fatigue. More importantly, commuting can contribute to the length of a flightcrew member's day, which also has the potential for contributing to fatigue.

b. Commuting and Schedules. Commuters normally plan their commute so they have at least 3 options (3 flights) to arrive at their domicile before their report time. This can result in the flightcrew member arriving at their domicile several hours before their report time. If a flightcrew member's first day of their trip is scheduled for 10 hours of duty and their commute requires another 4 hours, assuming they arrive at their domicile 3 hours prior to their report time, the flightcrew member's first day could exceed 17 hours without a rest period. Since air carrier

schedules are designed to account for the scheduled flight duty time, the additional time associated with a commute may add to the flightcrew member's fatigue for that day as well as aggravating the cumulative fatigue for the duration of the crew's schedule that the carrier had planned.

c. Evaluating Commuting Habits. In an extreme example, a flightcrew member is scheduled for an 8 a.m. report time at their domicile to start a 12-hour FDP. To ensure arriving at their domicile prior to the report time, the flightcrew member elects to commute through the night on an air carrier. Assuming sleep occurred prior to starting the commute, the flightcrew member has the potential for being awake at least 23 consecutive hours at the conclusion of the 12-hour FDP. Essentially, the flightcrew member is exposed to a sleep deficit, which contributes to cumulative fatigue. This kind of behavior is irresponsible commuting and may contribute to an unsafe operating condition that is contrary to the Federal aviation regulations. To that end, it is imperative that flightcrew members seriously evaluate their commuting habits to reduce the potential for being fatigued as a result of commuting.

13. PRE-DUTY ACTIVITIES.

a. Activities. Flightcrew members residing in their domicile that engage in activities prior to reporting for duty may unknowingly expose themselves to fatigue risks similar to those pilots that commute to work. Such activities include, but not limited to, work around the house, car repairs, yard work and other employment activities.

b. Flightcrew in the Domicile Versus Commuting Flightcrew. The total time of wakefulness for a flightcrew member residing in their domicile that engages in activities prior to duty may be similar to one that commutes to their domicile. The potential exposure to fatigue risks for that duty day affects both flightcrew members similarly. Essentially, they are both awake for the same time period prior to starting their duty period. While this may not be an issue for a midmorning report time, unless a flightcrew member has taken a nap prior to reporting, a mid or late evening report time exposes a flightcrew member to more of a potential to a fatigue event.

c. Minimize Pre-Duty Activities. As part of Public Law (PL) 111-216, § 212(c), the National Academy of Sciences (NAS) conducted a study on the effects of commuting on pilot fatigue. Outlined in one recommendation of the study NAS concluded, "Pilots should avoid planning commutes or other pre-duty activities that result in being awake beyond approximately 16 hours before the scheduled end of duty, endeavor to sleep at least 6 hours prior to reporting for duty, and obtain more than 6 hours of sleep per day whenever possible to prevent cumulative fatigue from chronic sleep restriction. Pilots should also consider the amount of sleep and time awake in their decision making relative to when to inform their supervisors that they should not fly due to fatigue."

d. Reduce Risk of Fatigue. It is imperative that flightcrew members realize that extended periods of wakefulness prior to starting a duty period may contribute to pilot fatigue. Therefore, flightcrew members must take the appropriate fatigue mitigations by obtaining the proper rest prior to starting any duty period to reduce the exposure to a fatigue-related event.

14. FIT FOR DUTY–FLIGHTCREW MEMBER'S RESPONSIBILITY.

a. Window of Circadian Low. Individuals living on a regular 24-hour routine with sleep at night have two periods of maximum sleepiness, known as Windows of Circadian Lows (WOCL). The primary WOCL occurs at night, roughly from 2 a.m. to 6 a.m., a time when physiological sleepiness is greatest and performance capabilities are lowest. The secondary WOCL occurs in the afternoon, roughly from 3 p.m. to 5 p.m. For the purpose of this AC, part 117 defines the primary WOCL as a timeframe of 0200 to 0559. During this timeframe, flightcrew members may find their performance degraded as a result of the body requiring sleep.

