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Principles and Guidelines For Duty and Rest Scheduling in Corporate And Business Aviation

Special FSF Task Force Report

Flight Safety Digest

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In This Issue

This month's issue of Flight Safety Digest *presents milestone fatigue management recommendations and guidelines developed by the special Flight Safety Foundation (FSF) Fatigue Countermeasures Task Force for corporate and business operations.*

The FSF task force, working closely with the U.S. National Aeronautics and Space Administration's (NASA's) Ames Research Center, looked at such issues as off-duty time, duty/flight time, extended-duty time and education and training. The result is a set of guidelines that for the first time provides operators with principles for duty and rest scheduling based on solid, empirical research. The FSF task force, which comprises more than a dozen representatives of operators, manufacturers and training suppliers, relied extensively on research from the NASA-Ames Fatigue Countermeasures Program in the Flight Management and Human Factors Division.

Like similar Foundation-led accident prevention and safety awareness efforts in the areas of controlled flight into terrain, wind shear and wake turbulence avoidance, the FSF task force has sought broad industry support and cooperation in developing effective strategies. To help achieve this, I urge anyone with comments about this final draft to complete the response/comment form at the end of the document.

— ***Stuart Matthews***
FSF Chairman, President and CEO

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Preface

Pilots routinely experience fatigue throughout their aviation careers. Many crew members consider it simply another occupational hazard. Subtle pressures to continue their flights, whether levied by employers or self-imposed, can cause even the best pilots to exceed reasonable duty limits and thus risk the safety of the aircraft, crew and passengers. Although fatigue is insidious and potentially very dangerous for all aircraft operators, its cumulative effects can be safely managed. By properly structuring their routines and schedules, pilots can enhance their ability to accomplish their missions, maintain an acceptable quality of life and, at the same time, improve safety.

With the emergence of business aircraft capable of remaining airborne for periods in excess of 14 hours, Flight Safety Foundation (FSF) organized a working group to review fatigue-reducing strategies that could facilitate the safe operation of these new aircraft. As the task force's work progressed, it became apparent that a broader scope was appropriate to address fatigue issues in all corporate/business aviation operations. It is just as important for the crews of multi-sector short-haul operations to understand fatigue-combating strategies as it is for their international long-haul colleagues.

The principles and guidelines contained in the following document represent the concepts and research currently available. It will be a dynamic document, updated when significant new information becomes available. The working group believes strongly that the fatigue challenges of corporate and business aircraft operators can best be managed through responsible use of these principles and guidelines, obviating the need for regulatory intervention.

Guidelines and recommendations based on both scientific research (Sections 1.0 and 2.0) and operational practices with empirical effectiveness (Section 3.0) have been included. The contents have been specifically identified as "principles and guidelines" because of the diverse nature of the industry. The working group understands the need to offer a scientifically based guide for all operators to use that will allow them to maintain the operational flexibility that keeps the segment of the aviation industry viable.

While this document directly addresses the rest and duty scheduling of crews who fly as a primary duty, the guidelines should be applied to all crew members. Management pilots need to set an example and follow the same guidelines that they establish for their full-time crews, maintaining an awareness of the added fatigue caused by their management duties and responsibilities.

The following principles and guidelines were developed specifically for corporate and business aviation, though the format, many sections and specific content are based on a U.S. National Aeronautics and Space Administration (NASA) Technical Memorandum (TM), "Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation." This NASA TM is cited as the principal source for a significant portion of the current document and some sections are cited directly from the NASA TM. The FSF Fatigue Countermeasures Task Force gratefully acknowledges the significant contributions of NASA to these principles and guidelines for corporate and business aviation. Rather than identify all of the specific contributions to the current document, it is recommended that interested parties obtain the NASA TM and other scientific information regarding fatigue in aviation operations directly from:

Fatigue Countermeasures Program
NASA Ames Research Center
MS: 262-4
Moffett Field, CA 94035-1000 U.S.

Principles and Guidelines for Duty and Rest Scheduling in Corporate and Business Aviation

Introduction

Twenty-four-hour Requirements of the Aviation Industry

The aviation industry requires 24-hour activities to meet operational demands. Growth in global long-haul and short-haul domestic operations will continue to increase these round-the-clock requirements. Flight crews must be available to support 24-hour-a-day operations to meet these industry demands. Corporate and business aviation, both domestic and international, can require crossing multiple time zones. Therefore, shift work, night work, irregular work schedules, unpredictable work schedules and time zone changes will continue to be commonplace components of the corporate and business aviation industry. These factors pose known challenges to human physiology, and because they result in performance-impairing fatigue, they pose a risk to safety. It is critical to acknowledge and, whenever possible, incorporate scientific information on fatigue, human sleep and circadian physiology into 24-hour aviation operations. Such scientific information can help to maintain and improve the safety margin. Such information also promotes crew performance and alertness during flight operations.

Challenges to Human Physiology

Throughout aviation history, operational capabilities and technology have evolved dramatically, while human physiological capabilities have not. Flight operations can engender fatigue, sleep loss and circadian disruption, and these physiological factors can result in decreased performance and alertness during operations. During the past 40 years, scientific knowledge about sleep, circadian physiology, sleepiness/alertness and the performance decrements associated with these factors has increased significantly. Scientific research has extended its examination of these factors to operational environments, including field and simulator studies. These studies have confirmed the presence in aviators of performance-impairing fatigue resulting from the sleep loss, circadian disruption and workload engendered by current flight and duty practices.

Humans are central to aviation operations and continue to perform critical functions to meet the 24-hour requirements of the industry. Therefore, human physiological capabilities, and limitations, remain crucial factors in maintaining safety and productivity in aviation.

Principles Based on Scientific Knowledge

Though research on fatigue, sleep and circadian physiology, and shiftwork schedules has generated an extensive body of scientific knowledge, the application of this information to the requirements of operational settings is relatively new. Although acknowledgment of this scientific information is increasing, its transfer to operations (e.g., scheduling, regulatory considerations, personal strategies, countermeasures) offers the greatest potential for its benefit. Current U.S. federal regulations and industry scheduling practices rarely acknowledge or incorporate such knowledge. The primary purpose of this document is to outline scientifically based principles that can be applied to the duty and rest scheduling requirements of the aviation industry. This document focuses on those guidelines that are supported by scientific data; however, some successful practices of corporate and business operators are included in Section 4.0.

Shared Responsibility

There is no one absolute or perfect solution to the demands of duty and rest scheduling in aviation. It is critical that safety be acknowledged as a shared responsibility among all the industry participants. Each component of the aviation system should be examined for avenues to incorporate scientific information and to apply guidelines and strategies that will maximize performance and alertness during flight operations. Regulatory considerations, scheduling practices, personal strategies and technology design are specific components of the industry that could be subject to such an examination.

Each of these components is complex and presents unique challenges. This document is focused on scientifically based principles and guidelines for duty and rest scheduling. Nevertheless, it is acknowledged that implementation involves many considerations, such as legality, economics and current practice. The intent of this document is that relevant scientific information be considered in regular operational practices.

"Safe" Can Be Difficult to Quantify

Determining a "safe" operation is a complex task. Aircraft accidents are such rare occurrences that they may not provide the best outcome variable to estimate safe operations. The aviation industry and flying public demand a high margin of safety and redundancy. Among modes of transportation, the aviation industry's reputation for safety is well deserved. As many segments of the industry increase their activities, as technology enables longer flights and as overall growth continues, the challenge will be to maintain, and where possible, improve the safety margin. The fatigue factors addressed in these principles can create a vulnerability for decrements in performance and alertness that can reduce the safety margin. Guidelines designed to specifically address these factors can help to minimize this vulnerability.

Objectives

The primary objective of this document is to provide empirically derived principles and guidelines for duty and rest scheduling in corporate and business aviation. In the first section, scientifically based principles related to operational issues posed by the aviation industry are outlined. In the second section, the principles are applied to guidelines for duty and rest scheduling in corporate and business aviation, with specifics provided where appropriate and available. In the third section, an overview of other potential corporate and business industry strategies to address these issues is provided and includes potential future directions.