b. Sleep Drive. The drive for sleep increases over time since the last sleep period and with any cumulative deficit in sleep relative to the average 8-hour day requirement. As a consequence, the sleep drive is at its lowest point in the morning, upon awakening. As the day progresses, the drive to sleep increases and the ability to sustain attention and engage in cognitive activities decreases. Once sleep begins, this drive gradually decreases until awakening.

c. Alertness. For the average person, the daily upswing in alertness produced by the circadian system tends to offset the decrease in alertness produced by depletion of the sleep regulatory process. The result is normal alertness and performance during the first 16 hours of continuous wakefulness. After about 16 hours of continuous wakefulness, most adults begin to notice reductions in the speed of performance and in alertness levels. However, the changes in behavior and alertness can be magnified by a prior history of insufficient sleep quantity and quality.

d. Fatigue and Performance. For the reason discussed in subparagraph 14c, Alertness, above, flightcrew members that conduct off duty activities prior to commencing flight duty must understand that their commuting behavior may contribute to the potential effects of fatigue. For example, if a flightcrew member has a midday report time for an 8-hour FDP, and the flightcrew member commutes on an early morning flight, there is a high likelihood of fatigue. Without some rest period before starting the FDP, taking into consideration the early morning wake that occurs during the WOCL, the flightcrew member could end up awake for 18 hours. Given this example, science has demonstrated that the flightcrew member's performance will be degraded. Such commuting practices, promotes the potential for not being physically fit for duty, which in turn elevates the risk for an incident, accident, or pilot deviation that may have been averted if the flightcrew member had received some rest prior to starting the FDP. This kind of activity, which may be contrary to Federal regulations, does not support a professional standard, and most importantly does not assure the carrier will operate to the highest level of safety.

15. FIT FOR DUTY–AIR CARRIER'S RESPONSIBILITY.

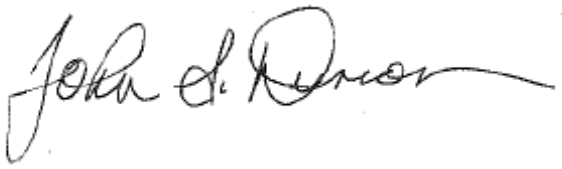
a. Responsibility. Section 117.5(a) does not place the burden of showing up fit for duty solely on the flightcrew member. Section 117.5(a), in conjunction with the other provisions of this rule, places a joint responsibility on the certificate holder and each flightcrew member. In order for the flightcrew member to report for an FDP properly rested as required by this section, the certificate holder must provide the flightcrew member with a meaningful rest opportunity that will allow the flightcrew member to get the proper amount of sleep. Likewise, the flightcrew member bears the responsibility of actually sleeping during the rest opportunity provided by the

certificate holder instead of using that time to do other things. The consequences of a flightcrew member reporting for duty without being properly rested are addressed by subparagraphs 15b, Unfit for Duty and/or 15c, Fitness for Duty, below, which prohibit the flightcrew member from beginning or continuing an FDP until he or she is properly rested.

b. Unfit for Duty. Whenever a flightcrew member reports to the air carrier that they are too fatigued to perform duties before or during their assigned FDP as prescribed in § 117.9, the air carrier may not assign the flightcrew member, and that flightcrew member may not accept a flight assignment.

c. Fitness for Duty. Since fitness for duty is a joint responsibility between the air carrier and flightcrew member, an air carrier should develop and implement fatigue countermeasure initiatives such as fatigue and commuting policies to assure the air carrier conducts each operation to the highest level of air safety. Equally, flightcrew members must commute in a responsible manner so as to prevent the potential effects of fatigue that may result as a contributing or causal factor to an incident, accident, or pilot deviation.

16. CONTACT INFORMATION. For more information about the content of this AC, please contact the Air Transportation Division (AFS-200), at 202-267-8166.



/s/ for

John M. Allen
Director, Flight Standards Service