1.0 General Principles

1.1 Sleep, Awake Time Off and Recovery Are Primary Considerations

1.1.1 Sleep

Sleep is a vital physiological need. Sleep is necessary to maintain alertness and performance, positive mood and overall health and well-being. Each individual has a basic sleep requirement that provides for optimal levels of performance and physiological alertness during wakefulness. On average, this is eight hours of sleep in a 24-hour period, with a range of sleep needs greater than and less than this amount. Losing as little as two hours of required sleep will result in acute sleep loss, which will induce fatigue and degrade subsequent waking performance and alertness. Over days, sleep loss — any amount of sleep less than is required — will accrue into a cumulative sleep debt. The physiological need for sleep created by a deficit can only be reversed by sleep. An individual who has obtained required sleep will be better prepared to perform after long hours awake or altered work schedules than one who is operating with a sleep deficit.

1.1.2 Awake time off

Fatigue-related performance decrements are traditionally defined by declines in performance as a function of time spent on a given task. Breaks from continuous performance of a required task, such as monitoring, are important to maintain consistent and appropriate levels of performance. Therefore, awake time off is introduced here to describe time spent awake and free of duty. Thus both awake time off and sleep are needed to ensure optimum levels of performance.

1.1.3 Recovery

Recovery from an acute sleep deficit, cumulative sleep debt, prolonged performance requirement or extended hours of continuous wakefulness is another important consideration. Operational requirements can engender each of these factors and it is important that a recovery period provide an opportunity to acquire recovery sleep and to re-establish normal levels of performance and alertness. Two nights of an individual's usual sleep requirement typically stabilize the sleep pattern and restore acceptable levels of alertness and performance.

Required sleep and appropriate awake time off promote performance and alertness. These are especially critical when challenged with extended periods of wakefulness (e.g., duty) and circadian disruption (e.g., altered work schedule). Recovery is important to reduce cumulative effects and to return an individual to usual levels of performance and alertness.

1.2 Frequent Recovery Periods Are Important

More frequent recovery periods reduce cumulative fatigue more effectively than less frequent ones. For example, weekly recovery periods afford a higher likelihood of relieving acute fatigue than monthly recovery periods. Consequently, guidelines that ensure minimum days off per week are critical for minimizing cumulative fatigue effects over longer periods of time (e.g., month, year).

1.3 Time-of-Day/Circadian Physiology Affects Sleep and Waking Performance

There is a clock in the human brain, as in other organisms, that regulates 24-hour patterns of body functions. This clock controls not only sleep and wakefulness alternating in parallel with the environmental light/dark cycle, but also the oscillatory nature of most physiological, psychological and behavioral functions. The wide range of body functions controlled by the 24-hour clock includes body temperature, hormone secretion, digestion, physical and mental performance, mood and many others. On a 24-hour basis, these functions fluctuate in a regular pattern with a high level at one time of day and a low level at another time. The circadian (*circa* = around, *dies* = day) pattern of wakefulness and sleep is programmed for wakefulness during the day and sleep at night. The circadian clock repeats this pattern on a daily basis. Certain hours of the 24-hour cycle, that is 0200 to 0600, are identified as a time when the body is programmed to sleep and during which performance is degraded. Time-of-day or circadian effects are important considerations in addressing 24-hour operational requirements because circadian rhythms do not adjust rapidly to change.

For example, an individual operating during the night is maintaining wakefulness in direct opposition to physiological programming to be asleep. Physiological, psychological and behavioral functions are set by the circadian system to a low status that cannot be compensated by being awake and active. Conversely, the same individual sleeping during the day is in direct opposition to physiological programming to be awake. The circadian system provides a high level of functioning during day that counteracts the ability to sleep. Thus, circadian disruption can lead to acute sleep deficits, cumulative sleep loss, decreases in performance and alertness, and various health problems (e.g., gastrointestinal complaints). Therefore, circadian stability is another consideration in duty and rest scheduling.

1.4 Continuous Hours of Wakefulness/Duty Can Affect Alertness and Performance

Extended wakefulness and prolonged periods of continuous performance or vigilance on a task will engender sleepiness and fatigue. Across duty periods, these effects can accumulate further. One approach to minimize the accumulation of these effects is to limit the duty time (i.e., continuous hours of wakefulness during operations). Acute effects can be addressed through daily limitations while cumulative effects can be addressed by weekly limitations. There is more scientific data available to support guidelines for acute limitations than to determine specific cumulative limitations. Nevertheless, cumulative limitations (weekly and beyond) remain an important consideration for minimizing accumulation of fatigue effects.

1.5 Human Physiological Capabilities Extend to Flight Crews

Fatigue has its basis in physiological limits, and performance deficits reflect these physiological limits. Flight crews' human physiology is not different from that of other humans. Therefore, it must be expected that the same fatigue-producing factors affecting performance and alertness in experimental subjects, physicians on call, shift workers, military personnel and others also affect flight crews. It follows that scientific findings relevant to human physiological capabilities and performance deficits from fatigue, sleep loss and circadian physiology extend to flight crews.

1.6 Flight Crews Comprise Individuals

There are considerable individual differences in the magnitude of fatigue effects on performance, physiological alertness and subjective reports of fatigue. These differences extend to the effects of sleep loss, night work and considerations of required sleep and recovery time for an individual. Individual differences can vary as a function of age, sleep requirement, experience, overall health and other factors. Individuals can also vary in their participation in activities that engender fatigue while on duty. In this regard, commuting across long distances immediately prior to starting a duty period is of concern.

1.7 Differences and Variability Preclude an Absolute Solution

It must be acknowledged that the aviation industry represents a diverse range of required work demands and operational environments. Sections 1.5 and 1.6 highlight the diverse situations and individuals that are encompassed by generalized guidelines. This further illustrates that guidelines cannot completely cover all personnel or operational conditions and that there is no single absolute solution to these issues.

2.0 Specific Principles, Guidelines and Recommendations

The following are specific principles, guidelines and recommendations to address the 24-hour duty and rest scheduling requirements of the corporate and business aviation industry. These principles and guidelines, based on the general principles introduced in Section 1.0, are intended to provide a consistent margin of safety across corporate and business aviation operations. Therefore, they are intended for application to minimum flight crew complements of two or more.

To provide specific guidelines, it is necessary to define the terms used in these guidelines. Altering these definitions may invalidate the principles that follow.

2.1 Off-duty Period

2.1.1 Definition of "off duty"

A continuous, predefined period of uninterrupted time during which a crewmember is free of all duties.

2.1.2 Off-duty period (acute sleep and awake-time-off requirements)

The off-duty period should allow for three components. The first critical component of the off-duty period is an eight-hour sleep opportunity. The general principles clearly describe that an acute sleep deficit and a cumulative sleep debt can degrade performance and alertness. Also, it should be recognized that an appropriate "spin down" time may be required to fall asleep. The second component is awake time off, an opportunity to break from the continuous performance of required tasks. The third component is the other activities necessary during an off-duty period. These other necessary activities can include transportation to and from layover accommodations, hotel check in/out, meals, shower and personal hygiene. Therefore, the off-duty period should be a minimum of 10 hours uninterrupted within any 24-hour period, to include an eight-hour sleep opportunity, awake time off and time for other necessary activities. (For extended flight-duty period, see Section 2.3.5.)

2.1.3 Off-duty period (recovery requirement)

The General Principles outline the importance of recovery to minimize the cumulative effects of sleep loss and fatigue. Two consecutive nights of usual sleep is a minimum requirement to stabilize sleep patterns and return waking performance and alertness to usual levels. Two consecutive nights of recovery sleep can provide recovery from sleep loss. Therefore, the standard off-duty period for recovery should be a minimum of 36 continuous hours, to include two consecutive nights of recovery sleep, within a seven-day period.

2.1.4 Off-duty period (following standard flight-duty periods during window of circadian low*)

Extensive scientific research, including aviation data, demonstrates that maintaining wakefulness during the window of circadian low is associated with higher levels of performance-impairing fatigue than during daytime wakefulness. Flight-duty periods that occur during the window of circadian low will have a higher potential for reduced performance and alertness than those that occur during daytime. Therefore, if three or more flight-duty periods within a seven-day period encroach on all or any portion of the window of circadian low, then it is recommended to ensure recovery that the standard off-duty period (36 continuous hours within seven days) be extended to 48 hours.

2.1.5 Off-duty period (following multiple time-zone change)

In general, the longer a flight crew member is away from the home-base/domicile time zone, the more recovery time is needed for readjustment back to home-base/domicile time. Therefore, it is recommended that for flight-duty periods that cross four or more time zones, and that involve 48 hours or more in another time zone away from the home-base/domicile time zone, a minimum of 48 hours off duty be allowed upon return to home-base/domicile time.

2.2 Duty Periods

2.2.1 Definition of "duty"

Any task a crew member is required by the operator to perform, including flight time, administrative work, managerial duties, training and deadheading.

2.2.2 Definition of "duty period"

A continuous period of time during which tasks are performed for the operator; determined from report time until free from all required tasks.

2.2.3 Duty period

To reduce vulnerability to performance-impairing fatigue from extended hours of continuous wakefulness and prolonged periods of continuous performance requirements, cumulative duty per 24 hours should be limited. It is recommended that this limit not exceed 14 hours within a 24-hour period. (For additional flight crew, see Section 2.3.6.)

* For definition of "window of circadian low," see Section 2.3.2.

2.3 Flight-duty Periods

2.3.1 Definition of "flight-duty period"

The sum of all flight time, calculated from block to block for each flight segment.

2.3.2 Definition of "window of circadian low"

The window of circadian low is best estimated by the hours between 0200 and 0600 for individuals adapted to a usual day-wake/night-sleep schedule. This estimate of the window is calculated from scientific data on the circadian low of performance, alertness, subjective report (i.e., peak fatigue) and body temperature. For flight-duty periods that cross three or fewer time zones, the window of circadian low is estimated to be 0200 to 0600 home-base/domicile time. For flight duty periods that cross four or more time zones, the window of circadian low is estimated to be 0200 to 0600 home-base/domicile time for the first 48 hours only. After a crewmember remains more than 48 hours away from home base/domicile, the window of circadian low is estimated to be 0200 to 0600 local time at the point of departure.

2.3.3 Standard flight-duty period

To reduce vulnerability to performance-impairing fatigue from extended hours of continuous wakefulness and prolonged periods of continuous performance requirements, cumulative flight duty per 24 hours should be limited. It is recommended that for standard operations, this cumulative flight-duty period not exceed 10 hours within a 24-hour period. Standard operations include multiple flight segments and day or night flying.

2.3.4 Extended flight-duty period: nonaugmented flight crew

An extended cumulative flight-duty period would be limited to 12 hours within a 24-hour period, to be accompanied by additional restrictions and compensatory off-duty periods. This limit is based on scientific findings from a variety of sources, including data from aviation, that demonstrate a significantly increased vulnerability for performance-impairing fatigue after 12 hours. It is readily acknowledged that in current practice, flight-duty periods extend to 14 hours in regular operations. Nevertheless, the available scientific data support a guideline different from current operational practice. The data indicate that performance-impairing fatigue does increase beyond the 12-hour limit and could reduce the safety margin.

2.3.4.1 Restrictions and compensatory off-duty periods

If the cumulative flight-duty period is extended to 12 hours, then the following restrictions and compensatory off-duty periods should be applied.

Work demand: restricted number of landings. Accident data and performance- and physiology-based fatigue research demonstrate that vulnerability and risk increase during critical phases of operation, with the highest level during descent and landing. Each additional landing can increase work demand, further degrade performance and represent a period of increased vulnerability. Therefore, if an extended flight-duty period contains a single continuous block-to-block flight period greater than 10 hours, then it is recommended that flight crew members be restricted to no additional landings following the flight.

Cumulative effects: maximum cumulative hours of extension. Over time, extended flight-duty periods can result in cumulative effects of fatigue. To support operational flexibility and still minimize the potential for cumulative effects, it is recommended that flight-duty periods can be extended by a cumulative total of four hours within a seven-day period. For example, there could be two two-hour extensions of the standard 10-hour flight-duty period (two hours x 2 = four hours) in a seven-day period. These extensions should not be scheduled on consecutive days.

Recovery: compensatory off-duty period. To promote recovery from the acute fatigue associated with an extended flight-duty period, additional off-duty time is recommended. The subsequent 10-hour off-duty period should be extended to 12 hours.

2.3.5 Extended flight-duty period: augmented flight crew

Augmented flight crew afford the opportunity for each flight crew member to reduce the time at the controls and provide for sleep during a flight duty period. Consequently, with additional flight crew and an opportunity for sleep, it would be expected that fatigue would accumulate more slowly. In such circumstances, flight-duty periods can be increased beyond the recommended limit of 10 hours within each 24-hour period. When an additional flight crewmember rotates into the flight-deck positions, the flight-duty period can be extended, with the specified restrictions. In each circumstance, it is required that each flight crew member be provided one or more on-duty sleep opportunities.

Each of the following extensions requires: a) a maximum sleep opportunity, with a minimum of four hours total per duty period; b) a maximum of two consecutive extended flight-duty periods can be scheduled; and c) a minimum of 18 hours off duty following two consecutive extended flight-duty periods. Controlled rest on the flight deck is not a substitute for the sleep opportunities or facilities required for additional flight crew members.

2.3.5.1 Four-hour extension (14-hour flight-duty period)

Requires a reclining seat for sleep that is separated and screened from the flight deck and passengers.

2.3.5.2 Six-hour extension (16-hour flight-duty period)

Requires adequate sleep facility (supine position) that is separated and screened from the flight deck and passengers.

2.3.6 Flight-duty period (cumulative)

A 24-hour cumulative flight-duty period limit, a minimum off-duty period per 24 hours and a specified off-duty recovery period per seven days focus specifically on short-term vulnerabilities and considerations. To minimize fatigue that is not compensated by short-term recovery and to reduce excessive accumulation across longer periods of time, cumulative flight-duty period limitations are recommended. There is not sufficient scientific data to provide specific guidance in this area, however, the General Principles apply. For example, when determining cumulative flight-duty limitations, shorter time frames should be considered. Therefore, in addition to 30-day and yearly cumulative flight-duty period limitations, a two-week limit should also be set. Also, these cumulative flight-duty period limitations should be adjusted downward across the longer time period. Rather than just multiplying the two-week cumulative flight-duty period limitation to calculate the 30-day and yearly amounts, the 30-day amount should be decreased a percentage from the two-week amount. The yearly cumulative flight-duty period limitation should be decreased a percentage from the 30-day amount. This will further reduce the potential for long-term accumulation of fatigue factors.

2.4 Standby

Flight crew members on standby provide a critical element to operational flexibility and the opportunity to meet unanticipated needs. It is important that flight crew members on standby obtain required sleep prior to a flight-duty period.

2.4.1 Definition of "standby"

A standby flight crew member required to be available to an operator (away from the airport) for assignment to a flight-duty period.

2.4.2 Standby status

Standby status should not be considered duty. Nevertheless, it is important that the flight crew member have an opportunity to obtain sleep prior to an assigned flight-duty period. Two specific principles should be applied. The flight crew member should be provided a: 1) predictable and 2) protected eight-hour sleep opportunity. "Predictable" indicates that the flight crew member should have prior information (24 hours notice is recommended) as to when the eight-hour sleep opportunity can be obtained within the 24-hour standby time. The eight-hour sleep opportunity should not vary by more than three hours on subsequent days to ensure circadian stability. "Protected" means there should be no interruption by assignment to a flight-duty period. Any approach that satisfies these two principles may be utilized.

2.5 Summary Overview: Guidelines and Recommendations

Table 1 (page 7) provides a summary overview of the guidelines and recommendations discussed in this document.

3.0 Education and Training

3.1 Principles

An important first step for the corporate and business aviation industry is to become informed about the extensive scientific knowledge now available regarding fatigue, sleep and circadian physiology as it relates to performance and aviation operations. Training shall reflect current scientific information derived from the study of fatigue, sleep loss and circadian disruption. Training shall provide information about the physiological mechanisms that underlie fatigue. Training shall demonstrate how this information may be applied to improve flight crew sleep, alertness and performance. Training shall recommend strategies for alertness management during flight operations.

3.2 NASA-Ames Education and Training Module on Fatigue

Education and training programs on fatigue countermeasures have been implemented successfully within the aviation industry. The NASA-Ames Education and Training Module, "Alertness Management in Flight Operations," will serve as the recognized standard for corporate and business aviation education and training activities. (Information regarding this module is available by writing the NASA-Ames Fatigue Countermeasures Program at the address provided in the Preface.) Although this module provides the basis for education and training activities, further materials may be developed to highlight the implementation of these principles and guidelines and other specific corporate and business aviation issues.

3.3 Dissemination of Information by Training Organizations

Where possible, information on fatigue should be integrated into existing training programs, such as Pilot Enrichment, Advanced Airmanship, Crew Resource Management, manufacturers' programs and others. The format for these courses should be tailored to the specific needs of the corporate operator, aviation organization and training programs. This information will be directed to all individuals in the corporate and business aviation industry, including pilots, managers, flight attendants, schedulers and maintenance technicians.

Table 1
Flight Safety Foundation Fatigue Countermeasures Task Force Summary Overview of Guidelines and Recommendations for the Corporate/Business Aviation Industry

	Off Duty			Duty		Flight Duty		
	Per 24-hour Period	**Per Week**	**Other**	**Per 24-hour Period**	**Weekly, Monthly, Annually**	**Per 24-hour Period**	**Per Week**	**Monthly, Annually**
Standard	10 hours	1) At least 36 continuous hours, including 2 consecutive recovery nights, in a 7-day period. 2) 48 continuous hours in 7-day period (following multiple flight-duty periods in circadian low).	48 continuous hours upon return home following flight-duty period across multiple time zones.	14 hours	There is not sufficient scientific data to provide specific guidance in this area.	10 hours		There is not sufficient scientific data to provide specific guidance in this area; however, cumulative flight-duty period limitations should be adjusted downward over increasing time frames.
Extended	12 hours (following extended flight-duty period).					10–12 hours (requires restricted landings, maximum cumulative hours, compensatory off-duty time).	Maximum of 4 cumulative hours of extension.	
Augmented (3 pilots)	Reclining seat: 12 hours Supine bunk: 12 hours			18 hours 20 hours		14 hours 16 hours	Restrictions— *Reclining seat:* Each flight crew gets maximum sleep opportunity with minimum 4 hours total; Maximum 2 consecutive duty periods with 18 hours off duty. *Supine bunk:* Each flight crew gets maximum sleep opportunity with minimum 4 hours total; maximum 2 consecutive duty periods with 18 hours off duty.	

Source: Flight Safety Foundation and U.S. National Aeronautics and Space Administration

3.4 Other Educational Forums

Other forums, such as professional publications, seminars, conferences and manufacturers' and operators' meetings, should be used to disseminate information on fatigue. These forums may be useful in establishing an ongoing interactive dialogue with operators on fatigue issues.

3.5 Quality Assurance

Current scientific literature and research, not opinion, personal experience or casual recommendations, shall drive these programs. Support literature shall be referenced or made available for additional reading. Instructors shall be well-read on fatigue-related topics and aware of the current literature and scientific findings. During training, ample time shall be made available for questions and answers.

3.6 Practical Application

Information gained from these education and training programs should be applied daily to corporate and business aviation activities and used to develop strategies that promote individual and organizational performance and alertness in flight operations.

4.0 Other Industry Strategies

4.1 Operational Countermeasures

A variety of other strategies for use during flight operations should be examined and utilized where appropriate. This includes the design and use of technology to promote performance and alertness during operations. Varying work demands or other creative uses of flight deck automation could be developed to maintain alertness and performance. Several activities in this area are under way, with some successful applications currently in use. The following are examples of strategies that may be useful to address fatigue in corporate and business aviation operations. These are provided here not as guidelines but as examples of the range of options available to manage fatigue in operations.

4.1.1 Break during duty day

For two-pilot crews, when the duty day includes a period of six hours or greater on standby at an en route stop, pilots should obtain maximum rest/sleep opportunity at a local hotel. In such cases, every two hours of hotel rest might be used to extend the duty day by one hour (e.g., four hours rest affords two hours duty-day extension).

4.1.2 Predeparture quarantine

For crews anticipating maximum-length duty days, predeparture quarantine at a local hotel near the departure airport will assist in ensuring that the duty day is initiated with either no or a minimum of accumulated sleep debt. In some cases, preparation of the aircraft by a backup crew may afford additional mission flexibility.

4.1.3 Preflight planning

For augmented crews, specific preflight planning of the in-flight duty-rest cycle is important. Priority should be given to the landing crew members, and cabin service personnel needs should be integrated into the plan.

4.1.4 Prepositioning crews

Where operational needs exceed recommended guidelines, relief crews could be prepositioned at appropriate locations along the route. Prepositioning should be planned so as to allow for travel contingencies and provide opportunities for circadian adaptation and recommended rest prior to commencing duty.

4.2 Scheduling Practices

The scientific information available can be particularly useful in guiding rational and physiologically based scheduling practices. Scheduling is a complex and multi-determined process. Nevertheless, it is possible and essential to include scientific data on human physiology as a factor for consideration. Obviously, priorities need to be established and cost/benefit considerations are critical. There are examples of successful integration of scientific information on fatigue into schedule construction.

4.3 Controlled Rest on the Flight Deck

Scientific data obtained during flight operations have clearly demonstrated the effectiveness of a planned cockpit rest period to promote performance and alertness in nonaugmented long-haul flight operations. Controlled rest is a single operational strategy and is not an answer to all fatigue engendered by flight operations. Controlled rest is absolutely not intended as a substitute for additional flight crew or appropriate rest facilities, or as support for extended duty. All possible strategies that maintain or improve the safety margin should be considered.

4.4 Other Physiological Stressors Associated with Flight

Besides fatigue, a variety of other physiological stressors are known to affect human performance in flight operations. These other physiological factors include hypoxia, barometric pressure changes, dehydration, vibration, noise, humidity, temperature changes and third spacing (associated with blood pooling in lower extremities). Managing these other physiological stressors is important to minimize their contribution to, or exacerbation of, fatigue.

4.5 Future Developments

A number of other approaches to manage fatigue in flight operations are in different stages of development. Provocative laboratory studies of several countermeasures are often cited. Nevertheless, validation of their effectiveness and safety in operational settings is still needed prior to widespread implementation. Research continues and may provide further findings on countermeasures relevant to scheduling, personal strategies and technology approaches to manage alertness in aviation operations.

In the process of developing this document, it became clear that a range of issues require further investigation. Focused research is needed to more clearly define sleep in reclining aircraft seats vs. onboard supine rest facilities; the relationship of minimum blocks of sleep totaling a certain amount and subsequent performance and alertness; the relationship between flight-duty period time and duty time; the effectiveness of operational strategies currently used to be applied more broadly as guidelines; and more.

As the corporate and business aviation industry effectively implements education and training programs, information and strategies for managing fatigue will become widespread. Once this core of knowledge and application is established, more specific materials and strategies may be developed to support future corporate and business activities.

Finally, it is clear that the document's principles and guidelines reflect the current operational demands of corporate and business aviation and the available scientific information. These principles and guidelines are intended to evolve as the demands of the industry change and as further scientific findings become available.♦

Comments

This document is in draft form to elicit comments prior to finalizing the document before its widespread distribution to the corporate and business aviation industry. To contribute your comments for consideration in the final version, please provide your input as follows:

1) Specific recommendations regarding word changes, sentence structure, etc. can be written directly on the document and returned.

2) More general content, larger text changes or other comments should be provided on the "Comments" form on page 11.

For your suggestions to be constructive, it is important that your comments be accompanied by a specific recommendation (e.g., word change, sentence addition or change, new section) on how to address the issue that you identify.

Please send these comments by Nov. 15, 1995, to:

Robert H. Vandel
Director of Technical Projects
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Comments

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Area of concern ______________________________

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Proposed modification ______________________________

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Rationale/justification ______________________________

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General comments ______________________________

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